

Lesson Exemplars for Physics 1

ACADEMIC ELECTIVE

Government Property
NOT FOR SALE

Lesson Exemplar for Physics 1

This material is intended exclusively for the use of senior high school teachers participating in the implementation of the **Strengthened Senior High School Curriculum**. It aims to assist in delivering the curriculum content, standards, and lesson competencies. Any unauthorized reproduction, distribution, modification, or utilization of this material beyond the designated scope is strictly prohibited and may result in appropriate legal actions and disciplinary measures.

Borrowed content included in this material is owned by their respective copyright holders. Every effort has been made to locate and obtain permission to use these materials from their respective copyright owners. The publisher and development team do not represent nor claim ownership over them.

Development Team

Writers: Geraldine E. Padilla, John-John Q. Garcia, Cesar F. Navales, Jr., Techie G. Vera Cruz, Crisanto D. Teano, John Paul G. De Juan, Mary Ann D. Lavilles, Jossel A. Niñalga, Michelle Ann P. Saribong, Kenneth C. Hermosisima

Validators: Jayson O. Abareta, Shirley L. Bulahan, Joseph M. Manlunas, Ana Jamille A. Restubog, Virginia C. Alindayo, Siegfred F. Tagupa, Portia B. Ngollob

Consultant: **Cerilina M. Maramag**
University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED)

Learning Area Specialist: **Danilo G. Soriano Jr.**
Supervising EPS, Teaching and Learning Division

Bureau of Learning Delivery
Bureau of Curriculum Development
Bureau of Learning Resources

Every care has been taken to ensure the accuracy of the information provided in this material. For queries or clarifications, you may contact the Bureau of Learning Resources – Office of the Director at blr.od@deped.gov.ph or via telephone at (02) 8634-1072. If you have feedback on the LE, please accomplish this form, which may be accessed through the following link: <https://bit.ly/sshsfeedbackform>.

Table of Contents

Lesson Exemplar 1	1
Lesson Exemplar 2	16
Lesson Exemplar 3	40
Lesson Exemplar 4	61
Lesson Exemplar 5	86
Lesson Exemplar 6	107
Lesson Exemplar 7	117
Lesson Exemplar 8	137
Lesson Exemplar 9	152
Lesson Exemplar 10	166
Lesson Exemplar 11	178
Lesson Exemplar 12	196
Lesson Exemplar 13	215
Lesson Exemplar 14	233
Lesson Exemplar 15	250
Lesson Exemplar 16	271
Lesson Exemplar 17	291
Lesson Exemplar 18	318
Lesson Exemplar 19	340
Lesson Exemplar 20	360
Lesson Exemplar 21	382

Learning Area	PHYSICS 1	Lesson Exemplar	1
---------------	-----------	-----------------	---

I. OBJECTIVES	
A. Content Standard	<i>Learners learned that... Physics is fundamental to understanding the natural world in a scientific way and leads to the development of many applications that benefit society.</i>
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Use secondary sources to evaluate the impact of physics in society and identify the range of careers that are available through the study of physics;</i>
II. REFERENCES and MATERIALS <i>(Selecting Resources and Material)</i>	<p>Department of Education. <i>Strengthened Senior High School Curriculum Guide in Physics 1</i>. Pasig City, Philippines: Department of Education, n.d.</p> <p>Department of Education Learning Resources Management and Development System (LRMDS). "Self-Learning Module – Physical Science Grade 11 and 12." Accessed May 20, 2026. DepEd LRMDS – SHS Physical Science Modules</p> <p>OpenStax. <i>College Physics for AP Courses</i>. Houston, TX: OpenStax, Rice University. Accessed May 20, 2026. https://openstax.org/details/books/college-physics-ap-courses.</p> <p>Khan Academy. "Physics." Accessed May 20, 2026. https://www.khanacademy.org/science/physics.</p> <p>National Aeronautics and Space Administration (NASA). "NASA Science." Accessed May 20, 2026. https://science.nasa.gov/.</p> <p>The Physics Classroom. "Physics Classroom." Accessed May 20, 2026. https://www.physicsclassroom.com/.</p> <p>Encyclopedia Britannica. "Physics." Accessed May 20, 2026. https://www.britannica.com/science/physics-science.</p> <p>TED. "Physics and Science Innovations." Accessed May 20, 2026. https://www.ted.com/topics/physics.</p> <p>Related Videos</p> <p><i>The Role of Physics in Everyday Life: Shocking Truths</i> – YouTube https://www.youtube.com/watch?v=XHouBblz6I</p> <p><i>ALL OF PHYSICS Explained in 14 Minutes</i> – YouTube https://www.youtube.com/watch?v=ZAqIoDhornk</p>

	<p><i>Physics in Motion Playlist – YouTube</i> https://www.youtube.com/playlist?list=PLMniSm5GhmXbVN0XdDUYDJ92TMJAJ41E-Applications of Physics in Real Life – YouTube https://www.youtube.com/watch?v=UVjtYLkyTic</p>	
III. CONTENT (Sequencing Content)	Introduction to Physics	
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	<p>At the end of this lesson, the learners should be able to:</p> <ol style="list-style-type: none"> 1. gather relevant information from at least two secondary sources about the importance of physics in the society; 2. describe at least three careers related to physics, including their roles and relevance to societal needs; and 3. evaluate the use of physics in a particular field (health, technology, or environment) and provide examples demonstrating some of its advantages and disadvantages. 	
IV. PROCEDURES (Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)		ANNOTATIONS *Instruction to the teacher on how to facilitate the activities.
<ul style="list-style-type: none"> • Activating Prior Knowledge 	<p>1. Activating Prior Knowledge</p> <p>Option 1: Physics Around Us</p> <ul style="list-style-type: none"> • The teacher will present pictures showing bridges, cellphones, X-ray machines, satellites, roller coasters, and electric fans. • Learners will work in groups and infer how physics is involved in each object. • Groups will write their ideas on meta cards and post them on the board. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What common ideas connect to all these objects? 2. What is Physics? 2. What would happen if physics knowledge did not exist? 3. Which object do you think uses physics the most? Why? 4. How does physics help improve people's lives? <p>Option 2: Technology I Use</p>	<p>NOTE FOR TEACHERS</p> <p>Learners may identify gadgets, transportation systems, medical equipment, communication devices, and community technologies as examples of physics applications. Encourage learners to connect prior experiences and observations to the lesson.</p> <p>FACILITATION TIPS</p> <ul style="list-style-type: none"> • Encourage participation and open sharing of ideas. • Accept varied responses during brainstorming.

	<ul style="list-style-type: none"> Learners identify technologies they frequently use and discuss how these technologies shape communication, health, transportation, or entertainment. <p>Guide Questions</p> <ol style="list-style-type: none"> How have physics-based technologies transformed society? What societal problems can science and technology help solve? What are the advantages and disadvantages of technology in society that show the applications of the study of physics? <p>Option 3: Community Connection</p> <ul style="list-style-type: none"> Learners identify community problems involving transportation, electricity, communication, disaster preparedness, or environmental concerns. Groups discuss how physics-based technologies may help address these issues. <p>Guide Questions</p> <ol style="list-style-type: none"> What problems in the community may be addressed through physics? How can physics contribute to public safety and convenience? What evidence supports the importance of physics in modern society? Why are physics professionals important in solving societal issues? <p>2. Establishing the Purpose of the Lesson</p> <p>Option 1: Physics in Everyday Life: Evidence Hunt</p> <ul style="list-style-type: none"> Learners watch a short video about the role of physics in medicine, transportation, communication, and space exploration. Suggested video: https://www.youtube.com/watch?v=XHouBblIz6I Learners identify at least five examples of physics applications. 	<ul style="list-style-type: none"> Ask follow-up questions to deepen learners' thinking. Connect examples to learners' daily experiences and community situations. Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs. <p>IDF RELEVANCE</p> <p><i>The activities activate prior knowledge by connecting learners' experiences, observations, and existing understanding to the societal importance of physics. Inquiry and collaboration prepare learners for evidence-based learning.</i></p> <p>MATERIALS</p> <ul style="list-style-type: none"> Pictures or printed visuals Meta cards/ sticky notes Markers and Manila paper Laptop/ projector/ TV (optional) Worksheets or guide questions <p>NOTE FOR TEACHERS</p> <p><i>Learners may recognize how physics contributes to healthcare, communication,</i></p>
--	---	---

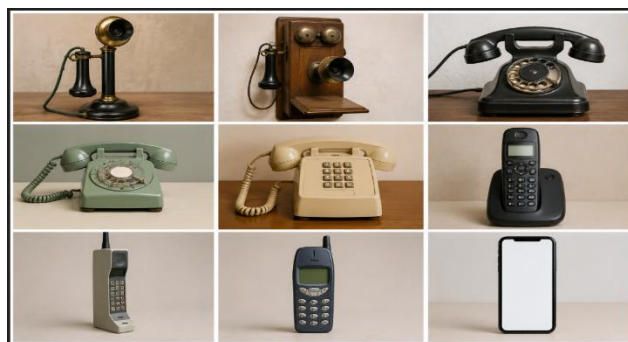
- They classify examples according to the societal field.

Guide Questions:

1. Which applications of physics surprised you the most? Why did it surprise you?
2. How does physics improve healthcare and technology?
3. Which career in the video interests you the most? Why?
4. What social problems can physics solve? How?

Option 2: “Physics Then and Now” Timeline Inquiry

- The teacher presents pictures, videos, or short descriptions of inventions influenced by physics such as the telephone, airplanes, MRI machines, satellites, smartphones, solar panels, and electric vehicles.



Suggested videos:

<https://www.youtube.com/watch?v=l9y8kjVQL3k>

<https://www.youtube.com/watch?v=Sgy-r2txGgI>

- Learners work in groups and arrange the inventions chronologically.
- Groups discuss how physics contributed to the development of these technologies and how these innovations changed society.

transportation, environmental protection, and technological innovation. Some learners may also identify future careers related to physics.

FACILITATION TIPS

- *Emphasize the relevance of physics in real-life situations.*
- *Encourage learners to explain why studying physics is important.*
- *Connect discussions on societal issues and future opportunities.*
- *Use motivating examples familiar to learners.*
- *Provide opportunities for learners to choose from the suggested way of presenting their output*
- *The teacher may opt to make a rubric which may be applicable to the learners' chosen way of presenting.*
- *Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs.*

	<p>Guide Questions</p> <ol style="list-style-type: none"> 1. How has physics contributed to technological advancement over time? 2. Which invention do you think had the greatest impact on society? Why? 3. How do physics-based technologies improve people’s lives today? 4. Why is it important to continue studying physics and innovation? <p>Option 3: “Why Does This Matter?” Collaborative Discussion Procedure</p> <ul style="list-style-type: none"> • Each group prepares a short evidence-based explanation answering: “Why is learning physics important today?” • Groups discuss why the issue is relevant to learners, communities, and society. • Learners connect the issue to: <ol style="list-style-type: none"> a. daily life, b. future careers, c. scientific literacy, d. responsible citizenship, e. and national/global development. • Learners may present through: <ol style="list-style-type: none"> a. oral reports, b. panel discussions, c. posters, d. digital presentations, e. or reflective summaries. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. How can physics contribute to improving quality of life? 2. How does scientific literacy help people make informed decisions? 3. Why should learners understand the role of physics in society? 4. How can science and technology be used responsibly and ethically? 	<p>IDF RELEVANCE</p> <p><i>The activities establish lesson purposes by helping learners understand the relevance of physics in society, technological advancement, and career opportunities. Learners become motivated through authentic and meaningful contexts.</i></p> <p>MATERIALS</p> <ul style="list-style-type: none"> • Videos or video clips • News articles or infographics • Pictures of inventions and technologies • Laptop/projector/TV • Worksheets and graphic organizers
--	--	--

<ul style="list-style-type: none"> Instituting New Knowledge 	<p>1. Presenting Examples</p> <p>Option 1: Physics in Society Gallery Walk</p> <ul style="list-style-type: none"> The teacher prepares stations containing articles, posters, infographics, and case studies about physics applications in medicine, transportation, communication, environmental science, sports, and energy. Groups rotate through stations and complete an Evidence Matrix. <table border="1"> <thead> <tr> <th>Sector/Field</th><th>Physics Application</th><th>Societal Contribution</th></tr> </thead> <tbody> <tr> <td> </td><td> </td><td> </td></tr> <tr> <td> </td><td> </td><td> </td></tr> </tbody> </table> <p>Guide Questions</p> <ol style="list-style-type: none"> How is physics applied in each sector/field? Which application has the greatest societal impact? Why? What risks or ethical concerns may arise from these technologies? <p>Option 2: Compare and Contrast</p> <ul style="list-style-type: none"> Learners compare two sectors and identify similarities and differences in the application of physics. <p>Example:</p> <ul style="list-style-type: none"> medicine and transportation communication and environmental science sports and energy transportation and communication Learners organize their findings using a Compare and Contrast Matrix or Venn Diagram. Groups present their findings. 	Sector/Field	Physics Application	Societal Contribution							<p>NOTE TO TEACHERS</p> <p><i>Learners may identify medicine, communication, transportation, sports, and environmental science as fields influenced by physics. Some learners may need guidance in evaluating evidence and source of credibility.</i></p> <p>FACILITATION TIPS</p> <ul style="list-style-type: none"> Encourage evidence-based discussion and inquiry. Ask learners to support ideas using information from sources. Highlight the importance of reliable and credible references. Use real-life and community-based examples whenever possible. Teachers may use the following sources for the gallery walk: <ul style="list-style-type: none"> ✓ https://science.nasa.gov/ ✓ https://www.khanacademy.org/science/physics ✓ https://www.physicsclassroom.com the presentations can be limited to 3-5 mins
Sector/Field	Physics Application	Societal Contribution									

	<p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Which sectors depend most on physics? 2. How are the applications similar? 3. Which field benefits society more? 4. How does physics make these systems efficient? <p>Option 3: Transportation Innovation</p> <ul style="list-style-type: none"> • Learners investigate modern transportation technologies such as electric vehicles, airplanes, and bullet trains. • Groups explain how physics concepts improve transportation. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. How does physics improve speed and safety? 2. Which transportation technology is most beneficial? 3. What environmental issues are connected to transportation? 4. What careers help develop transportation systems? <p>2. Discussing New Concept</p> <p>Option 1: Evidence-Based Reading Circles</p> <ul style="list-style-type: none"> • Learners are grouped and assigned different reading materials. • Each group extracts evidence showing how physics affects society. • Learners summarize key ideas through collaborative discussion. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What evidence shows that physics benefits society? 2. Which field benefits the most from physics? 	<ul style="list-style-type: none"> • <i>For the reading materials, visit the suggested links below:</i> <p>Suggested sources:</p> <ul style="list-style-type: none"> ○ NASA Space Communications and Navigation https://www.nasa.gov/directorates/heo/scan/ ○ NASA Science – Medical Technologies and Space Research https://science.nasa.gov/ ○ NASA Aeronautics Research https://www.nasa.gov/aeronautics/ ○ National Geographic Education – Transportation Technology https://education.nationalgeographic.org/ ○ TED Talks – Transportation and Innovation https://www.ted.com/topics/technology ○ Physics Classroom – Motion in One Dimension https://www.physicsclassroom.com/class/1DKin • <i>Teacher may use other offline resources available</i>
--	---	---

	<p>3. Are there disadvantages in some technologies?</p> <p>4. How can society use physics responsibly?</p> <p>Option 2: Physics Evidence Hunt Challenge</p> <ul style="list-style-type: none"> The teacher will prepare different secondary sources such as articles, infographics, brochures, journals, news clippings, and online excerpts about the applications of physics in medicine, transportation, communication, sports, energy, and environmental science. Learners will be grouped into teams and rotate through evidence stations every 3–5 minutes. Each group will gather relevant information from at least two secondary sources and record their findings using an Evidence Matrix. Learners will identify: <ul style="list-style-type: none"> the title/source of information, the physics application being discussed and its contribution to society. <p>Guide Questions:</p> <ol style="list-style-type: none"> What applications of physics were mentioned in the sources? How does physics improve people’s daily lives? Which source provided the most useful information? Why? Why is it important to gather information from multiple sources? <p>Option 3: Community Problem Investigation</p> <ol style="list-style-type: none"> Groups identify a community issue involving energy, communication, transportation, or disaster preparedness. Learners propose physics-based solutions. <p>Guide Questions:</p> <ol style="list-style-type: none"> What problem exists in the community? How can physics help solve the issue? 	<ul style="list-style-type: none"> <i>Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners’ needs.</i> <p>IDF RELEVANCE</p> <p><i>The activities develop conceptual understanding through inquiry, collaboration, evidence gathering, and analysis of authentic applications of physics in society.</i></p> <p>MATERIALS</p> <ul style="list-style-type: none"> <i>Printed articles and infographics</i> <i>Reference materials and journals</i> <i>Evidence matrices and worksheets</i> <i>Manila paper and markers</i> <i>Laptop/projector/TV</i> <i>Internet access (if available)</i>
--	---	--

3. What technologies can be applied?
4. How will the solution benefit society?

Sample Rubric:

Criteria	4 – Excellent	3 – Proficient	2 – Developing	1 – Beginning
Identification of Community Issue	Clearly identifies a realistic and relevant community issue with complete explanation	Identifies a relevant community issue with adequate explanation	Identifies a community issue but explanation is unclear or incomplete	Community issue is unclear or not relevant
Application of Physics Concepts	Physics concepts are accurately and clearly applied to the proposed solution	Physics concepts are mostly accurate and related to the solution	Some physics concepts are present but with inaccuracies	Physics concepts are missing or inaccurate
Proposed Solution	Solution is realistic, creative, and strongly addresses the problem	Solution addresses the problem adequately	Solution is somewhat related to the problem	Solution is unclear or unrealistic
Use of Evidence and Reasoning	Ideas are supported with strong evidence and logical reasoning	Ideas are supported with some evidence and reasoning	Limited evidence or reasoning provided	No evidence or reasoning evident
Collaboration and Participation	All members actively participated and contributed equally	Most members participated actively	Unequal participation among members	Minimal participation from group members
Presentation and Communication	Presentation is clear, organized, confident, and engaging	Presentation is mostly clear and organized	Presentation lacks clarity or organization	Presentation is difficult to understand

3. Developing Mastery

Option 1: Help or Harm?

- Learners will work in groups and investigate selected physics applications such as nuclear energy, artificial intelligence, transportation systems, renewable energy, or mobile communication.
- Using at least two secondary sources, groups will identify: benefits, limitations, societal impact, and possible solutions to minimize risks.
- Learners will organize their findings using the investigation table below.

Physics Application	Benefits to Society	Risks/Limitations	Possible Solutions	Sources Used

NOTE FOR TEACHERS

- *Encourage learners to justify ideas using evidence from at least two secondary sources.*
- *Ask higher-order thinking questions that require analysis, evaluation, and reasoning.*
- *Promote respectful collaboration and inquiry-based discussion during group work.*
- *Monitor group participation to ensure equitable contribution among members.*
- *Reinforce the importance of scientific literacy, evidence evaluation, and responsible use of technology.*
- *Connect discussions to real-life situations and future career opportunities related to physics.*
- *Provide appropriate scaffolds, guide questions, and varied output options to address learners' diverse strengths, interests, and readiness levels.*
- *Encourage learners to express understanding through multiple formats such as oral presentation, visual outputs, written explanations, role-play, or digital presentations.*

	<ul style="list-style-type: none"> Groups will present a short evidence-based explanation to the class. <p>Guide Questions</p> <ol style="list-style-type: none"> What evidence supports the benefits of this application? What risks or limitations may arise? How can society responsibly use this technology? Which source provided the strongest evidence? Why? Groups present evidence-based conclusions. <p>Option 2: Medical Physics Investigation</p> <ul style="list-style-type: none"> Learners analyze articles about MRI, X-ray, ultrasound, and radiation therapy. Groups identify the role of physics principles in healthcare. <p>Guide Questions:</p> <ol style="list-style-type: none"> How does physics help doctors diagnose diseases? What are the benefits of medical technology? What risks or limitations may occur? What careers are involved in medical physics? 	<p>IDF RELEVANCE</p> <ul style="list-style-type: none"> <i>Developing mastery strengthens learners' understanding through guided and independent practice activities that promote inquiry, collaboration, evidence gathering, analysis, and decision-making. The activities allow learners to apply concepts learned about the importance of physics in society and physics-related careers using authentic and evidence-based tasks.</i> <p>Materials Needed</p> <ul style="list-style-type: none"> Printed articles, journals, and infographics Career brochures and flashcards Investigation tables and matrices Manila paper/cartolina Markers, pens, and sticky notes Laptop/projector/TV (optional) Internet access (if available) Rubrics and worksheets
f. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Option 1: Career Expert Investigation Activity</p> <ul style="list-style-type: none"> Each group becomes “experts” on one career such as physicist, engineer, astronomer, architect, radiologic technologist, or meteorologist. Learners gather information from articles, books, or websites. 	<p>NOTE TO TEACHERS</p> <p><i>Learners may recognize both the benefits and limitations of physics applications in society. Some learners may focus only on positive effects and may need guidance in evaluating risks and ethical concerns.</i></p>

	<ul style="list-style-type: none"> • Groups prepare mini presentations. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What are the main tasks of the profession? 2. What physics concepts are commonly applied? 3. How does this career help society? 4. What educational preparation is needed? <p>Option 2: Career Decision Matrix</p> <ul style="list-style-type: none"> • Learners complete a matrix comparing salary, societal impact, risks, educational requirements, and interests. • Learners justify which career best fits their goals. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Which career aligns with your interests? 2. Which profession has the greatest societal contribution? 3. What factors influence career choice? 4. Why are STEM careers important? <p>Option 3: Future Career Reflection</p> <ul style="list-style-type: none"> • Learners write reflections connecting personal interests to physics careers. • Learners identify skills they need to develop. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Which career interests you the most? 2. What skills should you improve? 3. How can physics help achieve your goals? 4. How can you contribute to society through science? <p>2. Making Generalization</p> <p>Option 1: Big Ideas in Physics</p>	<p>FACILITATION TIPS</p> <ul style="list-style-type: none"> • <i>Encourage critical thinking and evidence-based evaluation.</i> • <i>Ask for higher-order thinking questions.</i> • <i>Guide learners in comparing benefits, risks, and societal impacts.</i> • <i>Promote respectful collaboration and participation.</i> • <i>Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs.</i> • <i>Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs.</i> <p>IDF RELEVANCE</p> <p><i>The activities strengthen learner understanding through analysis, evaluation, collaboration, and evidence-based inquiry. Learners apply concepts in authentic and meaningful contexts.</i></p>
--	--	--

	<ul style="list-style-type: none"> Learners create a concept map connecting physics, technology, careers, and society. Groups explain their maps. <p>Guide Questions:</p> <ol style="list-style-type: none"> How is physics connected to society? Which sectors benefit from physics? What careers rely on physics? Why is physics important in modern life? <p>Option 2: Exit Ticket Reflection</p> <p><i>“Physics Changed the World Because...”</i></p> <ul style="list-style-type: none"> Learners complete the statement on a slip of paper. Responses are shared and processed. <p>Option 3: “My Future in Physics” Reflection</p> <ul style="list-style-type: none"> Learners explain how physics may influence their future career or daily life. <p>Guide Questions:</p> <ol style="list-style-type: none"> How does physics affect your life today? Which application of physics is most meaningful? What new understanding did you gain? Why is scientific literacy important? 	<p>Materials Needed</p> <ul style="list-style-type: none"> Investigation tables and matrices Printed articles and secondary sources Worksheets and graphic organizers Markers and Manila paper Laptop/projector/TV (optional)
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>Option 1: PERFORMANCE TASK</p> <p>“Physics for Society Advocacy Campaign”</p> <ul style="list-style-type: none"> Learners will work in groups to create an advocacy campaign highlighting the importance of physics in society and careers related to physics. <p>Groups may choose one of the following outputs:</p> <ol style="list-style-type: none"> Infographic Video presentation Digital poster 	

- d. Brochure
- e. Mini exhibit

The output must contain:

1. At least three applications of physics in society;
 2. At least three careers related to physics;
 3. Advantages and limitations of one physics application; and
 4. Evidence gathered from at least two secondary sources.
- Groups will present their outputs in class.

Sample Rubric

Criteria	4 - Excellent	3 - Proficient	2 - Developing	1 - Needs Improvement
Content Accuracy	Information is complete, accurate, and evidence-based	Mostly accurate with minor errors	Some inaccuracies present	Major inaccuracies evident
Use of Sources	Used at least 2 reliable sources effectively	Sources are reliable but limited	Few sources used	No reliable sources evident
Creativity	Highly engaging and original	Creative and organized	Simple presentation	Minimal effort
Presentation	Clear, confident, and organized	Mostly clear and organized	Somewhat unclear	Difficult to understand
Collaboration	All members actively participated	Most members contributed	Unequal participation	Minimal collaboration

Option 2: Multiple Choice

Directions: Read each question carefully and choose the letter of the best answer.

1. Which situation BEST shows the importance of physics in society?
 - A. Creating fictional stories
 - B. Memorizing historical dates
 - C. Writing poems for entertainment
 - D. Developing MRI machines used in hospitals
2. Why is it important to use multiple secondary sources when gathering scientific information?
 - A. to make reports longer
 - B. to gather opinions only
 - C. to avoid reading difficult materials
 - D. to compare evidence and verify accuracy

- | | |
|--|---|
| | <p>3. A learner researched climate change using articles from NASA and a science journal. What is the MAIN advantage of using these sources?</p> <ul style="list-style-type: none">A. They are easier to memorize.B. They focus only on opinions.C. They contain entertainment content.D. They provide evidence-based scientific information. <p>4. Which profession does MOST directly apply to physics concepts in diagnosing diseases?</p> <ul style="list-style-type: none">A. AccountantB. ArchitectC. MeteorologistD. Radiologic Technologist <p>5. How do engineers contribute to society using physics?</p> <ul style="list-style-type: none">A. by creating fictional storiesB. by predicting historical eventsC. by studying only biological organismsD. by designing technologies and structures that solve problems <p>6. Which statement BEST explains why physics-related careers are important?</p> <ul style="list-style-type: none">A. They are only useful in laboratories.B. They focus mainly on memorization.C. They are unrelated to community problems.D. They contribute to technological advancement and societal development. <p>7. Which is an advantage of renewable energy technologies developed through physics?</p> <ul style="list-style-type: none">A. Increased pollution levelsB. Faster spread of diseasesC. Reduced dependence on fossil fuelsD. Higher transportation accidents <p>8. Which situation BEST demonstrates a disadvantage of technological advancement?</p> <ul style="list-style-type: none">A. Improved medical diagnosisB. Easier global communicationC. Increased electronic waste and environmental concernsD. Faster transportation systems |
|--|---|

	<p>9. A community plans to use solar panels for electricity. Which statement BEST supports this decision?</p> <p>A. Solar energy increases fossil fuel consumption. B. Solar panels use renewable energy and reduce environmental impact. C. Solar energy prevents communication systems. D. Solar panels increase air pollution.</p> <p>10. Which action BEST demonstrates responsible use of physics and technology?</p> <p>A. Sharing false scientific information online B. Ignoring environmental effects of technology C. Using scientific knowledge to develop sustainable solutions D. Using technology without considering risks</p> <p>Key Answer 1. D 2. D 3. D 4. D 5. D 6. D 7. C 8. C 9. B 10. C</p>
<p>VI. REFLECTION (Feedback and Continuous Improvement)</p>	<p>Learners Reflection I learned that _____.</p> <p>One important realization I gained from the lesson is _____.</p> <p>The activity I enjoyed the most was _____.</p> <p>The part of the lesson that was confusing or not clear was _____ because _____.</p> <p>I can apply what I learned by _____.</p> <p>Teachers Reflection</p> <p>1. Were the learners able to achieve the lesson objectives successfully?</p> <p>2. What teaching strategies or adjustments can further improve learner understanding and engagement?</p>
<p>VII. USE OF GENERATIVE AI</p>	<p><i>In preparing this Learning Exemplar (LE), the author(s) used ChatGPT, Microsoft Copilot and Gemini AI in order to assist in organizing lesson components, refining instructional language, generating activity ideas, improving alignment of objectives, activities, and assessments, and enhancing the overall structure and coherence of the lesson exemplar. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</i></p>

Learning Area	PHYSICS 1	Lesson Exemplar	2
----------------------	------------------	------------------------	----------

I. OBJECTIVES	
A. Content Standard	Learners learned that... Physics is fundamental to understanding the natural world in a scientific way and leads to the development of many applications that benefit society.
B. Performance Standard	At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.
C. Learning Competencies	Conduct simple experiments on the translational motion of objects in one and two dimensions using standard and alternative measuring tools to measure length and time quantitatively
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<p>Department of Education. <i>Physics 1 Curriculum Guide for Senior High School</i>. Pasig City, Philippines: Department of Education, n.d.</p> <p>Department of Education. <i>Lesson Exemplar in General Science</i>. Pasig City, Philippines: Department of Education, n.d.</p> <p>Department of Education. <i>Senior High School Physics Curriculum Guide</i>. Pasig City, Philippines: Department of Education, n.d.</p> <p>University of Colorado Boulder. PhET Interactive Simulations: Projectile Motion. Accessed May 20, 2026. https://phet.colorado.edu/en/simulation/projectile-motion.</p> <p>University of Colorado Boulder. PhET Interactive Simulations: The Moving Man. Accessed May 20, 2026. https://phet.colorado.edu/en/simulation/the-moving-man.</p> <p>Open Source Physics Project. Open Source Physics. Accessed May 20, 2026. https://www.compadre.org/osp/.</p> <p>Khan Academy. "Kinematics and Motion." Accessed May 20, 2026. https://www.khanacademy.org/science/physics/one-dimensional-motion.</p> <p>The Physics Classroom. "Motion and Kinematics." Accessed May 20, 2026. https://www.physicsclassroom.com/class/1DKin.</p> <p>YouTube. "Kinematics Basics." Accessed May 20, 2026. https://www.youtube.com/.</p> <p>YouTube. "Describing Motion." Accessed May 20, 2026. https://www.youtube.com/.</p> <p>YouTube. "Motion in Two Dimensions." Accessed May 20, 2026. https://www.youtube.com</p>

III. CONTENT <i>(Sequencing Content)</i>	Kinematics	
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	By the end of this lesson, the learners should be able to: 1. identify distance, time, and speed as used to describe motion; 2. measure the distance traveled and time of travel of an object moving in one dimension; and 3. conduct a simple investigation involving two-dimensional motion.	
V. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i>		ANNOTATIONS
1. Activating Prior Knowledge	1. Activating Prior Knowledge Option 1: “Motion Around Me” The teacher asks learners to observe and recall common activities they encounter every day that involve motion. Learners will individually list at least five examples of moving objects or activities observed at home, in school, or in the community. Examples may include: a. walking to school b. riding a bicycle c. vehicles moving on the road d. throwing a ball e. electric fan blades rotating After listing, learners will share their answers with a partner and identify similarities in their observations. Guide Questions 1. When can you say an object is in motion? 2. What information do you need to describe how an object moves?	NOTES FOR TEACHERS <ul style="list-style-type: none">Facilitate the activities by encouraging all learners to actively participate in sharing their observations and experiences about motion.Use familiar and contextualized examples from the learners’ environment to make the lesson meaningful and relatable.Allow learners to express ideas freely before introducing scientific terms and concepts.Guide to discussions using probing questions to help learners connect prior experiences with the concepts of distance, time, and speed. Facilitation Tips Option 1: “Motion Around Me” <ul style="list-style-type: none">Encourage learners to observe examples from their homes, school surroundings, or community.

	<p>3. What can you measure when an object moves from one place to another?</p> <p>4. How can you determine if an object moves fast or slow?</p> <p>5. What tools can help measure the movement of an object?</p> <p>6. Why are measurements important in describing motion?</p> <p>Option 2: Picture Analysis</p> <p>The teacher presents pictures or short video clips of moving objects such as:</p> <ul style="list-style-type: none"> • a running athlete • a moving car • a falling object • a basketball being thrown • a drone flying <p>Learners will observe carefully and describe the motion shown in each picture or video. They will identify possible quantities that can be measured during motion.</p> <p>The teacher may write learners' responses on the board and organize them into categories such as distance, time, and speed.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which object is moving in the picture or video? 2. How can you say that the object is moving? 3. From where did the object start and where did it move? 4. What can you measure about how far the object moved? 5. What can you measure about how long the movement happened? 6. What tools can be used to measure distance and time? 7. Why are distance and time important in describing motion? 	<ul style="list-style-type: none"> • <i>Accept varied answers as long as they involve motion.</i> • <i>Ask follow-up questions to deepen learners' understanding of movement and change in position.</i> • <i>Emphasize that motion is part of everyday life and can be scientifically described.</i> <p>Option 2: Picture Analysis</p> <ul style="list-style-type: none"> • <i>Select clear and relatable pictures or short video clips showing different types of motion.</i> • <i>Allow learners enough time to observe before answering guide questions.</i> • <i>Encourage learners to describe motion using their own words before introducing formal terminology.</i> • <i>Help learners identify measurable quantities such as distance and time.</i> <p>Option 3: Think–Pair–Share</p> <ol style="list-style-type: none"> 1. <i>Give learners enough wait time for individual thinking before pair discussions.</i> 2. <i>Encourage respectful sharing and listening during partner discussions.</i> 3. <i>Guide learners toward realizing that both distance and time are needed to describe how fast an object moves.</i> 4. <i>Connect learners' responses to the concept of speed.</i>
--	---	--

	<p>Option 3: Think–Pair–Share</p> <p>The teacher asks the question: “How do we know if an object is moving fast or slow?”</p> <p>Learners will first think individually and write their ideas. Afterwards, they will discuss their answers with a partner and share their responses with the class.</p> <p>The teacher facilitates the discussion by connecting learners’ responses to the concepts of distance, time, and speed.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. How can you tell if an object is moving fast or slow? 2. What information do you need to compare the motion of two objects? 3. Does an object that travels a longer distance always move faster? Why or why not? 4. How does the time of travel affect the motion of an object? 5. What quantities can help describe how fast an object moves? 6. What tools can be used to measure distance and time accurately? 7. Why are distance and time important in describing motion? 	<p>IDF Relevance</p> <p><i>The activities apply the principles of the Instructional Design Framework (IDF) by using learner-centered and contextualized strategies that connect the lesson to learners’ real-life experiences. Through observation, discussion, collaboration, and reflection, learners actively construct understanding of motion and its measurable components. The varied activities promote active engagement, communication, critical thinking, and meaningful learning while accommodating diverse learning styles and encouraging participation from all learners.</i></p> <p>Transition to the Lesson</p> <p><i>The teacher synthesizes learners’ responses and explains that motion can be described scientifically through measurements such as distance and time. These concepts are studied in Kinematics, a branch of physics that describes how objects move.</i></p> <p>Materials Needed</p> <ul style="list-style-type: none"> • Activity sheet/notebook • Pen or pencil • Manila paper/cartolina • Marker • Printed pictures of moving objects • Video clips of moving objects • Laptop/television/projector/speaker • Printed guide questions or presentation slides • Timer/stopwatch (optional)
--	--	---

	<p>2. Establishing the Purpose of the Lesson</p> <p>Option 1: “Which One Moves Faster?”</p> <p><i>“Car A arrived at the destination earlier than Car B even though both traveled on the same road.”</i></p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which car is faster? 2. How do you know that one object moves faster or slower than another? 3. What information do you need to compare their motion accurately? 4. What quantities can be measured during motion? 5. What tools can be used to measure distance and time? 6. Why are accurate measurements important in describing motion? 7. How can measuring motion help people in everyday life? 8. How does Physics help us understand and describe motion scientifically? <p>Option 2: “The Fastest Way Home”</p> <p>The teacher presents a simple situational problem: <i>“Three students are going home from school.</i></p> <ul style="list-style-type: none"> • Student A walks straight through the main road. • Student B rides a bicycle through a longer shortcut route. • Student C takes a tricycle but gets stuck in traffic. • Let the learners analyze the statements/situations and answer the question: <i>“Who do you think will arrive home first?”</i> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which student do you think will arrive home first? Why? 2. Is a shorter route always faster? Explain. 3. What information do you need to compare their motion accurately? 	<p>NOTE TO THE TEACHER</p> <ul style="list-style-type: none"> • <i>Facilitate the activities by emphasizing the relevance of motion in learners’ daily experiences and future real-life applications.</i> • <i>The teacher presents situational pictures or short scenarios involving motion</i> • <i>Learners discuss how they can determine which object moved faster and what information is needed to describe the motion accurately.</i> • <i>The teacher gradually introduces the idea that motion can be described scientifically using measurable quantities such as distance and time and measured using appropriate tools.</i> <p>Facilitation Tips</p> <ul style="list-style-type: none"> • <i>Use contextualized and relatable examples to increase learner motivation and engagement.</i> • <i>Encourage learners to explain their answers using their own experiences.</i> • <i>Ask probing questions to connect learners’ ideas to the lesson objectives.</i> • <i>Reinforce that the lesson focuses on understanding and measuring motion scientifically.</i> • <i>Allow collaborative discussions to promote communication and critical thinking skills.</i>
--	--	--

	<p>4. What quantities can be measured during travel? 5. What tools can help measure distance and time?</p> <p>Option 3: “Challenge Accepted!”</p> <p>The teacher presents a short problem scenario:</p> <p><i>“A rescue team needs to determine the fastest route to deliver emergency supplies after a typhoon. How can measuring distance and time help them?”</i></p> <p>Learners share possible answers and discuss why understanding motion is important in solving practical problems.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Why is it important to know how far the rescue team needs to travel? 2. Why is it important to know how long the travel will take? 3. What quantities can help describe the motion of the rescue vehicle? 4. What tools can be used to measure distance and time during travel? 5. How can measuring distance and time help the rescue team move faster? 6. Why is accurate measurement important during emergencies? 7. How can Physics help people understand and describe motion in real-life situations? 	<p>IDF Relevance</p> <p><i>The activities apply the Instructional Design Framework (IDF) by establishing meaningful connections between the lesson concepts and real-life situations familiar to learners. Through contextualized scenarios, guided discussions, and collaborative activities, learners recognize the relevance and purpose of studying motion. The activities promote learner engagement, critical thinking, communication, and active participation while setting clear learning expectations aligned with the lesson competencies and objectives.</i></p> <p>Transition to the Lesson</p> <p><i>The teacher synthesizes learners’ responses and explains that motion is present in everyday activities and can be described scientifically using measurements such as distance and time. The lesson introduces Kinematics, a branch of Physics that focuses on describing motion and understanding how objects move in one- and two-dimensions using appropriate measuring tools.</i></p> <p>Materials Needed</p> <ul style="list-style-type: none"> • Activity sheet/notebook • Pen or pencil • Printed situational cards/scenarios • Pictures or illustrations of vehicles, roads, and travel situations
--	---	--

		<ul style="list-style-type: none"> • Manila paper/ cartolina • Marker • Laptop/ television/ projector (optional for presentation of scenarios) • Timer/ stopwatch (optional)
2. Instituting New Knowledge	<p>1. Presenting Examples Experiment Option 1: “Walk and Measure” Objective Demonstrate how distance and time can be measured using standard and alternative measuring tools.</p> <p>Materials</p> <ul style="list-style-type: none"> • Meter stick or tape measure • Stopwatch or mobile phone timer • Masking tape/chalk • Alternative measuring tools (footsteps, hand spans, strings) • Activity sheet <p>Procedure A: Using Standard Measuring Tools</p> <ol style="list-style-type: none"> 1. Mark a straight path inside or outside the classroom using masking tape or chalk. 2. Using a meter stick or tape measure, measure the total length of the path. 3. Assign one group member to walk from the starting point to the endpoint at a normal pace. 4. Another group member records the time using a stopwatch or mobile timer. 5. Record the measured distance and time in the data table. 6. Repeat the activity if necessary to verify the measurement. 	<p>NOTE TO THE TEACHER</p> <ul style="list-style-type: none"> • Facilitate the experiments by emphasizing careful observation and proper use of measuring tools. • Focus the discussion on the importance of accurate measurement of distance and time as fundamental quantities in describing motion. • Avoid introducing computations at this stage and instead highlight measurement skills and comparison of tools. <p>Facilitation Tips</p> <ol style="list-style-type: none"> 1. Demonstrate the correct use of standard measuring tools before the activity. 2. Encourage learners to handle measuring tools carefully and record observations accurately. 3. Allow learners to repeat measurements to observe consistency of results. 4. Guide learners in comparing the precision and accuracy of standard and alternative tools. 5. Emphasize that scientific investigations require reliable and consistent measurements.

	<p>Guide Questions for Procedure A</p> <ol style="list-style-type: none"> 1. Was the standard measuring tool easy or difficult to use? Why? 2. What challenges did you encounter while measuring distance using the tape measure or meter stick? 3. Why is proper positioning important when using standard measuring tools? 4. Why is accurate time recording important in describing motion? 5. How do standard measuring tools help improve the accuracy of measurements? <p>Procedure B: Using Alternative Measuring Tools</p> <ol style="list-style-type: none"> 1. Measure the same path using alternative measuring tools such as: <ol style="list-style-type: none"> a. footsteps b. hand spans c. strings 2. Perform three trials using the same alternative measuring tool. 3. Record the measurements gathered in each trial. 4. Compare the measurements from the three trials with the measurements obtained using standard tools. 5. Discuss why measurements using alternative tools may vary. <p>Guide Questions for Procedure B</p> <ol style="list-style-type: none"> 1. Did all three trials produce the same measurement? Why or why not? 2. What disadvantages did you observe when using alternative measuring tools? 3. Why do measurements vary when using footsteps or hand spans? 	<p>IDF Relevance</p> <p><i>The experiments apply the Instructional Design Framework (IDF) by providing experiential and contextualized learning opportunities where learners actively engage in measuring real motion using both standard and alternative tools. Through hands-on investigation, observation, and collaborative discussion, learners develop foundational scientific process skills and construct understanding of the fundamental quantities of motion. The activities promote learner engagement, inquiry, critical thinking, and authentic learning experiences aligned with the lesson competencies and objectives.</i></p> <p>Transition to the Lesson</p> <p><i>The teacher synthesizes learners' observations and explains that accurate measurement of distance and time is essential in describing motion scientifically. These measurable quantities help explain how objects move and serve as the foundation for understanding speed and other concepts in Kinematics.</i></p>
--	---	--

	<p>4. Which measuring tool gave more consistent results?</p> <p>5. Why are standard measuring tools more reliable in scientific investigations?</p> <p>6. How can distance and time help describe the motion of the walker?</p> <p>Experiment Option 2: “Rolling Object Investigation”</p> <p>Objective Demonstrate how distance and time can be measured using standard and alternative measuring tools during the motion of an object.</p> <p>Materials</p> <ul style="list-style-type: none"> • Toy car, marble, or ball • Meter stick or tape measure • Stopwatch or mobile phone timer • String or improvised measuring materials • Chalk or masking tape • Activity sheet <p>Procedure</p> <ol style="list-style-type: none"> 1. Prepare a straight pathway on the floor. 2. Learners release a toy car or roll a ball from the starting line toward the endpoint. 3. Learners measure the distance traveled using a ruler or tape measure. 4. Another learner records the time the object takes to travel using a stopwatch. 5. Learners repeat the activity using alternative measuring tools such as strings or footsteps to estimate the distance traveled. 6. Learners compare the results obtained using standard and alternative measuring tools. 	<p>Facilitation Tips</p> <ul style="list-style-type: none"> • <i>Prepare a smooth and clear pathway before the activity to ensure consistent motion of the object.</i> • <i>Demonstrate the proper way of releasing or rolling the object to avoid applying excessive force.</i> • <i>Remind learners to start timing only when the object begins moving and stop timing when it reaches the endpoint.</i> • <i>Encourage learners to assign specific group roles such as: object releaser , timer, measurer, recorder</i> • <i>Allow learners to perform repeated trials to observe consistency of measurements.</i> • <i>Guide learners in properly aligning the ruler or tape measure to avoid inaccurate distance readings.</i> • <i>Encourage learners to compare the measurements gathered from standard and alternative tools carefully.</i> • <i>Ask probing questions such as:</i> <ol style="list-style-type: none"> a. <i>“Why do some measurements differ?”</i> b. <i>“Which tool was easier to use?”</i> c. <i>“Which tool gave more consistent results?”</i> • <i>Emphasize the importance of precision, accuracy, and proper measuring techniques during the discussion.</i> • <i>Encourage learners to relate the activity to real-life situations where</i>
--	--	---

	<p>7. The teacher facilitates a discussion on precision and accuracy of measurements.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which measuring tool provided more precise measurements? 2. Why are standard measuring tools commonly used in science? 3. What difficulties did you encounter using alternative tools? 4. Why is measuring time important in observing motion? 5. How do distance and time help describe the motion of an object? <p>2. Discussing New Concept</p> <p><i>Experiment Option 1: “Exploring Motion Paths”</i></p> <p>Objective</p> <p>Observe and measure two-dimensional motion using a tossed object.</p> <p>Materials</p> <ul style="list-style-type: none"> • Soft ball/paper ball • Meter stick or measuring tape • Stopwatch or mobile timer • Chalk or floor markers • Activity sheet <p>Procedure</p> <ol style="list-style-type: none"> 1. A learner gently tosses a ball forward. 2. Learners observe the curved path of the ball. 	<p><i>accurate measurement of motion is important.</i></p> <p>NOTES FOR TEACHERS</p> <ul style="list-style-type: none"> • <i>The teacher introduces two-dimensional (2D) motion as motion that occurs in more than one direction such as horizontal and vertical movement.</i> • <i>Learners explore how distance and time can still be measured in 2D motion using different measuring tools and applications.</i> • <i>Guide learners in observing the direction of motion and identifying how two-dimensional motion differs from one-dimensional motion.</i> • <i>Note that the activities focus on describing and measuring motion rather than solving mathematical computations.</i> • <i>Encourage learners to observe carefully, collaborate actively, and use measuring tools properly.</i> <p>Facilitation Tips</p> <ul style="list-style-type: none"> • <i>Demonstrate the correct use of measuring tools and digital applications before the activity.</i> • <i>Encourage repeated trials to improve reliability of measurements.</i> • <i>Allow learners to describe motion using their own observations before introducing formal concepts.</i>
--	--	---

	<ol style="list-style-type: none"> 3. Measure the horizontal distance traveled by the ball. 4. Record the time from release until the ball lands. 5. Learners repeat the toss using different strengths or angles. 6. The class discusses how the object moves both upward/downward and forward at the same time. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. How did the ball move from the starting point to the endpoint? 2. Did the ball move in only one direction or in more than one direction? 3. How is the motion different from motion in a straight line? 4. Why is the motion considered two-dimensional instead of one-dimensional? <p>Experiment Option 2: “Motion Path Picture Analysis”</p>  <p>Objective Analyze two-dimensional motion through observation of motion path images and identify the measurable quantities involved in motion.</p>	<ul style="list-style-type: none"> • <i>Emphasize the relationship between motion, distance, and time.</i> • <i>Use probing questions to help learners recognize that 2D motion occurs in more than one direction.</i> <p>IDF Relevance</p> <p><i>The activities apply to the Instructional Design Framework (IDF) by engaging learners in guided and experiential learning through hands-on investigations, collaborative discussions, and technology-enhanced activities. These activities promote inquiry, observation, critical thinking, and meaningful understanding of two-dimensional motion in real-world contexts.</i></p> <p>NOTES FOR TEACHERS</p> <ul style="list-style-type: none"> • <i>Guide learners in carefully observing the motion paths and encourage them to describe their observations using simple scientific terms.</i> • <i>This activity focuses only on recognizing and analyzing two-dimensional motion (2-D motion) through motion paths and measurable quantities involved in motion.</i> • <i>Projectile motion may be used only as an example of 2-D motion. Avoid discussing projectile motion equations, computations, and advanced concepts at this stage to prevent misconceptions and confusion among learners.</i>
--	---	---

	<p>Materials</p> <ul style="list-style-type: none"> • Motion path pictures • Activity sheet • Ruler (optional) <p>Procedure</p> <ol style="list-style-type: none"> 1. The teacher presents pictures showing objects moving at different angles and paths. 2. Learners carefully observe the direction and shape of the motion shown in each picture. 3. In groups, learners compare the height, distance, and direction of motion in the images. 4. Learners identify measurable quantities involved, such as distance and time. 5. Groups discuss how changing direction or angle affects the motion path. 6. Learners present their observations and explanations to the class. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. How does the object move in each picture? 2. Does the object move in only one direction or in more than one direction? 3. Which picture shows one-dimensional motion? Why? 4. Which picture shows two-dimensional motion? Why? 5. How can you describe the path followed by the object? 6. What measurable quantities can be observed in the motion? 7. How does changing the direction or angle affect the motion of the object? 8. How are one-dimensional and two-dimensional motions different from each other? 	<p>Facilitation Tips</p> <ul style="list-style-type: none"> • Allow learners enough time to compare the images carefully. • Use probing questions to guide analysis and interpretation. • Relate the activity to real-life motions such as throwing a ball or spraying water. • Encourage collaborative discussion and evidence-based observations. <p>IDF Relevance</p> <p><i>The activity applies the Instructional Design Framework (IDF) by using visual and guided inquiry activities that promote active engagement, observation, collaboration, and meaningful understanding of two-dimensional motion through real-world representations.</i></p> <p>Transition to Developing Mastery</p> <p><i>The teacher synthesizes learners' observations and explains that two-dimensional motion can be described by carefully measuring distance and time along different directions. These measurements help scientists analyze motion more accurately and prepare learners for deeper investigation and application of motion concepts in succeeding activities</i></p>
--	--	--

	<p>3. Developing Mastery</p> <p>Option 1: “Motion Analysis Challenge”</p> <p>Objective</p> <p>Strengthen learners’ understanding of one-dimensional and two-dimensional motion through analysis and classification activities.</p> <p>Materials</p> <ul style="list-style-type: none"> • Motion picture cards/video clips • Classification chart • Activity sheet <p>Procedure</p> <ol style="list-style-type: none"> 1. Learners observe pictures or video clips showing different motions. 2. Groups classify each motion as 1D or 2D. 3. Learners identify the measurable quantities involved in each motion. 4. Groups explain how distance and time describe the motion observed. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. What makes the motion one-dimensional or two-dimensional? 2. Which quantities can be measured in the activity? 3. Why are distance and time important in describing motion? 4. How can measuring tools improve observation? 	<p>NOTE TO THE TEACHER</p> <p><i>Facilitate the activity by guiding learners to focus on the direction of motion and the measurable quantities involved in each example. Encourage learners to justify their classifications using observations from the pictures or video clips rather than simply giving one-word answers.</i></p> <p>Facilitation Tips</p> <ul style="list-style-type: none"> • <i>Prepare motion examples that clearly show both one-dimensional and two-dimensional motion to avoid learner confusion.</i> • <i>Present the pictures or video clips one at a time to allow learners enough observation and analysis time.</i> • <i>Ask follow-up questions such as:</i> <ul style="list-style-type: none"> ○ <i>“Did the object move only forward or did it change direction?”</i> ○ <i>“What part of the motion can be measured?”</i> • <i>Remind learners to focus on distance and time as measurable quantities during discussion.</i> • <i>Allow groups to explain and defend their classifications before giving the correct answer.</i> • <i>Clarify misconceptions immediately, especially when learners confuse curved motion with straight-line motion.</i> • <i>Encourage collaborative discussion by assigning specific roles such as</i>
--	--	---

	<p>Option 2: “Design Your Own Motion Test”</p> <p>Objective</p> <p>Apply previously learned measurement skills by creating a simple motion investigation.</p> <p>Materials</p> <ul style="list-style-type: none"> • Available classroom materials • Measuring tools • Stopwatch/mobile timer • Activity sheet <p>Procedure</p> <ol style="list-style-type: none"> 1. Groups design a simple activity demonstrating either 1D or 2D motion. 2. Learners select appropriate measuring tools for the activity. 3. Groups perform the activity and record distance and time measurements. 4. Learners explain why they chose specific measuring tools and describe the motion observed. 5. Groups present their investigation to the class. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Why did you choose those measuring tools? 2. How did you measure the motion accurately? 3. What type of motion was demonstrated? 4. What challenges did you encounter during measurement? 	<p><i>observer, recorder, and presenter within each group.</i></p> <ul style="list-style-type: none"> • <i>Use real-life examples related to pictures or videos to make the lesson more meaningful and relatable.</i> <p>NOTES FOR TEACHERS</p> <p><i>Guide learners in designing simple but manageable motion investigations using available classroom materials. Encourage learners to apply the measurement skills previously learned and focus on proper use of measuring tools, accurate observation, and correct identification of one-dimensional or two-dimensional motion.</i></p> <p>Facilitation Tips</p> <ul style="list-style-type: none"> • <i>Set clear limitations on the materials and space to ensure safe and organized activities.</i> • <i>Encourage learners to design realistic and observable motion activities that can be measured easily.</i> • <i>Remind learners to assign group roles such as timer, measurer, recorder, presenter</i> • <i>Check out learners planned activities before implementation to ensure the motion can be measured properly.</i> • <i>Encourage learners to perform repeated trials to improve consistency of measurements.</i> • <i>Ask guiding questions during the activity.</i>
--	--	--

		<ul style="list-style-type: none"> • Encourage learners to justify their choice of measuring tools based on accuracy and convenience. • Remind learners to record observations immediately to avoid missing data. • During presentations, encourage learners to explain both the motion observed and the measurement process used. <p>IDF Relevance</p> <p><i>The activity applies to the Instructional Design Framework (IDF) by promoting experiential learning, collaboration, inquiry, and authentic application of measurement skills through learner-designed motion investigations. Learners actively construct understanding by planning, performing, observing, and explaining motion using real-world and hands-on experiences.</i></p>
3. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Option 1: Community Motion Problem-Solving Task</p> <p>Objective</p> <p>Apply understanding distance, time, and motion in solving a real-life community transportation problem.</p> <p>Materials</p> <ul style="list-style-type: none"> • Scenario cards • Community map/barangay sketch • Ruler 	<p>NOTES FOR TEACHERS</p> <ul style="list-style-type: none"> • Guide learners in analyzing the problem systematically and encourage them to justify their decisions using observations and measurements. • Emphasize practical application of motion concepts in community and real-life contexts. • In this activity, a straight path may be treated as one-dimensional motion for simplicity, while paths involving

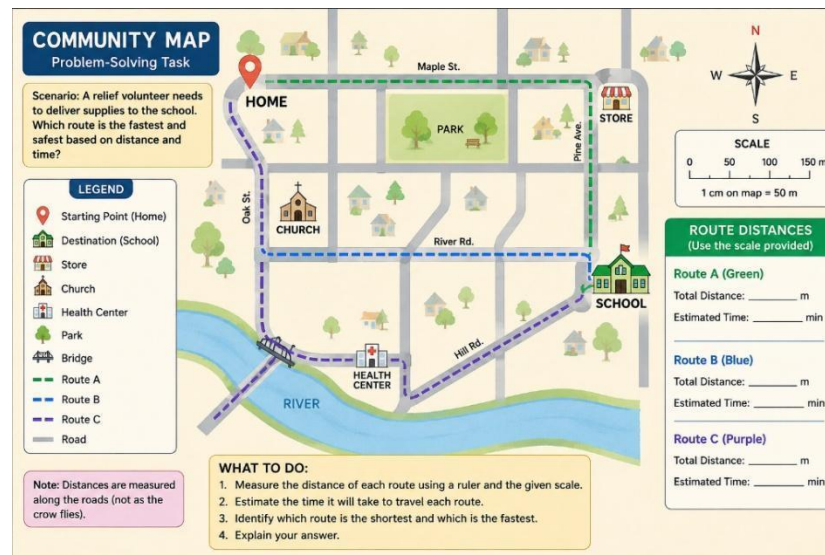
- Activity sheet
- Calculator (optional)

Procedure

1. Learners are grouped and given a community scenario such as:

“A relief volunteer needs to deliver supplies to different areas after a typhoon. The volunteer must choose the fastest and safest route.”

Learners examine the map provided showing different possible routes.



changes in direction may be represented as two-dimensional motion on a map. Emphasize that this is a simplified representation for describing motion.

Facilitation Tips

- Provide simple and clear maps appropriate to learners' level.
- Encourage learners to explain their reasoning during group discussions.
- Allow learners to compare different solutions and perspectives.
- Reinforce the importance of measurement and observation in problem-solving.
- Use probing questions to deepen analysis and decision-making.
- Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs.

IDF Relevance

The activity applies to the Instructional Design Framework (IDF) by engaging learners in collaborative and authentic problem-solving tasks that connect motion concepts to real-life community situations. The activity promotes critical thinking, inquiry, communication, and meaningful application of measurement skills.

	<p>2. Groups identify:</p> <ol style="list-style-type: none"> the shortest route the route with fewer turns possible one-dimensional and two-dimensional movements <p>3. Learners estimate the distance and travel time for each route using rulers or map scales.</p> <p>4. Groups recommend the best route and explain their reasoning based on distance, time, and motion.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> Which route is the most efficient for the relief of volunteers based on distance, travel time, and direction changes? Explain your answer. How do turns and changes in direction affect the movement of the volunteer along the route? Which routes demonstrate one-dimensional motion, and which demonstrates two-dimensional motion? What evidence from the map supports your answer? Why is accurate measurement of distance and travel time important in planning transportation and emergency delivery routes? How can understanding motion and route analysis help communities make better decisions during emergencies and disaster response? 	<p>NOTES FOR TEACHERS</p> <ul style="list-style-type: none"> Encourage learners to create simple and realistic representations of their route to school. Emphasize that the activity focuses on applying measurement concepts in real-life situations rather than artistic accuracy. Allow learners to use either manual estimation or digital applications when available. <p>Facilitation Tips</p> <ul style="list-style-type: none"> Provide examples of simple route maps before the activity. Encourage learners to include labels and landmarks on their maps. Guide learners in identifying changes in direction to distinguish 1D and 2D motion.
--	---	--

	<p>Option 2: My Route to School Map</p> <p>Objective</p> <p>Apply measurement skills by creating a simple map of the route traveled going to school and identifying measurable quantities involved in motion.</p> <p>Materials</p> <ul style="list-style-type: none"> • Bond paper/cartolina • Ruler • Pencil/colored pens • Measuring tools or mobile map applications (optional) • Activity sheet <p>Procedure</p> <ol style="list-style-type: none"> 1. Learners recall the route they usually take going to school. 2. On a sheet of paper, learners draw a simple map showing: <ol style="list-style-type: none"> a. starting point (home) b. roads or pathways traveled c. important landmarks d. endpoint (school) 3. Learners estimate or measure the distance traveled using available tools, footsteps, or digital map applications. 4. Learners identify portions of the route showing straight-line motion and motion involving turns or changes in direction. 5. Learners estimate the travel time from home to school. 6. Learners present their maps and explain how distance and time describe their daily motion. 	<ul style="list-style-type: none"> • Allow collaborative sharing of different routes and travel experiences. • Reinforce the practical importance of distance and time measurement in everyday life. • For long distances, the teacher may guide learners in using map scales when creating their route maps (ex., 1 km = 1 mm). • Teachers may develop, adapt, or contextualize rubrics depending on the nature of the procedural or performance-based activity, available resources, and learners' needs. <p>IDF Relevance</p> <p><i>The activity applies to the Instructional Design Framework (IDF) by connecting motion and measurement concepts to learners' real-life experiences through contextualized and authentic tasks. Learners actively construct understanding through mapping, estimation, observation, and collaborative sharing while developing meaningful application of measurement skills.</i></p>
--	--	--

Guide Questions

1. What route do you usually take from home to school?
2. Which parts of your route show movement in only one direction, and which involves changes in direction?
3. What quantities can be measured during your travel to school?
4. What tools or methods can help measure distance and travel time accurately?
5. Why are distance and time important in describing your daily motion to school?

Rubric for “Community Motion Problem-Solving Task”

Criteria	4 Excellent	3 Proficient	2 Developing	1 Beginning
Measurement Skills	Accurately measured all routes using the scale and appropriate tools	Measured most routes accurately with minimal errors	Measurements show some errors or inconsistencies	Measurements are incomplete or inaccurate
Analysis of Motion	Correctly identified and explained the routes using distance, time, and motion concepts	Correctly identified most motion concepts with minor errors	Demonstrated partial understanding of motion concepts	Demonstrated limited understanding of motion concepts
Problem-Solving and Decision Making	Clearly justified the best route using logical reasoning and evidence	Provided reasonable justification with some supporting evidence	Justification was incomplete or unclear	Unable to justify the chosen route
Use of Map and Data	Effectively interpreted the map, scale, and route information	Properly used most map elements and information	Used some map elements correctly	Had difficulty interpreting the map and data
Collaboration and Participation	Actively participated and contributed consistently to group work	Participated and contributed adequately	Participated minimally during the activity	Rarely participated in group tasks

Scoring Guide

Score Range	Description
17–20	Outstanding
13–16	Satisfactory
9–12	Developing
5–8	Beginning

2. Making Generalization

Option 1: “3-2-1 Reflection”

- Learners individually complete the following reflection prompts:
3- things I learned about motion
2- differences between one-dimensional and two-dimensional motion

NOTES FOR TEACHERS

- Facilitate the activities by encouraging learners to express their understanding and reflections using their own words and experiences.
- Guide learners in connecting the concepts of motion, distance, time, and types of motion to real-life situations. Use learners’ responses to reinforce correct concepts and address misconceptions.

Facilitation Tips

Option 1: “3-2-1 Reflection”

- Encourage learners to provide specific and meaningful responses.
- Allow learners enough reflection time before sharing.
- Use learners’ answers to identify concepts that need reinforcement.
- Highlight the connection between motion concepts and daily activities.

	<p>1- importance of measuring distance and time in daily life</p> <ul style="list-style-type: none"> • Learners share their responses with a partner or small group. • The teacher synthesizes learners' responses and highlights the major concepts of the lesson. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. What important ideas did you learn from the lesson? 2. How can motion be described scientifically? 3. Why is measurement important in studying motion? 4. How can the lesson be applied in real-life situations? <p>Option 2: "Stoplight Reflection"</p> <ul style="list-style-type: none"> • Learners reflect on their understanding of the lesson about motion and measurement. • Learners write their responses under the following categories: <ul style="list-style-type: none"> • Green – concepts I understand well • Yellow – concepts I partially understand • Red – concepts I still find difficult 1. Learners share selected responses with a partner or small group. 2. The teacher synthesizes common responses and clarifies misconceptions. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. What concepts about motion do you understand best? 2. Which part of the lesson needs more clarification? 3. How can distance and time describe motion? 	<p>Option 2: "Stoplight Reflection"</p> <ul style="list-style-type: none"> • Assure learners that honest responses are encouraged. • Use the red and yellow responses to identify areas needing clarification. • Encourage peer discussion to help learners explain concepts to one another. • Reinforce difficult concepts during synthesis. <p>Option 3: "Motion Charades"</p> <ul style="list-style-type: none"> • Select motion actions that clearly demonstrate 1D and 2D motion. • Encourage learners to justify their classifications using observations. • Promote active participation and respectful interaction during the activity. • Use follow-up questions to deepen conceptual understanding. <p>IDF Relevance</p> <p><i>The activities apply to the Instructional Design Framework (IDF) by promoting reflection, collaboration, active participation, and meaningful synthesis of lesson concepts through learner-centered and interactive activities.</i></p>
--	---	---

	<p>4. What is the difference between one-dimensional and two-dimensional motion?</p> <p>Option 3: “Motion Charades”</p> <ul style="list-style-type: none">• Learners take turns picking a motion action card.• Without speaking, the learner acts out the motion shown on the card (e.g., walking straight, turning while running, throwing a ball).• Classmates identify whether the motion demonstrated is one-dimensional or two-dimensional.• Learners explain why they classified the motion that way.• The teacher synthesizes the responses and reinforces the lesson concepts. <p>Guide Questions</p> <ol style="list-style-type: none">1. Did the motion move in one direction or more than one direction?2. What makes the motion one-dimensional or two-dimensional?3. What measurable quantities can describe the motion?	<p>Materials Needed</p> <ul style="list-style-type: none">• Activity sheet/notebook• Pen or pencil• Colored papers/ cards (green, yellow, red)• Marker• Motion action cards• Box/container for action cards• Manila paper/ cartolina (optional)• Tape or adhesive materials (optional)
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>Option 1: Written Task Multiple Choice: Read each question carefully and choose the letter of the best answer.</p> <ol style="list-style-type: none">1. A rescue team must deliver supplies after a typhoon. They can choose a short route with many turns or a longer straight route with less traffic. Which route is MOST likely the better choice?<ol style="list-style-type: none">A. Both routes are exactly the sameB. The route with more turns because it looks saferC. The shorter route because distance is the only important factorD. The longer straight route because fewer turns may reduce travel time and difficulty	

2. A group measured the motion of a toy car. It traveled 150 cm in Trial 1, 152 cm in Trial 2, and 151 cm in Trial 3. What can be said about their measurements?
 - A. The measurements are exactly the same.
 - B. The measurements are fairly consistent.
 - C. The measurements show that the car did not move.
 - D. The measurements are not useful because they are not identical.
3. Why is accurate measurement of distance and time important during emergency response operations?
 - A. It prevents vehicles from moving
 - B. It makes maps look more detailed
 - C. It reduces the need for communication systems
 - D. It helps responders choose efficient and safe routes
4. A cyclist travels 200 meters in 20 seconds while another cyclist travels 250 meters in 30 seconds. Which statement BEST explains who moved faster?
 - A. Both cyclists moved at exactly the same speed
 - B. Efficiency cannot be compared using distance and time
 - C. The second cyclist because the distance traveled was longer
 - D. The first cyclist because the travel time was shorter relative to the distance
5. A group used footsteps to measure the length of the hallway. Their results were 20 steps, 21 steps, and 19 steps. What is the BEST explanation for the differences in measurements?
 - A. The hallway changed length during the activity.
 - B. The learners did not perform the activity correctly.
 - C. Footsteps are more accurate than standard measuring tools.
 - D. Alternative measuring tools may produce varied measurements.

Answer Key

1. D 2. B 3. D 4. D 5. D

Option 2: Performance Task

“Domino Motion Challenge”

Task Description

Learners will design and create a domino pathway demonstrating motion in one-dimensional and two-dimensional directions. Learners will observe and describe how motion changes as the dominoes move through straight and turning paths while measuring the distance and time involved.

- Using dominoes or improvised materials, create a domino pathway with:
 - straight-line sections
 - curved or turning sections
- Push the first domino and observe how motion travels through the pathway.
- Measure or estimate:
 - the total distance covered by the domino path
 - the time from the first domino falling to the last domino falling
- Identify:
 - portions showing one-dimensional motion
 - portions showing two-dimensional motion
- Compare the motion in straight paths and turning paths.
- Present your observations and explain how motion changed throughout the activity.
- Use rubric and scoring guide

Criteria	4 Excellent	3 Proficient	2 Developing	1 Beginning
Application of Motion Concepts	Clearly identified and explained one-dimensional and two-dimensional motion accurately	Correctly identified most motion concepts with minor errors	Demonstrated partial understanding of motion concepts	Demonstrated limited understanding of motion concepts
Design and Construction of Domino Pathway	Domino pathway was creative, stable, organized, and clearly showed straight and turning paths	Domino pathway was organized and functional with minor issues	Domino pathway showed limited organization or incomplete sections	Domino pathway was poorly constructed or incomplete
Measurement and Observation Skills	Distance and time measurements were accurate, complete, and properly recorded	Measurements were mostly accurate with minimal errors	Measurements showed several inconsistencies	Measurements were incomplete or inaccurate
Analysis and Comparison of Motion	Clearly compared motion in straight and turning paths using logical explanations	Comparison was clear with minor details missing	Comparison lacked sufficient explanation	Comparison was unclear or incomplete
Presentation and Communication	Observations and explanations were presented clearly, confidently, and logically	Presentation was understandable and organized	Presentation lacked clarity in some parts	Presentation was unclear or incomplete
Participation and Collaboration	All members actively participated and contributed consistently	Most members participated adequately	Some members participated minimally	Limited participation from group members

VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p>Learners Reflection</p> <p>1. I learned that _____.</p> <p>2. One important realization I gained from the lesson is _____.</p> <p>3. The activity I enjoyed the most was _____.</p> <p>4. The part of the lesson that was confusing or not clear was _____ because _____.</p> <p>5. I can apply what I learned by _____.</p> <p>Teachers Reflection</p> <p>1. Were the learners able to achieve the lesson objectives successfully?</p> <p>2. What teaching strategies or adjustments can further improve learner understanding and engagement?</p>
VII. USE OF GENERATIVE AI	<p><i>In preparing this Learning Exemplar (LE), the author(s) used ChatGPT, Microsoft Copilot and Gemini AI in order to assist in organizing lesson components, refining instructional language, generating activity ideas, improving alignment of objectives, activities, and assessments, and enhancing the overall structure and coherence of the lesson exemplar. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</i></p>

Learning Area	PHYSICS 1	Lesson Exemplar	3
----------------------	-----------	------------------------	---

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that measuring should be done precisely and accurately, and must be expressed correctly; and qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners define the fundamental quantities and the basis of its SI units.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<p>Bureau International des Poids et Mesures (BIPM). 2019. <i>The International System of Units (SI Brochure)</i>. 9th ed. Sèvres, France: BIPM. https://www.bipm.org.</p> <p>Department of Education (DepEd), Philippines. 2017. <i>General Physics 1: Learner's Material</i>. Pasig City: Department of Education.</p> <p>Giancoli, Douglas C. 2014. <i>Physics: Principles with Applications</i>. 7th ed. Boston: Pearson.</p> <p>Halliday, David, Robert Resnick, and Jearl Walker. 2018. <i>Fundamentals of Physics</i>. 11th ed. Hoboken, NJ: Wiley.</p> <p>International Bureau of Weights and Measures (BIPM). 2019. <i>The International System of Units (SI)</i>. 9th ed. Sèvres, France: BIPM.</p> <p>Knight, Randall D. 2017. <i>Physics for Scientists and Engineers: A Strategic Approach</i>. 4th ed. Boston: Pearson.</p> <p>Navarro, Amelia M., and Reynaldo P. Bautista. 2016. <i>Fundamentals of Physics: Kinematics and Mechanics</i>. Quezon City: Phoenix Publishing House.</p> <p>Organisation for Economic Co-operation and Development (OECD). 2019. <i>PISA 2018 Assessment and Analytical Framework</i>. Paris: OECD Publishing. https://doi.org/10.1787/b25efab8-en.</p> <p>Serway, Raymond A., and John W. Jewett Jr. 2014. <i>Physics for Scientists and Engineers</i>. 9th ed. Boston: Cengage Learning.</p> <p>UNESCO. 2017. <i>Education for Sustainable Development Goals: Learning Objectives</i>. Paris: UNESCO Publishing. https://unesdoc.unesco.org.</p>
III. CONTENT (Sequencing Content)	<i>Kinematics</i>

IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	<i>At the end of this lesson, the learners should be able to:</i> <ol style="list-style-type: none"> 1. identify fundamental quantities used in describing motion and their SI base units and symbols; 2. distinguish between fundamental and derived quantities in physical measurements; and 3. explain the importance of using SI units for accurate scientific communication and real-life applications. 	
IV. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i>		ANNOTATIONS
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge</p> <p>Option 1: My Daily Measurement Map</p> <ol style="list-style-type: none"> 1. Let the learners draw a simple map or sequence of their trip from home to school. They may include walking, riding a jeepney, tricycle, bus, or any common mode of transportation. 2. Identify and label measurable quantities observed during the trip. 3. Classify each quantity as either: <ul style="list-style-type: none"> ○ Fundamental Quantity – basic quantities that stand alone (e.g., length or distance, time, mass) ○ Derived Quantity – quantities obtained from combining fundamental quantities (e.g., speed) 4. Use the following guide in labeling your map: <ul style="list-style-type: none"> ○ Length traveled → Fundamental Quantity ○ Time spent → Fundamental Quantity ○ Speed of travel → Derived Quantity ○ Number of stops made → Observation only 5. After completing the activity, they will pair up with their classmates and compare their answers. Discuss how the quantities were classified. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What measurable quantities did you identify during your trip? 2. Which are considered fundamental quantities? Why? 	<p>Note for Teachers:</p> <ul style="list-style-type: none"> • Do not introduce SI units yet; focus on natural descriptions of motion. <p>Materials Needed:</p> <ul style="list-style-type: none"> • Paper, pencil, ruler <p>IDF Relevance:</p> <ul style="list-style-type: none"> • The learners use motion maps of daily travel to apply distance, time, and stops in describing motion, compare experiences, and reflect on perceptions of “far” and “fast.”

	<p>3. Which quantity is considered derived? How is it obtained?</p> <p>4. Why is speed classified as a derived quantity?</p> <p>5. How do measurements help describe everyday activities such as traveling to school?</p> <p>Option 2: “Motion Word Association”</p> <ul style="list-style-type: none"> The teacher will write the following words on the board: <ul style="list-style-type: none"> jeepney basketball running tricycle falling object <p>Guide Questions:</p> <ol style="list-style-type: none"> What type of motion is involved? What quantities describe it? <p>Option 3: “Measure Me If You Can!”</p> <ul style="list-style-type: none"> The teacher will divide the learners into five (5) groups. Each group will: <ul style="list-style-type: none"> measure the distance traveled by the rolling object; measure the time it takes for the object to travel the distance; and record the measurements and units used. The learners will write the measurements and symbols they use on sticky notes. Each group will post their answers on the board under: <ul style="list-style-type: none"> What We Measured What Units We Used <p>Guide Questions:</p> <ol style="list-style-type: none"> What quantities did you measure directly? What units did you use? What quantity can you compute using distance and time? 	<p>Note for Teachers:</p> <ul style="list-style-type: none"> Accept all responses; later refine into scientific terms. <p>IDF Relevance:</p> <ul style="list-style-type: none"> The learners classify everyday words by type of motion and describe them using quantities such as speed, distance, time, and direction. <p>Notes for Teachers:</p> <ul style="list-style-type: none"> Facilitate questioning. Encourage learners to explain their prior experiences. Avoid directly giving answers. <p>Materials Needed:</p> <ul style="list-style-type: none"> Meter stick/tape measure Stopwatch or cellphone timer Small ball or toy car Sticky notes/manila paper <p>IDF Relevance:</p> <ul style="list-style-type: none"> This activity promotes experiential learning through direct observation and collaborative inquiry.
--	---	--

4. Why do we need standard units when describing motion?

2. Establishing the Purpose of the Lesson

The teacher will give emphasis on the statement below to avoid confusion.

- Length is a fundamental quantity. Distance and displacement are motion quantities measured using the SI unit for length, the meter.

Option 1: “Lost in Translation”

Scenario 1: SI Units (Clear Communication)

- A **Philippine expressway traffic monitoring team (NLEX–SLEX coordination unit)** is analyzing vehicle motion after a minor road accident involving a delivery truck. The report states:
 - Distance traveled: **120 meters (m)**
 - Time taken to stop: **8 seconds (s)**
 - Speed before braking: **25 m/s**
 - Acceleration during braking: **–3.1 m/s²**

Scenario 2: Nonstandard/Mixed Units (Confusing Communication)

- A different report from a local roadside assistant uses mixed and nonstandard units:
- Distance traveled: 120 meters or 0.12 km or 395 feet (mixed reporting)
- Time taken to stop: 8 seconds or “a few moments
- Speed before braking: 90 km/h or 55 mph (uncertain conversion)
- Acceleration: not clearly stated, only “fast slowing down”

Guide Questions:

After presenting both scenarios, learners will discuss:

*Understanding and Comparison

- Which scenario is easier to understand? Why?

Notes for Teachers:

- Present both scenarios clearly and slowly to ensure understanding.
- Use visual aids (slides or charts) if possible, to compare SI vs non-SI data.

Sample Chart

SIDE A: SI UNITS (CLEAR & STANDARDIZED)

Quantity	Value	Unit	Meaning
Distance	120	meter (m)	Exact road distance traveled
Time	8	second (s)	Exact stopping time
Speed	25	m/s	Consistent measurement of motion
Acceleration	–3.1	m/s ²	Rate of slowing down

SIDE B: NON-SI/MIXED UNITS (CONFUSING DATA)

Quantity	Value	Unit	Issue
Distance	120 m or 0.12 km or 395 ft	mixed	Multiple conversions cause confusion
Time	8 s / “few moments”	unclear	Not precise
Speed	90 km/h / 55 mph	mixed	Requires conversion
Acceleration	“Fast slowing down”	no unit	Not measurable scientifically

- Avoid immediately explaining answers; allow learners to analyze first.
- Ask probing questions such as:
 - What part of Scenario 2 causes confusion?

	<p>2. What makes the SI-based report clearer?</p> <p>*Problem Analysis</p> <ol style="list-style-type: none"> 1. What challenges arise in Scenario 2 (mixed/nonstandard units)? 2. How can confusion in units affect scientific or safety decisions? 3. What could happen if engineers misinterpret motion data? <p>*Learner Output: Groups complete the statement: “Today we need to learn about SI units because _____. ”</p> <p>Option 2: “The Wrong Delivery”</p> <p>Scenario 1: Using the English Measurement System A delivery company from another country sends instructions to a Filipino truck driver transporting medical supplies from Manila to Baguio. The instructions state:</p> <ul style="list-style-type: none"> • Travel distance: 155 miles • Speed limit: 60 mph • Bridge clearance: 12 feet • Cargo weight: 2,200 pounds <p>The driver becomes confused because Philippine Road signs and transportation measurements commonly use metric/SI units. As a result:</p> <ul style="list-style-type: none"> • The driver miscalculates the speed of conversion. • becomes uncertain about bridge clearance. • and arrives late at the delivery station. <p>Scenario 2: Using SI Units The same delivery instructions are rewritten using SI units:</p> <ul style="list-style-type: none"> • Travel distance: 250 kilometers (km) • Speed limit: 96 km/h 	<ul style="list-style-type: none"> ○ How would engineers react if data is unclear? ○ Why is it important that everyone uses the same unit system? ○ Encourage learners to justify their answers, not just choose. <p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity contextualizes learning through real-world relevance and authentic problem situations. <p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Encourage learners to analyze the consequences of unclear measurement systems before discussing SI standardization. • Ask guiding questions such as: <ul style="list-style-type: none"> ○ What if the bridge was lower than expected? ○ How can wrong speed conversion affect safety? ○ “Why do international companies prefer standardized units?” • Allow learners to express practical experiences related to transportation and road signs. • Emphasize that SI units help ensure: <ul style="list-style-type: none"> ○ consistency, ○ safety, ○ efficiency,
--	---	--

	<ul style="list-style-type: none"> • Bridge clearance: 3.7 meters (m) • Cargo weight: 1,000 kilograms (kg) <p>The driver clearly understands the instructions and safely completes the delivery on time.</p> <p>Guide Questions: After presenting both scenarios, learners discuss the following:</p> <p>Understanding and Comparison</p> <ol style="list-style-type: none"> 1. Which scenario is easier to understand for Filipino drivers and workers? Why? 2. What differences did you notice between the English system and SI units? 3. Which system allows faster and clearer communication? <p>Problem Analysis</p> <ol style="list-style-type: none"> 1. What challenges can happen when different unit systems are used? 2. Why can incorrect unit conversion become dangerous? 3. How can standardized SI units improve transportation and delivery services? 4. What could happen if the driver misunderstood the bridge clearance or speed limit? 	<ul style="list-style-type: none"> ○ and accurate communication worldwide. • Connect the activity to real-world applications in logistics, transportation, engineering, and science. <p>Materials Needed</p> <ul style="list-style-type: none"> • Printed scenario cards or slides • Comparison chart of English vs SI units • Whiteboard and markers • Pictures of delivery trucks, road signs, or bridge clearances (optional) <p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity develops critical thinking and real-world problem-solving by allowing learners to analyze how standardized SI units support safe and effective communication.
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>Option 1: “Kinematics Measurement Gallery Walk”</p> <p>Scenario 1: Fundamental Quantities in Kinematics “Basic Measurements of Motion”</p> <p>The teacher will set up stations focused on the fundamental SI quantities used in motion, specifically length and time. Each station contains:</p> <ul style="list-style-type: none"> • A picture/object/example • A guide question card • A short learner tasks 	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Facilitate group discussions and monitor participation. • Ask probing developmental questions to deepen learner understanding. • Encourage learners to compare and classify quantities. • Clarify misconceptions only after learners attempt explanations. • Highlight the relationship between:

	<p>Station Tasks – Scenario 1</p> <table border="1"> <thead> <tr> <th>Station</th><th>Example/Object</th><th>Developmental Guide Questions</th></tr> </thead> <tbody> <tr> <td>1A</td><td>Measuring Tape</td><td> What quantity is measured? What is its SI unit and symbol? Why is length considered a fundamental quantity? </td></tr> <tr> <td>1B</td><td>Stopwatch</td><td> What quantity is measured? What is its SI unit and symbol? Why is time considered a fundamental quantity? </td></tr> </tbody> </table> <p>Developmental Questions for Scenario 1</p> <p>*Similarities Among the Quantities</p> <ol style="list-style-type: none"> 1. What similarities do length, distance, displacement, and time have in measuring motion? 2. Which quantities use SI units? 3. Which quantities are important in describing motion? <p>*Differences Between the Quantities</p> <ol style="list-style-type: none"> 1. What is the difference between distance and displacement? 2. How is time different from length-related quantities? 3. Which quantities are fundamental and which are not? Why? <p>Scenario 2: Derived Quantities in Kinematics</p> <p>“Describing How Objects Move”</p> <p>The teacher will set up stations focused on derived kinematic quantities formed using length and time. Each station contains:</p> <ul style="list-style-type: none"> • A picture/object/example • A guide question card • A short learner tasks 	Station	Example/Object	Developmental Guide Questions	1A	Measuring Tape	What quantity is measured? What is its SI unit and symbol? Why is length considered a fundamental quantity?	1B	Stopwatch	What quantity is measured? What is its SI unit and symbol? Why is time considered a fundamental quantity?	<ul style="list-style-type: none"> ○ fundamental quantities (length and time), ○ and derived quantities (speed, velocity, acceleration). <p>Materials Needed:</p> <ul style="list-style-type: none"> • Measuring tape/meter stick • Stopwatch/timer • Distance–Displacement illustration card • Speedometer picture • Velocity scenario card (with direction) • Acceleration illustration card (e.g., speeding car or falling object) • Formula cards: <ul style="list-style-type: none"> ○ $Speed = \frac{Distance}{Time}$ ○ $Velocity = \frac{Displacement}{Time}$ ○ $Acceleration = \frac{Velocity}{Time}$ • Gallery Walk Worksheet <p>Gallery Walk Instructions for Learners</p> <ol style="list-style-type: none"> 1. Divide learners into small groups. 2. Each group will visit and work at each station. 3. Groups observe the material and discuss the developmental guide questions. 4. Learners complete their worksheet before rotating to the next station.
Station	Example/Object	Developmental Guide Questions									
1A	Measuring Tape	What quantity is measured? What is its SI unit and symbol? Why is length considered a fundamental quantity?									
1B	Stopwatch	What quantity is measured? What is its SI unit and symbol? Why is time considered a fundamental quantity?									

	Station Tasks – Scenario 2				5. Rotation continues every 3–4 minutes until all stations are completed.																																		
	<table><tr><th>Station</th><th>Example/Object</th><th>Developmental Guide Questions</th></tr><tr><td>2A</td><td>Speedometer</td><td>What quantity is measured? What quantities are combined to speed? What SI unit is used?</td></tr><tr><td>2B</td><td>Velocity Scenario Card</td><td>How is velocity different from speed? Why is direction important in velocity?</td></tr><tr><td>2C</td><td>Acceleration Illustration</td><td>What happens to velocity during acceleration? What SI unit is used? How is acceleration related to speed or velocity?</td></tr></table>	Station	Example/Object	Developmental Guide Questions	2A	Speedometer	What quantity is measured? What quantities are combined to speed? What SI unit is used?	2B	Velocity Scenario Card	How is velocity different from speed? Why is direction important in velocity?	2C	Acceleration Illustration	What happens to velocity during acceleration? What SI unit is used? How is acceleration related to speed or velocity?			6. After the rotation, groups share: <ul style="list-style-type: none">○ similarities among quantities,○ differences between quantities,○ and relationships between SI units and motion.																							
	Station	Example/Object	Developmental Guide Questions																																				
	2A	Speedometer	What quantity is measured? What quantities are combined to speed? What SI unit is used?																																				
	2B	Velocity Scenario Card	How is velocity different from speed? Why is direction important in velocity?																																				
	2C	Acceleration Illustration	What happens to velocity during acceleration? What SI unit is used? How is acceleration related to speed or velocity?																																				
	Developmental Questions for Scenario 2				IDF Relevance:																																		
	*Similarities Among the Quantities				<ul style="list-style-type: none">• This activity develops analytical thinking and collaborative inquiry by engaging learners in comparing and classifying kinematic quantities through hands-on exploration.																																		
	<ol style="list-style-type: none">1. What similarities do speed, velocity, and acceleration have?2. How are these quantities related to length and time?3. Which SI units are commonly used among these quantities?																																						
	*Differences Between the Quantities				Sample Gallery Walk Work Sheet																																		
<ol style="list-style-type: none">1. What is the difference between speed and velocity?2. How is acceleration different from speed and velocity?3. Which quantity describes change in motion?				<table><tr><th>Example</th><th>Quantity Measured</th><th>Fundamental or derived</th><th>SI Unit</th><th>Symbol</th></tr><tr><td>Measuring Tape</td><td>Length</td><td>Fundamental</td><td>meter</td><td>m</td></tr><tr><td>Stopwatch</td><td>Time</td><td>Fundamental</td><td>second</td><td>s</td></tr><tr><td>Displacement Card</td><td>Displacement</td><td>Derived</td><td>meter</td><td>m</td></tr><tr><td>Speedometer</td><td>Speed</td><td>Derived</td><td>meter per second</td><td>m/s</td></tr><tr><td>Velocity Scenario</td><td>Velocity</td><td>Derived</td><td>meter per second</td><td>m/s</td></tr><tr><td>Acceleration Card</td><td>Acceleration</td><td>Derived</td><td>meter per second squared</td><td>m/s²</td></tr></table>	Example	Quantity Measured	Fundamental or derived	SI Unit	Symbol	Measuring Tape	Length	Fundamental	meter	m	Stopwatch	Time	Fundamental	second	s	Displacement Card	Displacement	Derived	meter	m	Speedometer	Speed	Derived	meter per second	m/s	Velocity Scenario	Velocity	Derived	meter per second	m/s	Acceleration Card	Acceleration	Derived	meter per second squared	m/s²
Example	Quantity Measured	Fundamental or derived	SI Unit	Symbol																																			
Measuring Tape	Length	Fundamental	meter	m																																			
Stopwatch	Time	Fundamental	second	s																																			
Displacement Card	Displacement	Derived	meter	m																																			
Speedometer	Speed	Derived	meter per second	m/s																																			
Velocity Scenario	Velocity	Derived	meter per second	m/s																																			
Acceleration Card	Acceleration	Derived	meter per second squared	m/s²																																			
Option 2: “Classify the Motion Cards” - A Kinematics Measurement Gallery Walk Variation				Note for Teachers:																																			
<ul style="list-style-type: none">• Instead of rotating around stations, the teacher will distribute a complete set of scenario cards to each group.• The learners will analyze, classify, and organize the cards according to the type of kinematic quantity and SI unit involved.				<ul style="list-style-type: none">• Facilitate discussions and monitor group participation.																																			

Scenario Cards (Sample Set)

- **Card 1** - "A runner completed a 100-meter race."
- **Card 2** - "A stopwatch recorded 12 seconds during the sprint."
- **Card 3** - "A motorcycle traveled at 20 m/s."
- **Card 4** - "A car moved north at 15 m/s."
- **Card 5** - "A jeepney increased its velocity by 3 m/s²."
- **Card 6** - "A student measured the classroom length using a meter stick."
- **Card 7** - "A cyclist completed one lap in 45 seconds."
- **Card 8** - "A bus accelerated while leaving the terminal."

Suggested Classification Chart

Scenario Card	Quantity	Fundamental or derived	SI Unit	Symbol
Runner completed 100-meter race	Length/Distance	Fundamental	meter	m
Stopwatch recorded 12 seconds	Time	Fundamental	second	s
Motorcycle traveled at 20 m/s	Speed	Derived	meter per second	m/s
Jeepney increased velocity by 3 m/s ²	Acceleration	Derived	meter per second squared	m/s ²

Guide Questions:***Similarities Among the Quantities within a station**

1. What similarities do the quantities in the cards have?
2. Which quantities are used to describe motion?
3. Which quantities use SI units?
4. How are derived quantities connected to length and time?

***Differences Between the Quantities between two stations**

1. Which quantities are considered fundamental? Why?
2. Which quantities are considered derived? Why?

Each group will:

1. Read and analyze each scenario card.
2. Identify the quantity described.
3. Classify the quantity as:
 - Fundamental
 - Derived
4. Match the appropriate SI unit and symbol.
5. Organize the cards on the classification chart.

Materials Needed

- Scenario cards
- Classification chart/manila paper
- Marker pens
- Tape or adhesive
- Meta cards labeled:
 - Fundamental Quantities
 - Derived Quantities

IDF Relevance

- This activity strengthens classification, reasoning, and collaborative learning skills by engaging learners in analyzing and organizing real-life motion scenarios.

	<p>2. Discussing New Concept</p> <p>Option 1: “Concept Builders: Kinematics Edition”</p> <p>A. Group Formation</p> <ol style="list-style-type: none"> 1. The teacher will divide the class into small groups of 4–6 learners. 2. Give each group a set of mixed meta cards and a chart of paper. <p>B. Concept Building Task</p> <ol style="list-style-type: none"> 3. Instruct learners to sort and organize the cards into two major categories: <ul style="list-style-type: none"> ○ Fundamental Quantities <ul style="list-style-type: none"> ➤ Fundamental quantities are basic quantities that are measured directly and are not formed by combining other quantities. ○ Derived Quantities <ul style="list-style-type: none"> ➤ Quantities are formed by combining fundamental quantities. <p>C. Relationship Mapping</p> <ol style="list-style-type: none"> 4. Learners connect related cards using arrows or grouping patterns. Example: <ul style="list-style-type: none"> ○ Length → meter (m) ○ Time → second (s) ○ Speed → m/s → Distance ÷ Time ○ Velocity → m/s → Displacement ÷ Time ○ Acceleration → m/s² → Velocity ÷ Time <p>D. Group Explanation</p> <ol style="list-style-type: none"> 5. Each group presents their chart and explains: <ul style="list-style-type: none"> ○ Why are length and time fundamental quantities? ○ How are speed, velocity, and acceleration derived from length and time? ○ The relationship between quantities, symbols, and SI units. 	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Observe group discussions and guide learners using probing questions. • Encourage learners to justify their classifications. • Facilitate synthesis after presentations. • Clarify misconceptions only after learners attempt their own explanations. <p>Materials Needed</p> <ul style="list-style-type: none"> • Meta cards (prepared with quantities, symbols, SI units, and formulas) • Chart paper or manila paper • Marker pens • Tape or adhesive <p>Preparation of Meta Cards</p> <ul style="list-style-type: none"> • Prepare mixed cards containing the following: <p>Fundamental Quantity Cards</p> <ul style="list-style-type: none"> • Length • Time <p>SI Unit Cards</p> <ul style="list-style-type: none"> • meter (m) • second (s) • meter per second (m/s) • meter per second squared (m/s²)
--	---	--

	<p>Processing questions:</p> <ol style="list-style-type: none"> 1. What makes the quantity “fundamental”? 2. Why are length and time considered basic measurements in kinematics? 3. Why is speed considered a derived quantity? 4. How are velocity and acceleration related to length and time? 5. Which quantities are commonly used when describing motion? <p>3. Developing Mastery</p> <p>Option 1: “SI Relay Challenge: Kinematics Edition”</p> <p>Preparation Before the Activity</p> <ol style="list-style-type: none"> 1. The teacher will prepare 5 challenge stations around the classroom. 2. Each station contains: <ul style="list-style-type: none"> ○ A set of questions/tasks ○ A whiteboard and marker ○ Instructions for the group 3. Arrange learners into small groups with equal members. 4. Explain that groups will rotate from one station to another like a relay challenge. <p>Procedure</p> <p>A. Introduction (2–3 minutes)</p> <p>The teacher briefly reviews:</p> <ul style="list-style-type: none"> • Fundamental SI quantities in kinematics: <ul style="list-style-type: none"> ○ Length → meter (m) ○ Time → second (s) • Derived quantities: <ul style="list-style-type: none"> ○ Speed → m/s ○ Velocity → m/s ○ Acceleration → m/s² <p>The teacher explains that groups must work together quickly and accurately to complete each challenge station.</p>	<p>Derived Quantity Cards</p> <ul style="list-style-type: none"> • Speed • Velocity • Acceleration <p>Formula Cards</p> <ul style="list-style-type: none"> • Speed = Distance ÷ Time • Velocity = Displacement ÷ Time • Acceleration = Change in velocity ÷ Time <p>Symbol Cards</p> <ul style="list-style-type: none"> • l • t • v • a <p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity promotes constructivist learning by allowing learners to organize and defend their understanding. <p>Note for Teacher:</p> <ul style="list-style-type: none"> • Monitor teamwork and learner participation. • Observe learner reasoning rather than simply checking answers. • Ask scaffolding questions such as: <ul style="list-style-type: none"> ○ What basic quantities are needed to get speed? ○ Can acceleration exist without time?
--	--	---

	<p>B. Relay Mechanics</p> <ol style="list-style-type: none">1. Each group starts at an assigned station.2. Groups answer all tasks at the station within the allotted time (2–4 minutes).3. When time is called, groups rotate clockwise to the next station.4. Learners must discuss answers before writing them.5. Points are awarded for:<ul style="list-style-type: none">○ Correct answers, Clear explanations, Team collaboration <p>C. Challenge Stations</p> <p>STATION 1 – “Identify the SI Unit”</p> <p>Task: Identify the correct SI unit and symbol for each quantity.</p> <p>Sample Questions for Station 1:</p> <ol style="list-style-type: none">1. What is the SI unit of length?2. What is the SI symbol for the second?3. What SI unit is used for speed?4. What SI unit is used for acceleration?5. Which quantity uses meter (m) as its SI unit? <p>STATION 2 – “Fundamental or Derived?”</p> <p>Task: Classify each quantity as Fundamental or Derived.</p> <p>Sample Questions for Station 2:</p> <table><tr><th>Quantity</th><th>Classification</th></tr><tr><td>Length</td><td></td></tr><tr><td>Time</td><td></td></tr><tr><td>Speed</td><td></td></tr><tr><td>Velocity</td><td></td></tr><tr><td>Acceleration</td><td></td></tr></table> <p>Follow-Up Questions:</p> <ul style="list-style-type: none">• Why is time considered fundamental?• Why is acceleration considered derived?	Quantity	Classification	Length		Time		Speed		Velocity		Acceleration		<ul style="list-style-type: none">○ Why are derived quantities dependent on fundamental quantities? <ul style="list-style-type: none">• Encourage peer teaching and collaborative discussion.• Provide clarification only after learners attempt to reason independently. <p>Materials Needed:</p> <ul style="list-style-type: none">• Challenge station task cards• Whiteboards or mini whiteboards• Marker pens and erasers• Timer or stopwatch• Scoreboard (optional)• Answer sheets for teacher reference <p>IDF Relevance:</p> <p>This activity strengthens collaborative problem-solving, critical thinking, and immediate formative feedback through interactive relay-based learning.</p> <p>Expected Answers for Station 1:</p> <ul style="list-style-type: none">• Length → meter (m)• Time → second (s)• Speed → meter per second (m/s)• Acceleration → meter per second squared (m/s²)
Quantity	Classification													
Length														
Time														
Speed														
Velocity														
Acceleration														

STATION 3 – “Formula Match-Up”**Task:** Match the formula to the correct derived quantity.

Formula Cards	Quantity Cards	Expected Matches
Distance ÷ Time	Speed	
Displacement ÷ Time	Acceleration	
Velocity ÷ Time	Velocity	

Challenge Extension:

- The learners will explain how length and time are used in each formula.

STATION 4 – “Explain Your Reasoning”**Task:** Answer the questions using complete explanations.**Sample Questions:**

- Why is velocity considered a derived quantity?
- Why do speed and velocity have the same SI unit?
- How are length and time connected to acceleration?
- Why are fundamental quantities important in physics?

STATION 5 – “Challenge Round”**Task:** Solve mixed relay questions as fast as possible.**Sample Questions:**

- Which of the following is a derived quantity: velocity or length?
- What derived quantity uses the unit m/s^2 ?
- Which quantities are fundamental in kinematics?
- True or False: Speed is a fundamental quantity.
- Complete the statement:
“Acceleration measures the change in _____ over time.”

Expected Answers for Station 2:

Quantity	Classification
Length	Fundamental
Time	Fundamental
Speed	Derived
Velocity	Derived
Acceleration	Derived

Expected Learner Responses for Station 4:

- Velocity is a derived quantity because it is calculated from displacement and time.
- Speed and velocity have the same SI unit because both are expressed as distance or displacement per unit of time (m/s).
- Length and time are connected to acceleration because acceleration is the change in velocity (which involves length and time) over time, resulting in m/s^2 .
- Fundamental quantities are important because they serve as the basic building blocks for all other physical quantities.

Expected Answers for Station 5:

- Velocity
- Acceleration
- Length and Time
- False
- Velocity

	<p>Option 2: “Incomplete Motion Challenge”</p> <p>Procedure</p> <p>A. Introduction (2–3 minutes) The teacher briefly reviews: Fundamental Quantities in Kinematics</p> <ul style="list-style-type: none"> • Length → meter (m) • Time → second (s) <p>Derived Quantities</p> <ul style="list-style-type: none"> • Speed → Distance ÷ Time • Velocity → Displacement ÷ Time • Acceleration → Change in velocity ÷ Time <p>The teacher then asks: “Can we describe speed if one important quantity is missing?” The teacher introduces the challenge: <i>Learners must determine whether the given information is enough to describe motion quantities correctly.</i></p> <p>B. Relay Mechanics</p> <ol style="list-style-type: none"> 1. Each group starts at an assigned station. 2. Groups discuss and answer the challenge within the allotted time (2–4 minutes). 3. When time is called, groups rotate clockwise. 4. Learners must explain their reasoning before writing answers. 5. Points are awarded for: <ul style="list-style-type: none"> ○ Correct answers ○ Logical explanations ○ Team collaboration <p>C. Challenge Stations</p> <p>*STATION 1 – “May Distance Pero Walang Time” Task: Analyze whether speed can be identified. Scenario Card: “A motorcycle traveled 200 meters.” Guide Questions:</p> <ol style="list-style-type: none"> 1. Can you identify the speed of the motorcycle? 	<p>Notes for Teachers: Preparation Before the Activity</p> <ol style="list-style-type: none"> 1. The teacher will prepare 5 challenge stations around the classroom. 2. Each station contains: <ul style="list-style-type: none"> ○ Scenario cards ○ Whiteboard and marker ○ Guide questions ○ Short challenge task 3. Arrange learners into small groups with equal members. 4. Explain that groups will rotate from one station to another and analyze whether the information given is enough to describe motion. <p>Expected Learner Response for Station 1:</p> <ul style="list-style-type: none"> • No, speed cannot be identified. • Time is missing. • Speed requires both distance and time. <p>Expected Learner Response for Station 2:</p> <ul style="list-style-type: none"> • No, the speed is unknown. • Distance is missing. • Speed measures distance covered over time. <p>Expected Learner Response for Station 3:</p> <ul style="list-style-type: none"> • Yes. • Distance and time are both present.
--	---	--

	<div>2. What important quantity is missing?</div> <div>3. Why can't speed be determined?</div> <div>*STATION 2 – “May Time Pero Walang Distance”</div> <div>Task: Determine if motion speed can be described.</div> <div>Scenario Card: “A runner completed the race in 15 seconds.”</div> <div>Guide Questions:</div> <div><div>1. Is the runner's speed known?</div><div>2. What information is lacking?</div><div>3. Why is time alone not enough?</div></div> <div>STATION 3 – “Complete Motion Information”</div> <div>Task: Determine whether speed can now be described.</div> <div>Scenario Card: “A cyclist traveled 100 meters in 10 seconds.”</div> <div>Guide Questions:</div> <div><div>1. Can speed be identified?</div><div>2. What quantities are present?</div><div>3. Why is this considered a derived quantity?</div></div> <div>STATION 4 – “Velocity or Speed?”</div> <div>Task: Identify whether the quantity described is speed or velocity.</div> <div>Scenario Card: “A car traveled 20 m/s north.”</div> <div>Guide Questions:</div> <div><div>1. Is this speed or velocity?</div><div>2. What information makes it different?</div><div>3. Why is direction important?</div></div> <div>STATION 5 – “Build the Formula”</div> <div>Task: Complete the missing parts of motion formulas.</div> <div>Challenge Board:</div> <div><table><tr><th>Quantity</th><th>Needed Quantities</th></tr><tr><td>Speed</td><td>_____ + _____</td></tr><tr><td>Velocity</td><td>_____ + _____</td></tr><tr><td>Acceleration</td><td>_____ + _____</td></tr></table></div>	Quantity	Needed Quantities	Speed	_____ + _____	Velocity	_____ + _____	Acceleration	_____ + _____	<div><div><div>• Speed is derived from length and time.</div></div></div> <div>Expected Learner Response for Station 4:</div> <div><div><div>• Velocity.</div><div>• It includes direction (“north”).</div><div>• Velocity describes motion with direction.</div></div></div> <div>Expected Answers for Station 5:</div> <div><table><tr><th>Quantity</th><th>Needed Quantities</th></tr><tr><td>Speed</td><td>Distance + Time</td></tr><tr><td>Velocity</td><td>Displacement + Time</td></tr><tr><td>Acceleration</td><td>Velocity + Time</td></tr></table></div> <div>Notes for Teachers:</div> <div><div><div>• Observe learner reasoning and explanations.</div><div>• Encourage learners to justify their answers using formulas and concepts.</div><div>• Ask scaffolding questions such as:<div><div>○ What information is missing?</div><div>○ Can speed be measured without time?</div><div>○ What is the relationship between distance and time in motion?</div></div></div></div></div>	Quantity	Needed Quantities	Speed	Distance + Time	Velocity	Displacement + Time	Acceleration	Velocity + Time
Quantity	Needed Quantities																	
Speed	_____ + _____																	
Velocity	_____ + _____																	
Acceleration	_____ + _____																	
Quantity	Needed Quantities																	
Speed	Distance + Time																	
Velocity	Displacement + Time																	
Acceleration	Velocity + Time																	

	<p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Why are speed and velocity considered derived quantities? 2. What fundamental quantities are needed to describe motion? 3. Can derived quantities exist without fundamental quantities? <p>Processing Questions:</p> <ol style="list-style-type: none"> 1. Why can't you call it speed if there is no time? 2. Why is distance important in measuring speed? 3. What happens if information about motion is incomplete? 4. How are derived quantities formed from fundamental quantities? 	<ul style="list-style-type: none"> • Clarify misconceptions only after learners attempt reasoning. • Emphasize that derived quantities are formed from fundamental quantities.
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Activity: “Global Science Mission”</p> <p>Scenario:</p> <p>The learners are part of a Global Science Mission Team composed of young scientists from different countries, including the Philippines, Japan, Germany, and the United States. The team is collaborating with an international transportation research agency to study vehicle motion and road safety.</p> <p>The agency is investigating how vehicles accelerate, maintain speed, and stop in different road conditions. However, they discovered that some countries report data using different measurement systems, causing confusion and errors in data comparison.</p> <p>To solve this problem, the learners are tasked to recommend a standard measurement system using SI units to ensure accurate and unified scientific communication.</p>	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Facilitate rather than directly instruct; allow learners to analyze the problem first. • Encourage learners to connect physics concepts to real-world transportation and safety issues. • Use guiding questions such as: <ul style="list-style-type: none"> ○ What could go wrong if speed is measured differently in each country? ○ Why is it important that engineers around the world understand the same data? ○ How does SI help prevent accidents in transportation systems? • Monitor group collaboration and ensure all members participate.

	<p>Task: Each group will create a short scientific recommendation report explaining how motion should be measured consistently in a global research setting. Your output must include:</p> <p>A. SI Quantities and Units Used in Vehicle Motion The learners must identify and explain:</p> <ul style="list-style-type: none"> • Length → meter (m) • Time → second (s) • Speed → meter per second (m/s) • Velocity → meter per second (m/s) • Acceleration → meter per second squared (m/s²) <p>They must explain:</p> <ul style="list-style-type: none"> • What each quantity measures in vehicle motion • Why each unit is appropriate in scientific studies <p>B. Importance of Standardized SI Units in Global Science The learners must explain:</p> <ul style="list-style-type: none"> • Why must scientists from different countries use the same measurement system? • How do SI units help avoid confusion in international research? • How does standardization improve collaboration in transportation studies? <p>C. Consequences of Using Inconsistent Units The learners must discuss possible real-world problems such as:</p> <ul style="list-style-type: none"> • Misinterpretation of vehicle speed or acceleration data • Engineering design errors in transportation systems • Safety risks in road construction and vehicle testing • Communication breakdown between international teams <p>Output Options (Choose One) Each group will present their ideas using ONE of the following:</p> <ul style="list-style-type: none"> • Mini Poster (hand-drawn or digital) 	<ul style="list-style-type: none"> • Clarify misconceptions about speed, velocity, and acceleration after learning. • Encourage creativity in presentation while maintaining scientific accuracy. • Emphasize real-life relevance in global science and engineering. <p>Expected Learner Realization:</p> <ul style="list-style-type: none"> • The learners understand that SI units are essential for accurate, safe, and consistent communication in global scientific research, especially in transportation and motion studies. <p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity develops critical thinking, collaboration, and global scientific awareness by engaging learners in solving real-world problems using standardized SI measurements. <p>Note for Teacher:</p> <ul style="list-style-type: none"> • Facilitate synthesis. • Highlight learner-generated conclusions. <p>Expected Learner Generalization:</p> <ul style="list-style-type: none"> • Fundamental quantities are basic measurable quantities with standard SI units.
--	---	--

	<ul style="list-style-type: none"> • Infographic • Short Role-Play (2–3 minutes) • News Report Simulation (scientific reporting style) <p>2. Making Generalization</p> <p>“3-2-1 Reflection”</p> <p>Procedure: The learners individually write:</p> <ul style="list-style-type: none"> • 3 fundamental quantities used in motion • 2 differences between fundamental and derived quantities • 1 reason why SI units are important globally <p>Processing:</p> <ul style="list-style-type: none"> • The teacher will select learners to share insights with the class. 	<ul style="list-style-type: none"> • Derived quantities are formed from combinations of fundamental quantities. • SI units ensure accurate communication and consistency worldwide. <p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity encourages metacognition and learner ownership of understanding.
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>Performance-Based Assessment: “Motion Measurement Investigation”</p> <p>Integrated Performance Task: “Design a 10 km Fun Run Map”</p> <p>Situation</p> <p>A sports organizer is preparing an international 10 km fun run involving participants from different countries. To ensure fair competition, accurate recording of results, and clear communication among participants and officials, standardized measurements must be used throughout the event. The organizer needs a Motion Measurement Guide and Fun Run Route Map that clearly shows the motion quantities involved in the event using proper SI units.</p> <p>Task: The learners will work in groups to design a:</p> <ul style="list-style-type: none"> • “10 km Fun Run Motion Measurement Guide and Route Map” <p>The output should:</p> <ul style="list-style-type: none"> • Present a 10 km fun run route/map • Show the use of distance and time measurements • Explain the SI quantities involved in motion • Demonstrate the importance of standardized SI units in an international sports event 	

Output Options - The learner output may be presented as:

- Poster, Infographic, Brochure, Chart Presentation, Digital Slide Presentation

Required Content of the Output

A. 10 km Fun Run Map - The group must create a simple **10 km fun run route map** showing:

- Starting Point
- Finish Line
- Kilometer markers (e.g., 2 km, 5 km, 8 km, 10 km)
- Estimated travel time checkpoints
- Direction of movement/arrows
- Distance labels using SI units

Example Table to Include in the Map

Checkpoint	Distance Travelled	Estimated Time	Possible Speed
Start Line	0 km	0 min	—
Water Station 1	2 km	12 min	2.78 m/s
Water Station 2	5 km	30 min	2.78 m/s
Medical Station	8 km	48 min	2.78 m/s
Finish Line	10 km	60 min	2.78 m/s

B. Fundamental Quantities in Kinematics - The learners must identify and explain the **fundamental quantities** used in the fun run.

Quantity	SI Unit	Symbol
Length	meter	m
Time	second	s

The learners should explain:

- What each quantity measures
- Why each quantity is considered fundamental
- How these quantities are used in the fun run map

Example:

- Length → measures the total route distance
- Time → measures runner performance duration

C. Derived Quantities in Motion - The learners must identify and explain the following derived quantities:

	<table><tr><th>Derived Quantity</th><th>Formula</th><th>SI Unit</th></tr><tr><td>Speed</td><td>Distance ÷ Time</td><td>m/s</td></tr><tr><td>Velocity</td><td>Displacement ÷ Time</td><td>m/s</td></tr><tr><td>Acceleration</td><td>Velocity ÷ Time</td><td>m/s²</td></tr></table>	Derived Quantity	Formula	SI Unit	Speed	Distance ÷ Time	m/s	Velocity	Displacement ÷ Time	m/s	Acceleration	Velocity ÷ Time	m/s ²		
	Derived Quantity	Formula	SI Unit												
	Speed	Distance ÷ Time	m/s												
	Velocity	Displacement ÷ Time	m/s												
	Acceleration	Velocity ÷ Time	m/s ²												
	<p>The learners should explain:</p> <ul style="list-style-type: none">• How these quantities are formed using length and time• How each quantity is used during the event														
	<p>Examples:</p> <ul style="list-style-type: none">• Speed → measures how fast runners move• Velocity → describes motion with direction along the route• Acceleration → shows changes in runner motion														
	<p>D. Importance of SI Standardization</p> <p>The learners must explain why SI units are important in an international event.</p>														
	<p>Guide Questions:</p> <ol style="list-style-type: none">1. Why should all countries use the same measurement system?2. What problems might happen if different units are used?3. How do SI units help scientists, athletes, and organizers communicate accurately?														
	<p>Performance-Based Assessment: “Motion Measurement Investigation – 10 km Fun Run Map”</p> <table><tr><th>Criteria</th><th>4 – Advanced</th><th>3 – Proficient</th><th>2 – Developing</th><th>1 – Beginning</th></tr><tr><td>Accuracy of the Fun Run Map</td><td>The map is complete, accurate, and uses correct SI units for distance and time.</td><td>The map is mostly accurate with minor errors.</td><td>The map has several missing or incorrect details.</td><td>The map is incomplete or unclear.</td></tr><tr><td>Understanding of Fundamental and Derived Quantities</td><td>Correctly explains fundamental and derived quantities with proper SI units and formulas.</td><td>Explain most quantities correctly with minor errors.</td><td>Shows partial understanding of quantities and units.</td><td>Shows little understanding of quantities and SI units.</td></tr></table>	Criteria	4 – Advanced	3 – Proficient	2 – Developing	1 – Beginning	Accuracy of the Fun Run Map	The map is complete, accurate, and uses correct SI units for distance and time.	The map is mostly accurate with minor errors.	The map has several missing or incorrect details.	The map is incomplete or unclear.	Understanding of Fundamental and Derived Quantities	Correctly explains fundamental and derived quantities with proper SI units and formulas.	Explain most quantities correctly with minor errors.	Shows partial understanding of quantities and units.
Criteria	4 – Advanced	3 – Proficient	2 – Developing	1 – Beginning											
Accuracy of the Fun Run Map	The map is complete, accurate, and uses correct SI units for distance and time.	The map is mostly accurate with minor errors.	The map has several missing or incorrect details.	The map is incomplete or unclear.											
Understanding of Fundamental and Derived Quantities	Correctly explains fundamental and derived quantities with proper SI units and formulas.	Explain most quantities correctly with minor errors.	Shows partial understanding of quantities and units.	Shows little understanding of quantities and SI units.											

	Application of SI Units and Standardization	Clearly explains the importance of SI units in the fun run event.	Explains the importance of SI units with minor gaps.	Gives limited explanation of SI units.	Gives unclear or inaccurate explanations.
	Organization and Visual Presentation	Output is organized, neat, and easy to understand.	Output is mostly organized and understandable.	Output is somewhat organized but unclear in parts.	Output is difficult to follow and poorly organized.
	Collaboration and Participation	All members actively contributed to the task.	Most members participated actively.	Only some members participated.	Very limited group participation.
	IDF Relevance: This performance task develops collaboration, critical thinking, communication, and real-world application of scientific concepts through authentic problem-solving.				
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	Reflection Questions for Learners: <ol style="list-style-type: none"> 1. <i>What is the difference between fundamental and derived quantities, and how did the activities help you better understand these concepts?</i> 2. <i>How can using SI units improve accuracy and communication when describing motion in everyday situations (e.g., travel, sports, or deliveries)?</i> 3. <i>Which activity (e.g., map drawing, gallery walk, relay challenge) helped you understand the lesson the most, and what difficulties did you encounter while learning the concepts?</i> Reflection Questions for Teachers: <ol style="list-style-type: none"> 1. <i>Which instructional strategy (e.g., scenario-based learning, gallery walk, relay challenge) most effectively helped learners grasp the concepts of SI units? Why?</i> 2. <i>What common misconceptions did learners show (e.g., confusion between speed and velocity, or fundamental vs derived quantities), and how were these addressed during the lesson?</i> 3. <i>What challenges did you encounter in teaching this lesson (e.g., time constraints, varying student abilities, limited materials, or difficulty in conceptual understanding), and what strategies can be improved for future implementation?</i> 				
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used ChatGPT, Microsoft Copilot, and Google Gemini in order to support the development and refinement of instructional activities, guide questions, and expected answers. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.				

Learning Area	PHYSICS 1	Lesson Exemplar	4
----------------------	------------------	------------------------	----------

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that measuring should be done precisely and accurately and must be expressed correctly; and qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners calculate displacement, velocity, and acceleration in one-dimensional motion.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<p>BBC Bitesize. <i>Forces and Motion – Physics</i>. https://www.bbc.co.uk/bitesize/subjects/zpm6fg8</p> <p>CK-12 Foundation. <i>Physics FlexBook: Motion and Forces</i>. https://www.ck12.org/physics/</p> <p>Department of Education. <i>Strengthened Senior High School Curriculum: Physics 1 Curriculum Guide</i>. Manila, Philippines: DepEd, 2025.</p> <p>Diwa Learning Systems Inc. <i>Senior High School Physics (General Physics 1 & 2)</i>. Manila: Diwa Learning Systems, various editions.</p> <p>Giancoli, Douglas C. <i>Physics: Principles with Applications</i>. 7th ed. Boston, MA: Pearson, 2014.</p> <p>HyperPhysics (Georgia State University). <i>Mechanics: Kinematics</i>. http://hyperphysics.phy-astr.gsu.edu/</p> <p>Khan Academy. <i>Physics: One-dimensional motion and vectors</i>. https://www.khanacademy.org/science/physics</p> <p>PhET Interactive Simulations (University of Colorado Boulder). <i>Motion and Forces Simulations</i>. https://phet.colorado.edu/</p> <p>Rex Book Store. <i>Physics for Senior High School (General Physics Series)</i>. Manila: Rex Book Store, various editions.</p> <p>Serway, Raymond A., and John W. Jewett. <i>Physics for Scientists and Engineers</i>. 9th ed. Boston, MA: Cengage Learning, 2014.</p> <p>The Physics Classroom. <i>Motion in One Dimension</i>. https://www.physicsclassroom.com/</p> <p>Young, Hugh D., and Roger A. Freedman. <i>University Physics with Modern Physics</i>. 14th ed. Boston, MA: Pearson, 2016.</p>

III. CONTENT (Sequencing Content)	Kinematics									
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	By the end of this lesson, the learners should be able to: <div><div>1. differentiate between scalar quantities (distance and speed) and vector quantities (displacement and velocity);</div><div>2. rearrange relevant formulas to solve for an unknown variable in one-dimensional motion problems;</div><div>3. compute for the displacement, average velocity and average acceleration of an object given specific time intervals; and</div><div>4. interpret the physical meaning of positive and negative signs in the calculated values of velocity and acceleration.</div></div>									
IV. PROCEDURES		ANNOTATIONS								
A. Activating Prior Knowledge	<div><div>1. Activating Prior Knowledge</div><div>Option 1: Direction Card Sorting<div><div><div><div>DISTANCE</div></div><div><div>DISPLACEMENT</div></div><div><div>SPEED</div></div></div><div><div><div>VELOCITY</div></div><div><div>TIME</div></div><div><div>ACCELERATION</div></div></div></div><div><p>This image is generated from ChatGPT</p><div><div><div><div>DOES NOT REQUIRE DIRECTION</div><div></div><div></div><div></div><div></div></div><div><div>REQUIRES DIRECTION</div><div></div><div></div><div></div><div></div></div></div><div><div>• The learners will sort cards into:</div></div></div></div></div></div>	<div><div>Notes for Teachers:<div><div>• Encourage justification rather than memorization.</div><div>• Clarify misconceptions immediately during discussion.</div></div></div><div><div>Materials Needed:<div><div>• Flashcards with quantities</div><div>• Direction cards</div><div>• Pocket chart/board/manila paper</div></div></div></div><div><div>Expected Answers:<table><tr><th>DOES NOT REQUIRE DIRECTION</th><th>REQUIRES DIRECTION</th></tr><tr><td>Distance</td><td>Displacement</td></tr><tr><td>Speed</td><td>Velocity</td></tr><tr><td>Time</td><td>Acceleration</td></tr></table></div><div><div>Expected Answers for Guide Questions:<div><div>1. Quantities need direction if they describe both magnitude and motion direction, while others only describe magnitude.</div></div></div></div></div></div>	DOES NOT REQUIRE DIRECTION	REQUIRES DIRECTION	Distance	Displacement	Speed	Velocity	Time	Acceleration
DOES NOT REQUIRE DIRECTION	REQUIRES DIRECTION									
Distance	Displacement									
Speed	Velocity									
Time	Acceleration									

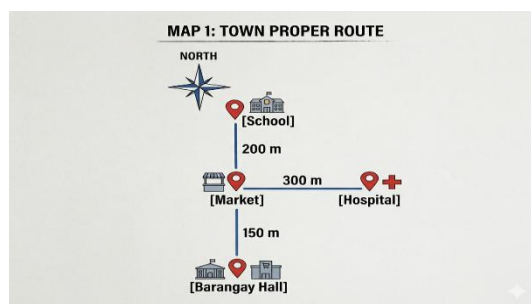
	<ul style="list-style-type: none">Each group will explain why certain quantities require direction. <p>Guide Questions:</p> <ol style="list-style-type: none">Why do some quantities need direction to be completely described, while others do not?Which quantities can be described using magnitude only?Which quantities need both magnitude and direction?Can speed be classified as a quantity with direction? Why or why not?What happens when direction is added to speed?Why do velocity and acceleration require direction? <p>Option 2: Motion Charades</p> <ul style="list-style-type: none">The teacher will form groups of 4–5 members.One learner picks an action card and silently performs the motion.Examples:<ul style="list-style-type: none">Walking northRunning fastMoving backwardOther group members will identify whether the motion description includes direction or does not include direction.The learners will organize their answers using a simple two-column chart on their mini whiteboard or paper: <table><tr><th>DOES NOT REQUIRE DIRECTION</th><th>REQUIRES DIRECTION</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table> <ul style="list-style-type: none">Each group will explain their reasoning.	DOES NOT REQUIRE DIRECTION	REQUIRES DIRECTION							<ol style="list-style-type: none">Displacement includes direction of change in position, while distance only measures total path length.No, because speed has no direction and becomes velocity when direction is included.Both velocity and acceleration include direction as part of describing motion. <p>IDF Relevance:</p> <ul style="list-style-type: none">This activity enhances classification and reasoning skills through collaborative concept analysis. <p>Notes for Teachers:</p> <ul style="list-style-type: none">Keep activities fast-paced and interactive.Reinforce that vector require direction. <p>Materials Needed:</p> <ul style="list-style-type: none">Action cardsMini whiteboards/PaperMarker/Ballpen <p>IDF Relevance:</p> <ul style="list-style-type: none">This activity promotes active participation and conceptual understanding through kinesthetic learning. <p>Expected Answers for Guide Questions:</p> <ol style="list-style-type: none">Actions like “walking north” and “moving backward” show motion
DOES NOT REQUIRE DIRECTION	REQUIRES DIRECTION									

Guide Questions:

1. Which actions showed motion with direction and which showed motion without direction?
2. How can you tell if the motion includes direction just by observing the action?
3. Which quantities describe motion without direction, and which ones require direction?
4. How is velocity different from speed based on the actions performed?

2. Establishing the Purpose of the Lesson**Option 1: “Navigation Challenge”****Materials Needed:**

- Printed maps
- Scenario cards
- Manila paper
- Marker

Scenario Card 1: “Emergency Supply Delivery”

(This image is generated from Gemini AI)

- A rescue team starts at the **Barangay Hall**.
- They travel:
 - 150 m north to the Market
 - then 300 m east to the Hospital

with direction, while “running fast” shows motion without direction.

2. Motion includes direction if it shows where the object is going (e.g., north, backward), not just how fast it moves.
3. Speed describes motion without direction, while velocity and displacement require direction.
4. Velocity includes both speed and direction, while speed only describes how fast an object moves.

Notes for Teachers:

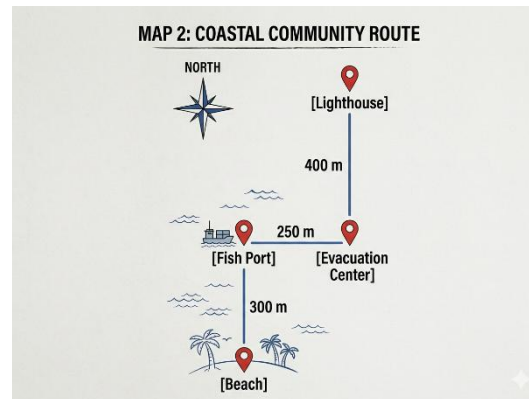
- The given maps and scenarios are only examples. You may also create your own maps and scenarios based on your community.
- Make the distances between establishments or locations realistic. Use Google Maps or a local map to estimate actual distances between places in your community. Search for actual distances of these places in your locality using google search or map.

Answer for Scenario 1

- Total Distance = 150 m + 300 m = **450 m**
- Direction = **North then East**
- Displacement $\approx$ **335 m Northeast**

Tasks:

1. Determine the **total distance traveled**.
2. Describe the **route taken**.
3. Estimate the **displacement** from the starting point to the final point.
4. State the **direction of displacement**.
5. Explain why direction is important in this situation.

Scenario Card 2: "Typhoon Evacuation"

(This image is generated from Gemini)

- Residents start from the **Beach**.
- They move:
 - 300 m north to the Fish Port
 - then 250 m east to the Evacuation Center

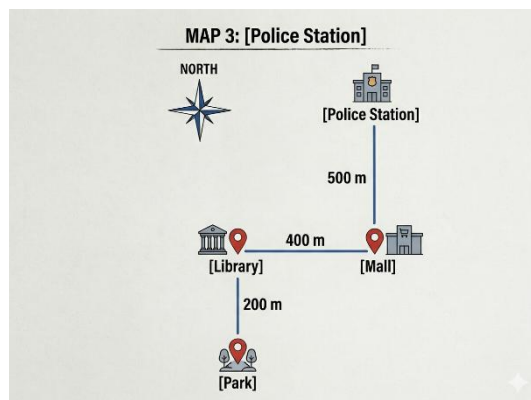
Tasks:

1. Calculate the **total distance traveled**.
2. Describe the **direction of movement**.
3. Estimate the **displacement** from the Beach to the Evacuation Center.
4. Why is displacement useful during evacuation planning

Answer for Scenario 2

- Total Distance = 300 m + 250 m = **550 m**
- Direction = **North then East**
- Displacement $\approx$ **390 m Northeast**

Scenario Card 3: "Delivery Route Challenge"



(This image is generated from Gemini)

- A rider begins at the **park**.
- The rider travels:
 - 200 m north to the library
 - then 400 m east to the mall

Tasks:

1. Find the **total distance traveled**.
2. State the **final direction of travel**.
3. Estimate the rider's **displacement**.
4. Why is displacement more useful than distance in navigation apps?

Guide Questions:

- Is distance alone sufficient to describe motion of object? Explain your answer.
- How does direction affect the description of motion?

Option 2: Best Route Investigation

- The teacher will group the learners into five (5) groups. Each group will be given a copy of a school map.
- The learners will examine the school map.
- Each group will compare routes from a **common starting point and ending point**, such as:

Answer for Scenario 3

- Total Distance = 200 m + 400 m = **600 m**
- Direction = **North then East**
- Displacement $\approx$ **447 m Northeast**

IDF Relevance:

The activity strengthens contextualized learning through real-world applications.

Notes for Teachers:

- Provide a copy of school map.
- Encourage learners to connect physics to everyday commuting.

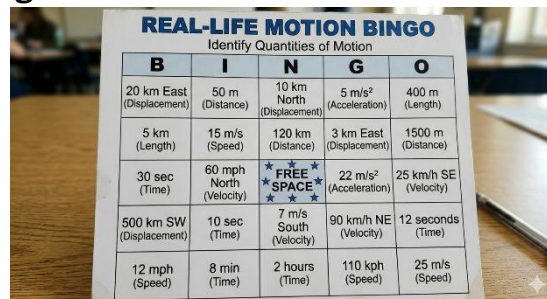
	<ul style="list-style-type: none"> ○ From the School Gate (Starting Point) to the classroom (End Point) ● Each group will identify: <ul style="list-style-type: none"> ○ Longest route → the path that covers the greatest distance from the school gate to the classroom ○ Shortest route → the path that covers the least distance from the school gate to the classroom ● The learners will compare the distances of different routes and identify the displacement as the straight-line change in position from the starting point to the ending point. ● Emphasize that if the starting point and ending point are the same, the displacement is the same even if the routes taken are different. ● Each group will justify their chosen route. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Which route has the shortest distance? Would this route likely save time? Why or why not? 2. Which route has the shortest distance? Does it always mean it has the smallest displacement? 3. Why is displacement useful when choosing the best route from the starting point to the destination? 	<p>Materials Needed:</p> <ul style="list-style-type: none"> ● School Map layout ● Ruler ● Marker <p>IDF Relevance:</p> <ul style="list-style-type: none"> ● This activity develops decision-making and spatial reasoning skills.
B. Instituting New Knowledge	<p>After the Activating Prior Knowledge activities, the teacher will process the learners' answers (e.g., measurements identified in their daily travel map or motion activities such as distance, time, and speed).</p> <ul style="list-style-type: none"> ● The teacher will highlight that learner already identified quantities such as: <ul style="list-style-type: none"> ○ Distance and time (without direction) ○ Speed (how fast) ○ Motion with direction (e.g., "walking north") ● The teacher will then guide the class by asking: <ul style="list-style-type: none"> ○ <i>"Which of your answers included direction?"</i> ○ <i>"Which ones only described how much or how fast?"</i> 	

	<ul style="list-style-type: none"> Using the learners' responses, the teacher will introduce: <ul style="list-style-type: none"> Scalar quantities → quantities with magnitude only (e.g., distance, speed, time) Vector quantities → quantities with magnitude and direction (e.g., displacement, velocity, acceleration) The teacher will emphasize that: <ul style="list-style-type: none"> Some quantities become more complete when direction is included (e.g., speed → velocity) Understanding this difference is important in describing motion accurately The teacher will then conclude: <i>"Now that you can distinguish between scalar and vector quantities based on your own examples, you are ready to analyze motion situations more systematically in the next activities."</i> <p>1. Presenting Examples</p> <p>Option 1: Scalar or Vector Gallery Walk</p> <ul style="list-style-type: none"> The class will be divided into small groups (3–5 members each). Each group will start at a different picture station. At every station, observe the picture carefully. Identify the physical quantity shown in the picture (acceleration, speed, velocity, distance, displacement, time). Decide whether the quantity is scalar or vector. Write your answer and a short explanation on a meta card (why it is scalar or vector) then paste it on the board or manila paper. After a given time (e.g., 3–5 minutes per station), rotate to the next station upon teacher signal. Continue until all stations are visited. Return to your original station and review the answers written by other groups, then prepare to share insights. <p>Guide Questions:</p>	<p>Note for Teachers:</p> <ol style="list-style-type: none"> Prepare 5–8 picture stations showing real-life motion scenarios (e.g., running athlete, moving car with direction arrows, falling object, walking student, airplane flight path). Clearly label each station. Ensure learners understand the difference between scalar (magnitude only) and vector (magnitude with direction) before starting. Monitor group discussions and guide learners who struggle in identifying direction-based quantities. Encourage learners to justify their answers rather than only stating classifications.
--	---	--

	<ol style="list-style-type: none"> 1. What made a quantity scalar or vector in your chosen picture? 2. Why is direction important in some situations but not others? 3. How would scalar and vector quantities apply in your daily life (e.g., travel, sports, or navigation)? 4. What problems might occur if direction is ignored in real-life situations? <p>Peer Feedback Questions:</p> <ol style="list-style-type: none"> 5. Which group explanation did you agree with the most? Why? 6. What suggestions can you give to improve another group's explanation? <p>Option 2: Real-Life Motion Bingo</p> <ul style="list-style-type: none"> • The teacher will distribute a Bingo card containing different real-life motion situations. • The teacher will read a motion scenario aloud one at a time. • For each scenario, the learners will decide whether it represents a scalar quantity or a vector quantity. <ul style="list-style-type: none"> ◦ After hearing the scenario, decide if it is scalar or vector. ◦ Find the matching box on your Bingo card. ◦ Mark the box only if your answer is correct. ◦ Continue until you complete a row, column, or diagonal. • The first learner to complete a Bingo must say "Bingo!" then prepare to explain each marked answer. • The winning learner explains why each chosen item is scalar or vector. • The class discusses and confirms correct answers together. <p>Sample Situations:</p> <ul style="list-style-type: none"> • "Car moves 20 km east." → Vector • "Runner traveled 5 km." → Scalar • "A cyclist speeds up to 15 m/s." → Scalar 	<p>IDF Relevance:</p> <ul style="list-style-type: none"> • This activity strengthens observational and analytical skills by engaging learners in real-world interpretation of motion concepts through collaborative inquiry. <p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Prepare Bingo cards in advance with a balanced mix of scalar and vector situations. • Read each scenario clearly and at a steady pace. • Repeat scenarios when necessary for understanding. • Observe learners during the activity to check for misconceptions (especially confusion between distance vs displacement and speed vs velocity). • After a winner is declared, facilitate a discussion by asking: <ul style="list-style-type: none"> ◦ <i>What keywords helped you decide scalar or vector?</i> ◦ <i>How does direction change your classification?</i> • Correct misconceptions immediately and provide simple clarifications with examples.
--	--	---

- “A boat travels 10 km north.” → Vector
- “Time taken is 30 seconds.” → Scalar
- “A plane flies 500 km southwest.” → Vector
- “A car accelerates at 2 m/s² to the east.” → Vector

Sample Bingo Card



This image is generated from Gemini

2. Discussing New Concept

Basic Quantities and Formulas in One-Dimensional Motion

QUANTITY	FORMULA	SI UNIT	SCALAR OR VECTOR
Time (t)		second (s)	Scalar
Distance (d)		meter (m)	Scalar
Speed (v)	$v = \frac{d}{t}$	meter per second (m/s)	Scalar
Displacement (d)	$\Delta x = x_f - x_i$	meter (m)	Vector
Average Velocity (v)	$v = \frac{\Delta d}{\Delta t}$	meter per second (m/s)	Vector
Acceleration (a)	$a = \frac{\Delta v}{\Delta t}$	meter per second squared (m/s ²)	Vector

The table presents important quantities used in one-dimensional motion. These quantities help describe how objects move. Some quantities are **scalars**, meaning they only

Materials Needed:

- Bingo cards (with mixed scalar and vector situations)
- Situation cards or a prepared list of motion scenarios
- Marker or pen for each learner

IDF Relevance:

- This activity develops quick conceptual recognition and reasoning by engaging learners in fast-paced identification of scalar and vector quantities in real-life contexts.

have magnitude. Examples are **time**, **distance** and **speed**. Other quantities are **vectors**, meaning they have both magnitude and direction. Examples are **displacement**, **velocity**, and **acceleration**.

The formulas shown in the table are used to solve motion-related problems:

1. **Displacement** describes the change in position of an object.

$$\Delta d = \mathbf{x}_f - \mathbf{x}_i$$

Where:

- $\mathbf{x}_f$ = final position
- $\mathbf{x}_i$ = initial position

2. **Average velocity** measures how fast displacement changes over time.

$$\mathbf{v} = \frac{\Delta \mathbf{d}}{\Delta t}$$

Where:

- $\Delta \mathbf{d}$ (**Displacement**): The change in position, or final position ($\mathbf{x}_f$) minus initial position ($\mathbf{x}_i$)

$$\Delta \mathbf{d} = \mathbf{x}_f - \mathbf{x}_i$$

- Δt (**Time Interval**): The total time elapsed, or final time (t_f) minus initial time (t_i).

$$\Delta t = t_f - t_i$$

This formula can also be rearranged to solve for:

$$\mathbf{v} = \frac{\Delta \mathbf{d}}{\Delta t}$$

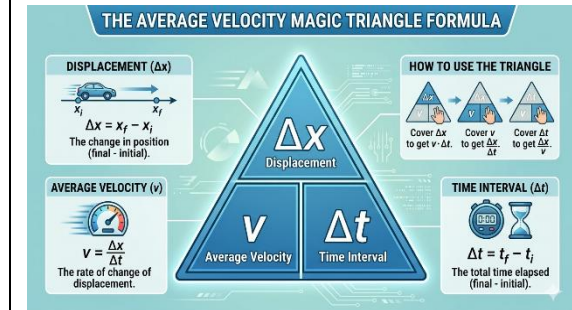
- Displacement: $\Delta \mathbf{d} = \mathbf{v} \Delta t$
- Time: $\Delta t = \frac{\Delta \mathbf{d}}{\mathbf{v}}$

3. **Average Acceleration** measures how velocity changes over time.

$$\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t}$$

Notes for Teachers:

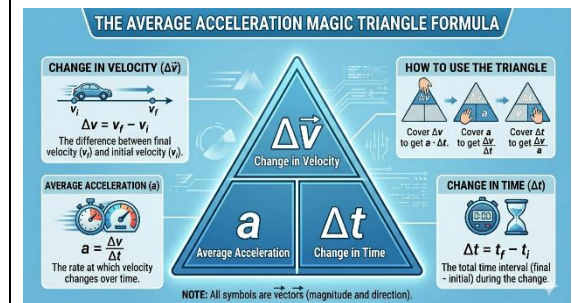
- To help you visualize the relationship between velocity, displacement, and time, you can use the **Formula Triangle**.



(This image is generated from Gemini)

In this triangle, the quantity on top is divided by the ones on the bottom, while the two on the bottom are multiplied together.

- Just like with velocity, the relationship for **Average Acceleration** can be organized into a "Magic Triangle" to make rearranging the variables a breeze.



(This image is generated from Gemini)

	<p>Where:</p> <ul style="list-style-type: none"> • Δv (Change in Velocity): The final velocity (v_f) minus initial velocity (v_i) $\Delta v = v_f - v_i$ <ul style="list-style-type: none"> • Δt (Change in Time): The time interval during which the velocity changes. <p>This formula can be rearranged to solve for:</p> $a = \frac{\Delta v}{\Delta t}$ <ul style="list-style-type: none"> • change in velocity: $\Delta v = a\Delta t$ • time: $\Delta t = \frac{\Delta v}{a}$ <p>Option 1: Formula Rearrangement Relay</p> <ul style="list-style-type: none"> • The teacher will form groups with 4–5 members. • Each group receives formula cards containing: <ul style="list-style-type: none"> ○ displacement formula ○ velocity formula ○ acceleration formula • The teacher flashes an unknown variable (example: solve for time). • Each group will rearrange the formula as quickly as possible. One representative writes the answer on the board. • Each group will explain the steps used in rearranging the equation. <p>Sample Problems:</p> <ol style="list-style-type: none"> 1. Rearrange velocity formula to solve for time. 2. Rearrange acceleration formula to solve for change in velocity. 3. Rearrange displacement formula to solve for final position. <p>Option 2: Motion Formula Treasure Hunt</p> <ul style="list-style-type: none"> • The learners will work in groups of 4–5 members. • Each group will be assigned a specific starting clue card instead of searching randomly. 	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Emphasize proper algebraic manipulation. • Encourage learners to explain every step clearly. • Check if learners maintain equation balance. Tell learners to include correct symbols and units. <p>Materials Needed:</p> <ul style="list-style-type: none"> • Formula cards • Whiteboard/manila paper • Marker • Timer <p>Expected Answers:</p> <ol style="list-style-type: none"> 1. $\Delta t = \frac{\Delta d}{v}$ 2. $\Delta v = a\Delta t$ 3. $x_f = \Delta x + x_i$ <p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Hide clue cards in accessible classroom areas before the activity starts. • Ensure that all formulas align with the lesson objectives. • Monitor teamwork and accuracy while learners solve equations. • Encourage learners to explain their reasoning before receiving the next clue. • Reinforce correct algebraic manipulation throughout the activity.
--	---	--

	<ul style="list-style-type: none"> Clue cards will be placed in designated stations around the classroom to avoid crowding. <p>Procedure:</p> <ol style="list-style-type: none"> Each group goes to their assigned first station. Read the formula clue and solve the required variable together. Once finished, the group will quickly show their answer to the teacher (or check using an answer key posted at the station). If correct, the group proceeds to the next assigned station (rotation order provided by the teacher). If incorrect, the group revises their answer immediately before moving on. <ul style="list-style-type: none"> All groups rotate in an organized sequence until all stations are completed. The activity ends when all groups finish or when time is up (e.g., 10–15 minutes). The group with the most correct answers within the time limit is recognized. <p>Materials Needed:</p> <ul style="list-style-type: none"> Hidden formula clue cards Task sheets Tape Stopwatch or timer <p>Sample Clue Tasks:</p> <ol style="list-style-type: none"> Solve the velocity formula for displacement. Rearrange the acceleration formula to solve for time. Rearrange the displacement equation to solve for initial position. <p>3. Developing Mastery</p> <p>The teacher will explicitly demonstrate how to solve motion problems using an organized step-by-step format. Learners will be guided to follow the structure below for every problem:</p>	<p>IDF Relevance:</p> <ul style="list-style-type: none"> This activity promotes collaborative reasoning, accuracy, and analytical decision-making during mathematical problem-solving tasks. <p>Expected Answers:</p> <ol style="list-style-type: none"> $\Delta d = v\Delta t$ $\Delta t = \frac{\Delta v}{a}$ $x_i = x_f - \Delta x$ <p>Notes for Teachers:</p> <ul style="list-style-type: none"> Guide learners in identifying the correct formula. Monitor if learners correctly substitute values and units. Encourage learners to analyze the meaning of positive and negative values. Encourage learners to connect formulas with real-life motion. Ask learners to explain what their answers mean physically. Clarify misconceptions about vector quantities and direction.
--	---	---

1. **Given** - Identify and list all known values with correct SI units.
2. **Required** - Identify what is being asked in the problem.
3. **Formula** - Write the appropriate formula needed to solve the problem.
4. **Solution** - Substitute the given values into the formula and solve step by step.
5. **Final Answer** - State the answer clearly with the correct unit.
6. **Interpretation** - Explain the meaning of the answer in a real-life context.

Option 1: Motion Computation Stations

**This activity is for average learners.*

- The teacher will form groups with 4–5 members.
- Each group rotates through six (6) computation stations.
- The learners will read the problem carefully and identify the:
 - given quantities
 - unknown quantity
- The learners will use the appropriate formula to solve the problem. Show complete solutions including:
 - formula
 - substitution
 - final answer with SI unit
- The learners will write their answers on the worksheet.
- After all groups finish, present and explain one station problem to the class.

Sample Scenario Problems

Scenario	Solution	Meaning of Positive and Negative Signs
A student walks from 5 m east to 20 m east along a straight path. Find the displacement.	$\Delta d = x_f - x_i$ $\Delta d = 20 \text{ m} - 5 \text{ m}$ $\Delta d = 15 \text{ m, east}$	The displacement of 15 m east means that the student ended up 15 meters farther east from

Materials Needed:

- Scenario cards
- Calculator
- Graph paper (optional)
- Worksheet
- Pencil

IDF Relevance:

- This activity enhances critical thinking and evidence-based reasoning applicable in problem-solving and situational analysis.

			their starting position of 5 m east , moving along the same direction, so their overall change in position is toward the east without any change in direction.
	A car moves from 12 m to -8 m on a straight road. Find the displacement.	$\Delta d = x_f - x_i$ $\Delta d = -8 \text{ m} - 12 \text{ m}$ $\Delta d = -20 \text{ m}$	A negative displacement means the object moved in the opposite or negative direction. The object moved 20 meters backward/west/left from the reference point.
	A cyclist travels 90 m in 15 s. Find the average velocity.	$v = \frac{\Delta d}{\Delta t}$ $v = \frac{90 \text{ m}}{15 \text{ s}}$ $v = 6 \text{ m/s}$	A positive velocity means the object is moving in the positive direction. The object moves 6 meters every second in the positive direction.
	A runner covers a displacement of 200 m in 25 s. Find the average velocity.	$v = \frac{\Delta d}{\Delta t}$ $v = \frac{200 \text{ m}}{25 \text{ s}}$ $v = 8 \text{ m/s}$	The calculated average velocity is 8 m/s, which is positive, meaning the runner is moving in the same direction as the displacement (forward direction).
	A motorcycle increases its velocity from 8 m/s to 28 m/s in 5 s. Find the average acceleration.	$a = \frac{\Delta v}{\Delta t}$ $a = \frac{28 \frac{\text{m}}{\text{s}} - 8 \frac{\text{m}}{\text{s}}}{5 \text{ s}}$	A positive acceleration means velocity increases in the positive direction. The object

		$a = \frac{20 \text{ m/s}}{5 \text{ s}} = 4 \text{ m/s}^2$	speeds up by 4 meters per second every second.	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> Challenge learners to explain the physical meaning of each computed value. Encourage learners to justify why answers are positive or negative. Allow learners to compare different motion situations and identify patterns. <p>Materials Needed:</p> <ul style="list-style-type: none"> Investigation task cards Calculator Graph paper Manila paper Marker Worksheet <p>Expected Answers</p> <p>1. Displacement</p> $\Delta d = x_f - x_i$ $\Delta d = 85 \text{ m} - (-15 \text{ m})$ $\Delta d = 100 \text{ m}$ <p>Meaning: The displacement is 100 m, which means the patrol car moved 100 meters in the positive direction, where the positive direction can be defined as east (or forward/right depending on the chosen reference direction).</p> <p>2. Average Velocity</p> $v = \frac{\Delta d}{\Delta t}$ $v = \frac{100 \text{ m}}{10 \text{ s}} = 10 \text{ m/s}$
	A car slows down from 30 m/s to 10 m/s in 4 s. Find the average acceleration.	$a = \frac{\Delta v}{\Delta t}$ $a = \frac{10 \frac{\text{m}}{\text{s}} - 30 \frac{\text{m}}{\text{s}}}{4 \text{ s}}$ $a = \frac{-20 \frac{\text{m}}{\text{s}}}{4 \text{ s}}$ $a = -5 \text{ m/s}^2$	Negative acceleration means the acceleration is in the negative direction. If the object is moving in the positive direction, negative acceleration means the object is slowing down. In this example, the car is still moving forward, but its speed is decreasing. That is why the acceleration is negative.	

Option 2: Motion Investigation Challenge

**This activity is for advanced learners*

- The teacher will form groups with 4–5 members.
- Each group receives a motion investigation scenario.
- The learners will read and analyze the situation carefully. Identify the:
 - initial and final positions
 - initial and final velocities
 - time interval
- Each group will compute the following:
 - displacement
 - average velocity
 - average acceleration
- Let the learners interpret the meaning of positive and negative signs in the answers.
- Each group will present the complete solution and explanation to the class.

	<p>Investigation Scenario 1 (Sample Scenario) A police patrol car starts at position -15 m. After 10 s, it reaches position 85 m. Its velocity changes from 5 m/s to 25 m/s during the same interval.</p> <p>Solve for:</p> <ol style="list-style-type: none"> 1. Displacement 2. Average velocity 3. Average acceleration 	<p>Meaning: The patrol car's average velocity of 10 m/s means it moves 10 meters every second in the positive direction, where the positive direction can be defined as east (or forward/right based on the chosen reference frame).</p> <p>3. Average Acceleration</p> $a = \frac{\Delta v}{\Delta t}$ $a = \frac{25 \frac{m}{s} - 5 \frac{m}{s}}{10 s} = 2 m/s^2$ <p>Meaning: The patrol car's velocity increased by 2 m/s every second.</p>
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>“Traffic Accident Motion Investigation” The learners will interpret positive and negative signs in one-dimensional motion and compute average acceleration using a realistic traffic scenario.</p> <p>Scenario: A minor traffic accident occurred along a straight highway involving a motorcycle and a pedestrian crossing area. According to eyewitness reports and CCTV footage, the motorcycle was moving east at a speed of 20 m/s when the rider suddenly applied the brakes upon seeing an obstacle ahead. Traffic investigators reviewed the CCTV footage and gathered the following evidence:</p> <ul style="list-style-type: none"> • Initial velocity: 20 m/s east • Final velocity after braking: 5 m/s east • Time of braking: 3 seconds <p>The investigators must analyze the motorcycle's motion to determine how the rider slowed down and assess whether proper braking was applied.</p>	<p>Notes for Teachers:</p> <ol style="list-style-type: none"> 1. Emphasize that: <ul style="list-style-type: none"> ○ Negative acceleration does NOT mean backward motion but indicates slowing down in the positive direction. ○ Interpretation depends on the chosen reference direction (east = positive). 2. Connect the lesson to real-life accident investigation: <ul style="list-style-type: none"> ○ Braking reduces velocity over time ○ Acceleration helps determine how quickly a vehicle stops ○ Useful for evaluating driver response and safety

Part A: Situation Analysis

1. The teacher will form groups of 4–5 members.
2. Each group will carefully read and examine the accident scenario and evidence.
3. Learners will identify and complete the table:

Quantity	Value
Initial Velocity ($\mathbf{v_i}$)	20 m/s east
Final Velocity ($\mathbf{v_f}$)	5 m/s east
Time Interval (Δt)	3 seconds

4. Learners will determine the reference direction:
 - Since the motorcycle is moving east, **east is defined as the positive direction.**

Part B: Computation Proper

5. Use the average acceleration formula: $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t}$
6. Solve step-by-step.
 - Step 1: Solve for change in velocity: $\Delta \mathbf{v} = \mathbf{v_f} - \mathbf{v_i}$

$$\Delta \mathbf{v} = \mathbf{v_f} - \mathbf{v_i}$$

$$\Delta \mathbf{v} = 5 \frac{\text{m}}{\text{s}} - 20 \text{ m/s}$$

$$\Delta \mathbf{v} = -15 \text{ m/s}$$
 - Step 2: Solve for average acceleration:

$$\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t}$$

$$\mathbf{a} = \frac{-15 \text{ m/s}}{3 \text{ sec}}$$

$$\mathbf{a} = -5 \text{ m/s}^2$$

Part C: Interpretation of Motion

7. Learners will analyze the meaning of the negative acceleration using guided questions:

Guide Questions:

- Why is the acceleration negative?
- Does negative acceleration mean the motorcycle moved backward?

3. Guide learners to connect mathematical results to physical meaning, not just computation.
4. Ask higher-order questions:
 - *What if the rider did not brake for 3 seconds—what would happen?*
 - *How does acceleration affect stopping distance and collision risk?*
 - *Why is it important for investigators to use correct motion data?*
5. Monitor group work and ensure all learners:
 - Participate in solving
 - Explain reasoning clearly
 - Use correct SI units and signs

IDF Relevance:

- This activity develops critical interpretation, analytical reasoning, and evidence of evaluation skills using realistic traffic investigation scenarios.

	<ul style="list-style-type: none"> ○ What does the negative value tell us about the motion? ○ What happened to the motorcycle's speed during braking? <p>8. Write a short interpretation of the result in their paper or share it with the class.</p> <p>Expected Interpretation: The acceleration is -5 m/s^2, which means the motorcycle is slowing down while still moving east (positive direction). The rider reduced speed by 5 m/s every second due to braking, showing controlled deceleration rather than moving backward.</p> <p>Part D: Motion Representation</p> <p>9. Learners will draw a motion diagram or number line showing:</p> <ul style="list-style-type: none"> ○ Positive direction (east $\rightarrow$) ○ Initial velocity (20 m/s $\rightarrow$) ○ Final velocity (5 m/s $\rightarrow$) ○ Decreasing motion (shorter arrows over time) <p>10. Learners must label directions and values clearly.</p> <p>Part E: Group Presentation</p> <p>11. Each group will present:</p> <ul style="list-style-type: none"> ○ Complete computation ○ Motion diagram ○ Interpretation of negative acceleration ○ Explanation of how braking affected motion <p>12. Learners will explain:</p> <ul style="list-style-type: none"> ○ <i>Why negative acceleration is important in traffic accident analysis</i> <p>2. Making Generalization</p> <p>Concept Mapping Synthesis</p> <p>The learners will integrate and synthesize the concepts of distance, displacement, speed, velocity, and acceleration in one-dimensional motion.</p>	<p>Notes for Teachers:</p> <ul style="list-style-type: none"> • Allow learners to create different but scientifically correct concept map structures.
--	---	---

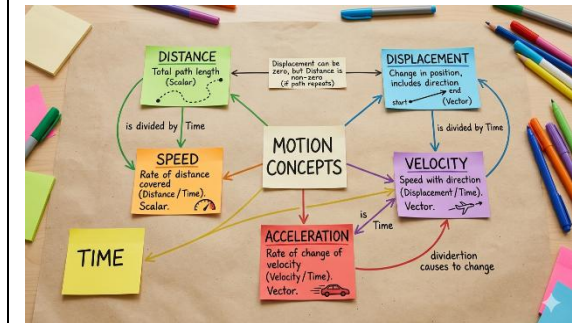
	<p>Part A: Group Organization</p> <ol style="list-style-type: none"> 1. The teacher will form groups with 4–5 members. 2. Each group will assign roles within the group: <ul style="list-style-type: none"> ○ leader/facilitator ○ writer ○ illustrator ○ presenter ○ materials manager <p>Part B: Concept Identification</p> <ol style="list-style-type: none"> 3. Write the following motion concepts on separate sticky notes: <ul style="list-style-type: none"> ○ Distance ○ Displacement ○ Speed ○ Velocity ○ Acceleration 4. Place the concepts on the manila paper. 5. Discuss within the group how the concepts are related to one another. <p>Part C: Concept Map Construction</p> <ol style="list-style-type: none"> 6. Draw connecting arrows between related concepts. 7. Along each arrow, write a short phrase explaining the relationship. <p>Example Connections:</p> <ul style="list-style-type: none"> ○ <i>“Distance is used to compute speed.”</i> ○ <i>“Displacement includes direction.”</i> ○ <i>“Velocity changes when acceleration occurs.”</i> ○ <i>“Speed is scalar while velocity is vector.”</i> <ol style="list-style-type: none"> 8. Add formulas to the appropriate concepts. <p>Part D: Synthesis and Interpretation</p> <ol style="list-style-type: none"> 9. At the bottom of the concept map, write a 3–5 sentence synthesis explaining: <ul style="list-style-type: none"> ○ <i>how the concepts work together in describing motion;</i> 	<ul style="list-style-type: none"> ● Encourage creativity in organizing ideas and using colors or symbols. ● Guide learners in making meaningful connections rather than memorizing definitions. ● Ask probing questions such as: <ul style="list-style-type: none"> ○ <i>How is displacement different from distance?</i> ○ <i>Why is velocity considered a vector quantity?</i> ○ <i>How does acceleration affect velocity?</i> ● Prepare a rubric so that the learners will be guided in making their output. <p>IDF Relevance:</p> <ul style="list-style-type: none"> ● This activity strengthens metacognitive reflection, analytical organization, and meaningful knowledge integration applicable in investigative and decision-making processes. <p>Expected Outputs: The learners should produce:</p> <ul style="list-style-type: none"> ● a complete concept map; ● correct relationships among motion concepts; ● accurate formulas and classifications; ● meaningful explanations and synthesis.
--	--	--

- *the difference between scalar and vector quantities;*
- *why understanding motion is important in real-life situations.*

Part E: Presentation

10. Present the concept map to the class.
11. During the presentation, explain:
 - *the relationships among the concepts;*
 - *why certain arrows and connections were used;*
 - *how the formulas help describe motion.*
12. Be ready to answer questions from classmates and the teacher.

Sample Concept Map



This image is generated from Gemini

Possible Answers for Part E: Presentation (No. 11):

a. Relationships among the concepts

- Distance and displacement describe how far an object moves, but displacement includes direction.
- Speed is calculated using distance and time, while velocity uses displacement and time.
- Acceleration describes how velocity changes over time.
- All these concepts work together to describe motion completely.

b. Why certain arrows and connections were used

- Arrows connect related concepts to show how one quantity depends on another (e.g., distance → speed).
- Connections like “velocity includes direction” were used to show differences between scalar and vector quantities.

		<ul style="list-style-type: none"> Links between velocity and acceleration show that motion can change over time. <p>c. How the formulas help describe motion</p> <ul style="list-style-type: none"> Formulas (e.g., speed = distance ÷ time, velocity = displacement ÷ time) show how quantities are mathematically related. They help calculate how fast an object moves and how its motion changes. Formulas allow us to predict and analyze real-life motion situations accurately.
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>PART A — WRITTEN ASSESSMENT (Individual Task) Directions: Read and solve the following problems carefully. Show complete solutions and explanations.</p> <p>I. IDENTIFICATION (Scalar or Vector) Direction: Write Scalar if the quantity has magnitude only and Vector if the quantity has both magnitude and direction.</p> <ol style="list-style-type: none"> Distance Velocity Speed Acceleration Displacement <p>II. FORMULA REARRANGEMENT Direction: Rearrange the following formulas to solve for the indicated variable.</p> <ol style="list-style-type: none"> Average Velocity: $v = \frac{\Delta d}{\Delta t}$ Solve for: <ol style="list-style-type: none"> Δd Δt Average Acceleration: $a = \frac{\Delta v}{\Delta t}$ Solve for: <ol style="list-style-type: none"> Δv Δt 	

III. PROBLEM SOLVING

Directions: Read and analyze the given problems below. Show your solutions correctly.

Problem 1 — Displacement and Average Velocity

A student walks from 5 m east of the classroom to 25 m east in 4 seconds. Find:

1. Displacement
2. Average velocity

Problem 2 — Average Acceleration

A tricycle increases its velocity from 4 m/s to 16 m/s in 6 seconds.

1. Find the average acceleration.

IV. CONCEPTUAL ANALYSIS

Situation Analysis: A motorcycle is moving westward at 18 m/s. After applying brakes, its velocity becomes 6 m/s after 4 seconds.

Guide Questions:

1. *What happened to the motorcycle's speed?*
2. *Is the acceleration positive or negative?*
3. *What does the sign of acceleration indicate?*
4. *If braking continues, what may happen next?*

Expected Insights:

- The motorcycle slowed down.
- Acceleration is negative relative to the chosen direction.
- Negative acceleration indicates slowing down in the given reference direction.
- The motorcycle may eventually stop.

PART B — PERFORMANCE TASK (Group Activity) - "Campus Motion Investigation"

Task Description: The learners will be grouped into 5 groups. Each group will conduct a simple motion investigation within the school campus. Each group will:

1. Observe or simulate motion.
2. Measure distance and time.
3. Determine displacement.
4. Compute average velocity and acceleration.
5. Interpret positive and negative signs in motion.
6. Present findings using tables, diagrams, and explanations.

Suggested Situations:

- Walking along a hallway
- Moving school service vehicle
- Rolling cart experiment
- Running activity on the court

Required Output: Each group shall submit:

- Motion diagram
- Computation sheet
- Explanation of motion
- Interpretation of signs
- Reflection on real-life applications

Guide Questions:

1. *How is displacement different from distance in your investigation?*
2. *Why is direction important in motion analysis?*
3. *What does positive velocity indicate?*
4. *What does negative acceleration indicate?*
5. *How are these concepts useful in daily life?*

PERFORMANCE RUBRIC

**Discuss the rubrics with the class*

Criteria	Excellent (4)	Proficient (3)	Developing (2)	Beginning (1)
Conceptual Understanding	Concepts are accurate, complete, and interconnected	Minor conceptual errors	Partial understanding shown	Major misconceptions evident
Computation Accuracy	All solutions are correct and complete	Few computation errors	Several errors present	Most computations incorrect
Interpretation of Motion	Insightful explanation of signs and direction	Adequate interpretation	Limited interpretation	Minimal explanation
Application to Real-Life Context	Strong connection to practical situations	Adequate connection	Weak connection	No practical application shown
Collaboration and Presentation	Highly organized and collaborative	Organized with active participation	Some participation evident	Minimal participation

<p>VI. REFLECTION <i>(Feedback and Continuous Improvement)</i></p>	<p>Reflection Questions for Learners:</p> <ol style="list-style-type: none"> 1. <i>How can you differentiate scalar quantities (distance, speed) and vector quantities (displacement, velocity, acceleration), and why is direction important in describing motion?</i> 2. <i>How did the step-by-step process (Given–Required–Formula–Solution–Answer–Interpretation) help you solve motion problems more accurately?</i> 3. <i>How can the concepts of displacement, velocity, and acceleration be applied in real-life situations such as transportation, sports, or traffic safety?</i> <p>Reflection Questions for Teachers</p> <ol style="list-style-type: none"> 1. <i>Which teaching strategies (e.g., gallery walk, bingo, computation stations, motion investigation) were most effective in helping learners understand scalar and vector quantities and solve motion problems? Why?</i> 2. <i>What challenges did learners encounter (e.g., confusion between distance vs displacement, speed vs velocity, or interpreting negative signs), and how were these addressed during the lesson?</i> 3. <i>What improvements can be made in future lessons to better support learners in solving and interpreting one-dimensional motion problems, especially in connecting mathematical solutions to real-life applications?</i>
<p>VII. USE OF GENERATIVE AI</p>	<p>In preparing this Learning Exemplar (LE), the author(s) used ChatGPT, Microsoft Copilot, and Google Gemini in order to support the development and refinement of instructional activities, guide questions, and expected answers. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	5
---------------	-----------	-----------------	---

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners create and interpret motion graphs of one-dimensional motion (displacement-time, velocity-time, and acceleration-time graphs).</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	Teacher's Supplementary Material: tinyurl.com/P1LE5TSM Teaching Resources: Meta cards, manila paper/cartolina, markers, sticky tapes, printed worksheets, mobile phone with installed Fizziq application, internet connection, printer, laptop, projector/TV External Resources: Physics Lens. "Kinematics Graphs Interactive." Accessed May 20, 2026. https://www.physicslens.com/kinematics-graphs-interactive/ FizziQ. FizziQ (Physics Experiments App). Accessed May 20, 2026. https://www.fizziq.org/
III. CONTENT (Sequencing Content)	Creating and Interpreting Motion Graphs
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	<ol style="list-style-type: none"> 1. Construct displacement-time, velocity-time, and acceleration-time graphs from experimental or simulated data for one-dimensional motion 2. Interpret motion graphs in terms of patterns, slope, and area under the curve 3. Differentiate uniform motion and uniformly accelerated motion using displacement-time, velocity-time, and acceleration-time graphs 4. Relate the slope and area of motion graphs to displacement, velocity, and acceleration formulas

V. PROCEDURES		ANNOTATIONS
<i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i>		
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge</p> <p>OPTION 1: COLLABORATIVE WORD MAP</p> <ol style="list-style-type: none"> 1. The class is divided into pre-defined groups. 2. The teacher gives each group a manila paper and a marker. 3. The teacher then instructs the learners that they will be creating a word map of the words or phrases that they can associate with the central word written in the middle of the manila paper. 4. The learners complete the task within five minutes. They may only begin after the teacher says the central word. The central word is “motion.” 5. After five minutes, the learners post their outputs on the board. Each group presents their word map where the members take turns explaining their definitions of each word or phrase related to the central word. 6. The teacher processes the responses by addressing misconceptions immediately and asking follow-up questions if necessary. <p>OPTION 2: THE FLOOR IS LAVA</p> <ol style="list-style-type: none"> 1. The teacher instructs the learners to move the chairs to the sides. 2. The floor is divided into two, one for TRUE and one for FALSE. 3. The teacher then presents statements related to motion from the previous grade levels. 4. If the statement is true, they stand on the TRUE side. Otherwise, they stand on the FALSE side. 	<p><i>Alignment to IDF: The word map surfaces learners’ prior conceptions about “motion” (e.g., displacement/velocity/acceleration) and lets the teacher observe vocabulary, misconceptions, and readiness before introducing formal motion-graph constructs. This matches the IDF intent that prior knowledge be activated through short collaborative tasks and discussion to connect previous learning with new content. Collaborative sharing enables immediate feedback and refining understanding, consistent with IDF feedback as a mechanism for checking whether instructional pieces are aligned and well-placed.</i></p> <p><i>Notes for Teachers: For the Collaborative Word Map, the teacher may give a sample word (e.g. distance, speed) to give learners a jumpstart for recall. Moreover, during the presentation, the teacher must address misconceptions immediately to avoid further misconceptions as the lesson progresses. Expected words include movement, time, distance, displacement, speed, velocity, acceleration, and deceleration.</i></p>

	<p>5. For each statement, learners are given 15 seconds to think.</p> <p>6. Before revealing the correct answer, the teacher asks one learner from each side to defend their stand.</p> <p>7. If the learners are mistaken, they go back to their seats.</p> <p>8. All learners can return to the lava floor when there is no learner left on the floor, and still there are remaining statements.</p> <p>Statements:</p> <ol style="list-style-type: none"> 1. Displacement is the change in position of an object from its initial position to its final position. 2. Distance and displacement are always equal in one-dimensional motion. 3. Velocity includes both speed and direction. 4. An object with zero velocity must also have zero acceleration. 5. In a one-dimensional motion, constant velocity means zero acceleration. 6. The slope of a displacement-time graph represents velocity. 7. A horizontal line on a displacement-time graph means the object is moving at constant velocity. 8. The slope of a velocity-time graph represents acceleration. 9. A horizontal line on a velocity-time graph means the object has zero velocity. 10. If acceleration is constant, the velocity-time graph is a straight line. <p>OPTION 3: K-W-L IN TANDEM</p> <ol style="list-style-type: none"> 1. The learners work in pairs. The teacher asks them to complete the K-W-L chart on the topic of motion. 2. The learners may remind each other of the concepts they have previously learned to be placed in the K column. Likewise, they shall collaborate in filling in the W and L columns. 3. The teacher calls random pairs to present their outputs. 	<p><i>Alignment to IDF: The true/false movement + defense prompts learners to externalize reasoning about key motion statements (e.g., slope meanings, acceleration vs velocity). The teacher then recognizes misconceptions through defended answers and uses them to reteach/clarify (ESRU pattern), ensuring readiness for graph interpretation tasks. This is Responsive because it diagnoses learner profiles/misconceptions (tailored correction) and differentiates support through explanation and rationalizations.</i></p> <p><i>Notes for Teachers: For the “The Floor is Lava”, the teacher must remind the learners regarding their safety as they move around the room. Rationalizations for the answers are given in the Teacher’s Supplementary Material (TSM), the link to which is provided in Part III (References and Materials) of this lesson exemplar (Activating Prior Knowledge – Option 2: The Floor is Lava).</i></p> <p><i>Alignment to IDF: By pairing learners to fill K-W-L and then consolidating responses, the lesson explicitly maps entry knowledge (K), learning goals/questions (W), and expected takeaways (L). This aligns with IDF’s direction that activating prior knowledge should be done through</i></p>
--	--	--

	<p>4. The teacher facilitates the flow by asking other learners if they have the same items or if there are other items not stated by the presenters.</p> <p>5. The teacher bridges learners' prior knowledge with the current lesson by asking the learners how they define displacement, velocity, and acceleration based on the previous lesson.</p> <p>The class should come up with agreed and correct definitions before proceeding. The teacher may use probing and leading questions to come up with the correct definitions.</p> <p>2. Establishing the Purpose of the Lesson</p> <p>The teacher asks the following questions:</p> <ol style="list-style-type: none"> 1. Why is it important to predict the motion of an object? 2. Can you think of real-life instances where predicting the motion of an object is important? 3. Can we predict motion without describing its pattern first? 4. What methods are used to describe motion? How can we predict it? <p>The teacher then presents the lesson objectives for the learners to read together.</p> <p>The teacher says, "In this lesson, we will use graphs as another way to describe and predict motion. Instead of only using words or equations, we will study how the shape, slope, and area of graphs reveal important information about an object's motion."</p>	<p><i>short activities/discussion that connect old learning to new concepts and prepare learners for the lesson purpose. The K-W-L structure supports metacognition (what I know/ need to learn), aligning with the Reflective delivery principle.</i></p> <p><i>Notes for Teachers: For the K-W-L in Tandem, the format of the chart is given in the TSM (Activating Prior Knowledge – Option 3: K-W-L in Tandem).</i></p> <p><i>Alignment to IDF: The guiding questions ("Why is it important to predict motion...?") explicitly connect the competency (describing patterns to predict motion) to authentic need. This enacts the IDF requirement that learners understand goals and real-life applications to boost motivation and set expectations before new instruction begins. This is Relevant (real-world application) and supports constructive alignment by orienting learners to the unit of objectives that activities and assessments will measure.</i></p>
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>ESSENTIAL INTRODUCTION: THE AXES IN GRAPHS OF ONE-DIMENSIONAL MOTION</p> <p>The teacher presents three graphs representing one-dimensional motion whose axes are labelled accordingly:</p>	<p><i>Alignment to IDF: By using labeled $x-t$, $v-t$, $a-t$ graphs and guided questions on dependent/independent variables, the lesson builds the prerequisite concept that time is the</i></p>

	<p>displacement-time (d-t), velocity-time (v-t), and acceleration-time (a-t). The following guide questions are then asked:</p> <ol style="list-style-type: none"> 1. Recall from your mathematics subjects. What do we call these figures? 2. In what grade level or topics in mathematics did you encounter graphs? 3. How many axes are in these graphs? 4. These graphs represent motion. What quantities are represented by the y-axes of the three graphs? 5. What quantity is represented by the x-axes of the three graphs? 6. What do you notice with the quantity represented by the x-axes of the three graphs? 7. Which is/are the dependent variable? 8. Which is/are the independent variable? 9. What is the physical meaning of this classification of variables? <p>The teacher emphasizes that, apart from the equations in the previous lesson, motion can also be represented by graphs. In motion graphs, the x-axis is always the time variable which is the independent variable. Displacement, velocity, and acceleration are the dependent variables because their values depend on the time of observation or measurement.</p> <p>CONSTRUCTING AND INTERPRETING d-t GRAPHS</p> <p>OPTION 1: ACTUAL OBSERVATION WITH FIZZIQA APP</p> <p>This option is viable for classroom settings with sufficient mobile devices with the Fizziq app installed. Refer to the TSM (Presenting Examples: Constructing and Interpreting d-t Graphs – Option 1: Actual Observation with Fizziq App) for the activities to be performed and the worksheet to be accomplished by pre-defined groups. This will be the same group of learners throughout this lesson.</p>	<p><i>independent variable, and motion quantities are dependent. This directly supports the competency of creating and interpreting motion graphs and prepares learners for the subsequent plotting and sense-making activities. The IDF stresses coherence among objectives, activities, and assessments; this “axes” mini-lesson ensures later graphing tasks measure the intended learning rather than basic graph literacy gaps.</i></p> <p><i>Notes for Teachers: These are the expected answers.</i></p> <ol style="list-style-type: none"> 1. Graphs. 2. The answers may vary. 3. Two. 4. Displacement, velocity, and acceleration. 5. Time. 6. The same for all three graphs – all the time. 7. Displacement, velocity, and acceleration. 8. Time. 9. Displacement, velocity, and acceleration are dependent on (or a function of) time. Time does not depend on the other quantities. <p><i>Notes for Teachers: Learners may be allowed to study how to use the Fizziq app beforehand. The teacher may likewise conduct a short demonstration of the use of the app.</i></p>
--	--	--

	<p>OPTION 2: VISUAL REPRESENTATIONS OF MOTION</p> <p>The teacher distributes a set of visual representations of motion to learners in pre-defined groups. Refer to the TSM (Presenting Examples: Constructing and Interpreting d-t Graphs – Option 2: Visual Representations of Motion) for the visual representations and the worksheet which is parallel to that in Option 1.</p> <p>The learners plot data from the four tables in the worksheet on separate graphs found on the TSM (Presenting Examples: Constructing and Interpreting d-t Graphs) and answer the guide questions related to the construction and interpretation of the graphs. After doing so for 20 to 30 minutes, they tack their outputs on the board and present them. The teacher processes each presentation by asking questions and letting the class answer them. Afterwards, the teacher asks more questions for the learners to answer.</p> <ol style="list-style-type: none"> 1. What can be inferred about the motion of the object represented by the first graph? The second graph? The third graph? The fourth graph? 2. Describe the pattern of the d-t graph in relation to the actual motion it represents. 3. Can you predict the displacement of the object in the next second? Two seconds after? Three seconds after? (The teacher emphasizes that graphs can be used to extrapolate data and predict future outcomes, but only to some extent.) <p>The teacher asks the learners what they recall about the shape of graphs 3 and 4. These shapes are parabolic, resembling a parabola which they encountered in mathematics in junior high school. The teacher also explains the physical meaning of a parabolic pattern and may use the table to show the progression of values.</p>	<p><i>Note for Teachers: Explain to the learners that we use d-t instead of x-t or y-t because we are referring to displacement instead of position.</i></p> <p><i>Alignment to IDF: Fizziq-based observation strengthens understanding because learners generate/observe motion data, then represent it graphically—an inquiry-like pathway that makes the abstract relationship between motion and graph shape concrete. This aligns with IDF’s expectation that strategies be learner-centered and evidence-based, including technology-enhanced approaches to promote meaningful learning. The activity directly targets Lesson Objectives #1 and #2 (construct + interpret graphs) and builds toward assessments that require graphing and interpretation.</i></p> <p><i>Alignment to IDF: Option 2 preserves the same learning intent as Option 1 (plotting/interpretation) using visual motion representations and parallel worksheets. By providing a non-tech pathway that still yields the same target performance, the lesson demonstrates Responsive instruction (adapting to context/resources while keeping objectives constant). Presentations and teacher processing questions operationalize feedback for misconception-checking and real-time adjustment.</i></p>
--	--	--

	<p>RELATING d-t GRAPH AND AVERAGE VELOCITY</p> <ol style="list-style-type: none"> 1. Q1: How can we know the average velocity of the objects based on the d-t graphs? 2. The teacher asks all groups to write the formula for average velocity from the previous lesson. 3. The teacher then asks the learners to recall the formula for slope, write it down, and use d instead of y and t instead of x, pointing these out on the axes of the x-y graph and the d-t graph. 4. Q2: What similarities do you notice between the two equations? 5. Q3: Based on the equations, what can you infer about the average velocity and the slope of the d-t graph? 6. The teacher asks all the groups to solve the average velocity of graphs 1 and 2 for any given time interval. 7. The teacher also asks the learners to solve the slopes of graphs 1 and 2 given the same time interval. The time interval used in graph 1 should be the same for the two solving activities. Similarly, the time interval used in graph 2 should be the same for the two solving activities. 8. Q4: What can you say about the values of the average velocity and the slope? 9. After eliciting responses, the teacher emphasizes that the slope of the d-t graph is the average velocity of the object in the same time interval. 10. The teacher also highlights again the parallel between the formulas for average velocity and slope of the d-t graph. 11. The teacher emphasizes that graphs and equations are just two of the ways to understand, represent, describe, and predict motion. 	<p><i>Notes for Teachers: In the graphing activities, graphs may not always be perfectly straight or parabolic. The teacher should explain the limitations related to the act of measurement, the tools used, and the nature of actual (not ideal) scenarios in the physical world. For curved d-t graphs, the slope between two points gives average velocity over that interval. The slope of a tangent line gives instantaneous velocity.</i></p> <p><i>Notes for Teachers: Throughout the lesson, it is important that the teacher always relates the graphs to equations and tables to align with the Content Standard aiming for learners to learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i></p> <p><i>Note to Teacher: If learners find it hard to create the graphs, the teacher can demonstrate how to use the graphing feature of the Fizziq app. They may study the graphs developed by the app and use them as a guide. However, the learners are still required to create their own graph.</i></p> <p><i>Alignment to IDF: Redoing the observation increases participation and strengthens the link between velocity change and graph slope, supporting lesson objectives on interpretation (patterns/trends, slope,</i></p>
--	---	--

	<p>CONSTRUCTING AND INTERPRETING v-t GRAPHS OPTION 1: ACTUAL OBSERVATION WITH FIZZIQ APP</p> <p>This option is viable for classroom settings with sufficient mobile devices with the Fizziq app installed. This is a continuation of Option 1 under Constructing and Interpreting d-t Graphs, but it is recommended that learners redo the activity to further familiarize themselves with the technology, immerse themselves more in scientific investigation and empirical inquiry, and give other group members more opportunities for participation. Refer to the TSM (Presenting Examples: Constructing and Interpreting v-t Graphs – Option 1: Actual Observation with Fizziq App) for the activities to be performed and the worksheet to be accomplished by the same groups.</p> <p>OPTION 2: VISUAL REPRESENTATIONS OF MOTION</p> <p>This is a continuation of Option 2 under Constructing and Interpreting d-t Graphs, but it is recommended that learners redo the activity to immerse themselves further in scientific investigation and empirical inquiry and give other group members more opportunities for participation. Refer to the TSM (Presenting Examples: Constructing and Interpreting v-t Graphs – Option 2: Visual Representations of Motion) for the visual representations and the worksheet which is parallel to that in Option 1.</p> <p>The learners plot data from the four tables in the worksheet on separate graphs found on the TSM (Presenting Examples: Constructing and Interpreting v-t Graphs) and answer the guide questions related to the construction and interpretation of the graphs. After doing so for 20 to 30 minutes, they tack their outputs on the board and present them. The teacher processes each presentation by asking questions and letting the class answer them. Afterwards, the teacher asks more questions:</p>	<p><i>and meaning). This matches IDF guidance that strategies promote active engagement and build adaptability, especially when technology supports investigation and collaboration.</i></p> <p><i>Notes for Teachers: Explain that the values of velocity measured by the Fizziq app during the experiment in Option 1 or as shown in the table in Option 2 is not always constant in Motions 1 and 2. This is due to limitations of the measurement tool and the measurement process, as well as other factors present in the real world. To show that the velocity is generally uniform, however, the teacher may show the graph generated by Fizziq using linear interpolation of the v-t graph and zooming out. This should show a roughly horizontal graph.</i></p> <p><i>Alignment to IDF: Providing a parallel worksheet and plotted data tasks allows learners to practice the same interpretive reasoning (slope → acceleration; area considerations) even without devices, maintaining constructive alignment across teaching activities and assessment expectations.</i></p>
--	---	---

	<ol style="list-style-type: none"> 1. What can be inferred about the motion of the object represented by the first graph? The second graph? The third graph? The fourth graph? 2. Describe the pattern of the $\mathbf{v}$-t graph in relation to the actual motion it represents. 3. How can you predict the velocity of the object in the next second? Two seconds after? Three seconds after? (The teacher reemphasizes that graphs can be used to extrapolate data and predict future outcomes, but only to some extent.) 4. Given the velocity of the object, can you predict the position of the object in the next second? Two seconds after? Three seconds after? (The teacher reemphasizes that graphs can be used to extrapolate data and predict future outcomes, but only to some extent.) <p>RELATING $\mathbf{v}$-t GRAPH AND AVERAGE ACCELERATION</p> <ol style="list-style-type: none"> 1. Q1: Can we know the average acceleration of the objects based on the $\mathbf{v}$-t graphs? How? 2. The teacher asks all groups to write the formula for average acceleration from the previous lesson from the formula for acceleration. That is, $\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$. 3. The teacher then asks the learners to recall the formula for slope, write it down, and use $\mathbf{v}$ instead of y and t instead of x, pointing these out on the axes of the x-y graph and the $\mathbf{v}$-t graph. 4. Q2: What similarities do you notice between the two equations? 5. Q3: Based on the equations, what can you infer about the average acceleration and the slope of the $\mathbf{v}$-t graph? 6. The teacher asks all the groups to solve the average acceleration of graphs 1 and 2 for any given time interval. 7. The teacher also asks the learners to solve the slopes of graphs 1 and 2 given the same time interval. The time interval used in graph 1 should be the same for the two 	
--	---	--

	<p>solving activities. Similarly, the time interval used in graph 2 should be the same for the two solving activities.</p> <ol style="list-style-type: none"> Q4: What can you say about the values of the average acceleration and the slope? After eliciting responses, the teacher emphasizes that the slope of the $\mathbf{v}$-t graph is the average acceleration of the object in the same time interval. The teacher also highlights the parallel between the formulas for average acceleration and slope of the $\mathbf{v}$-t graph. The teacher reemphasizes that graphs and equations are just two of the ways to understand, represent, describe, and predict motion. <p>RELATING $\mathbf{v}$-t GRAPH AND DISPLACEMENT</p> <ol style="list-style-type: none"> Q1: How can we know the displacement of an object during a time interval given a $\mathbf{v}$-t graph? The teacher asks all groups to write the formula for displacement from the previous lesson from the formula for velocity. That is, $\Delta x = v\Delta t$ from $v = \frac{\Delta x}{\Delta t}$. However, $\Delta x = d$, so the formula can also be written as $d = v\Delta t$. The teacher asks learners to recall the formula for the area of a rectangle, $A=lw$, and compare it with the area under a $\mathbf{v}$-t graph by using $\mathbf{v}$ as the height and Δt as the width. Q2: What similarities do you notice between the two equations? Q3: Based on the equations, what can you infer about the displacement and the area under the $\mathbf{v}$-t graph? The teacher asks all the groups to solve the displacement of graphs 1 and 2 for any given time interval. The teacher also asks the learners to solve the area under graphs 1 and 2 given the same time interval. The time interval used in graph 1 should be the same for the 	
--	--	--

	<p>two solving activities. Similarly, the time interval used in graph 2 should be the same for the two solving activities.</p> <ol style="list-style-type: none"> 8. Q4: What can you say about the values of the displacement and the area? 9. After eliciting responses, the teacher emphasizes that the area under the $\mathbf{v}$-t graph is the displacement of the object in the same time interval. 10. The teacher also highlights the parallel between the formulas for displacement and area under the $\mathbf{v}$-t graph. 11. The teacher reemphasizes that graphs and equations are just two of the ways to understand, represent, describe, and predict motion. <p>The teacher may proceed with graphs 3 and 4 to prove the area-displacement relationship (note that different shapes have different area formulas), emphasizing the physical meaning of negative displacement or area values of graphs 2 and 4.</p> <p>CONSTRUCTING AND INTERPRETING $\mathbf{a}$-t GRAPHS</p> <p>OPTION 1: ACTUAL OBSERVATION WITH FIZZIQQ APP</p> <p>This option is viable for classroom settings with sufficient mobile devices with the Fizziq app installed. This is a continuation of Option 1 under Constructing and Interpreting $\mathbf{d}$-t Graphs and Option 1 under Constructing and Interpreting $\mathbf{v}$-t Graphs, but it is recommended that learners redo the activity to further familiarize themselves with the technology, immerse themselves more in scientific investigation and empirical inquiry, and give other group members more opportunities for participation. Refer to the TSM (Presenting Examples: Constructing and Interpreting $\mathbf{a}$-t Graphs – Option 1: Actual Observation with Fizziq App) for the activities to be performed and the worksheet to be accomplished by the same groups.</p>	<p><i>Alignment to IDF: Learners observe acceleration-related data and represent it in $\mathbf{a}$-t form, strengthening conceptual coherence among x-t, v-t, and a-t. This supports the competency of creating and interpreting multiple motion graphs and aligns with IDF's preference for technology-enhanced, evidence-based learning experiences.</i></p>
--	--	---

	<p>OPTION 2: VISUAL REPRESENTATIONS OF MOTION</p> <p>This is a continuation of Option 2 under Constructing and Interpreting d-t Graphs and Option 2 under Constructing and Interpreting v-t Graphs, but it is recommended that learners redo the activity to immerse themselves further in scientific investigation and empirical inquiry and give other group members more opportunities for participation. Refer to the TSM (Presenting Examples: Constructing and Interpreting a-t Graphs – Option 2: Visual Representations of Motion) for the visual representations and the worksheet which is parallel to that in Option 1.</p> <p>The learners plot data from the four tables in the worksheet on separate graphs found on the TSM (Presenting Examples: Constructing and Interpreting a-t Graphs) and answer the guide questions related to the construction and interpretation of the graphs. After doing so for 20 to 30 minutes, they tack their outputs on the board and present them. The teacher processes each presentation by asking and letting the class ask questions. Afterward, the teacher asks more questions:</p> <ol style="list-style-type: none"> 1. What can be inferred about the motion of the object represented by the first graph? The second graph? The third graph? The fourth graph? 2. Describe the pattern of the a-t graph in relation to the actual motion it represents. 3. How can you predict the acceleration of the object in the next second? Two seconds after? Three seconds after? (The teacher reemphasizes that graphs can be used to extrapolate data and predict future outcomes, but only to some extent.) 4. Given the acceleration of the object, can you predict the velocity of the object in the next second? Two seconds after? Three seconds after? (The teacher reemphasizes that graphs can be used to extrapolate data and predict future outcomes, but only to some extent.) 	<p><i>Alignment to IDF: Similar to x-t and v-t alternatives, the visual-data route keeps the instructional objective intact (constructing and interpreting a-t graphs) while adapting the method to available resources, reflecting the IDF principle of Responsive instruction.</i></p> <p><i>Notes for Teachers: Explain that the values of acceleration measured by the Fizziq app during the experiment in Option 1 or as shown in the table in Option 2 is not always equivalent to 0 m/s² in Motions 1 and 2 or 9.8 m/s² (acceleration due to gravity) in Motions 3 and 4. This is due to limitations of the measurement tool and the measurement process, as well as other factors present in the real world. To show that the acceleration is generally uniform, however, the teacher may show the graph generated by Fizziq using linear interpolation of the a-t graph and zooming out. This should show a roughly horizontal graph.</i></p>
--	--	--

	<p>RELATING a-t GRAPH AND CHANGE IN VELOCITY</p> <ol style="list-style-type: none"> 1. Q1: Can we know the change in velocity of an object during a time interval given an a-t graph? How? 2. The teacher asks all groups to write the formula for change in velocity from the previous lesson formula for acceleration. That is, $\Delta v = a\Delta t$ from $a = \frac{\Delta v}{\Delta t}$. 3. The teacher asks learners to recall the formula for the area of a rectangle, $A=lw$, and compare it with the area under an a-t graph by using a as the height and Δt as the width. 4. Q2: What similarities do you notice between the two equations? 5. Q3: Based on the equations, what can you infer about the change in velocity and the area under the a-t graph? 6. The teacher asks all the groups to solve the change in velocity of graphs 3 and 4 for any given time interval. 7. The teacher also asks the learners to solve the area under graphs 3 and 4 given the same time interval. The time interval used in graph 3 should be the same for the two solving activities. Similarly, the time interval used in graph 4 should be the same for the two solving activities. 8. Q4: What can you say about the values of the change in velocity and the area? 9. After eliciting responses, the teacher emphasizes that the area under the a-t graph is the change in velocity of the object at the same time interval. 10. The teacher also highlights again the parallel between the formulas for change in velocity and area under the a-t graph. 11. The teacher reemphasizes that graphs and equations are just two of the ways to understand, represent, describe, and predict motion. 	
--	--	--

	<p>The teacher may emphasize the physical meaning of negative acceleration or area under graph 4. It is not recommended to proceed with graphs 1 and 2 as they show zero acceleration and the area under the graph is zero although average velocity is non-zero. This may confuse the learners.</p> <p>UNIFORM MOTION AND STATIONARITY</p> <p>In the same groups, the learners retrieve the graphs they crafted in the previous activities. They will then answer a worksheet to be provided by the teacher from the TSM (Presenting Examples – Uniform Motion and Stationarity).</p> <p>After doing so for seven to ten minutes, they tack their outputs on the board and present them. The teacher processes each presentation by asking and letting the class ask questions. Afterward, the teacher asks more questions:</p> <ol style="list-style-type: none"> 1. Based on the activity, what is uniform motion? What does it mean in the physical world? 2. What do the patterns of d-t, v-t, and a-t graphs of uniform motion show, respectively? 3. Based on the activity, what is uniformly accelerated motion? What does it mean in the physical world? 4. What do the patterns of d-t, v-t, and a-t graphs of uniformly accelerated motion show, respectively? 5. Can a stationary object be considered an object in uniform motion? Can it be considered an object in uniformly accelerated motion? <p>2. Discussing New Concepts</p> <p>The teacher uses a teacher-made visual aid (preferably through a technology-enabled presentation) to discuss the following important points. This may also be done through a question-and-answer format, but emphasis should be given to explicit discussion instead of the activity.</p> <ol style="list-style-type: none"> 1. There are different methods to understand, represent, describe, and predict motion, including word situations, tables, equations, and graphs. 	<p><i>Alignment to IDF: Learners retrieve previously created graphs and use them to answer a worksheet on uniform motion, uniformly accelerated motion, and stationarity. This is mastery-building because learners apply interpretation patterns across graph types, directly addressing Lesson Objective #3 (differentiate motion types using data). Teacher processing and class questioning serve as feedback mechanisms to address misconceptions and refine understanding.</i></p> <p><i>Notes for Teachers: Emphasize that stationary objects (although with constant zero velocity and acceleration) are not considered in uniform motion or uniformly accelerated motion. They are simply at rest or stationery. The teacher may go back to the basic definition of motion which involves a change in position.</i></p> <p><i>Alignment to IDF: After hands-on/visual graph work, you explicitly discuss key principles (slope/area meanings, graph patterns, motion-type definitions). This matches the IDF requirement that “Discussing New</i></p>
--	--	--

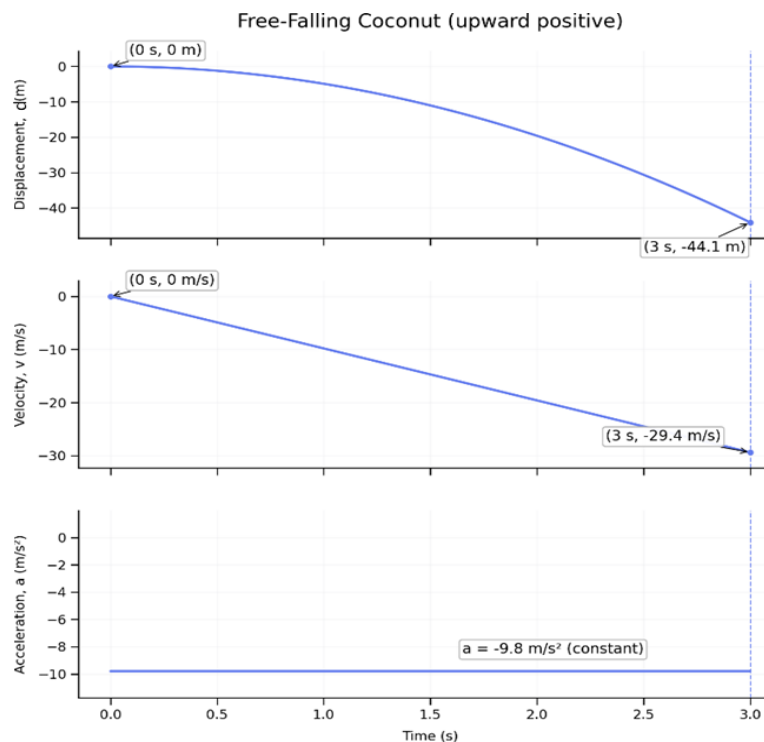
	<ol style="list-style-type: none"> 2. A uniform motion with positive velocity has and-t graph that increases linearly to the right, and an a-t graph that is zero. 3. A uniform motion with negative velocity has and-t graph that decreases linearly to the right, and an a-t graph that is zero. 4. A uniformly accelerated motion is motion with constant acceleration. Its d-t graph is parabolic, its v-t graph is diagonal, and it's a-t graph is horizontal. 5. For a uniformly accelerated motion moving in the positive direction with positive acceleration, the v-t graph increases linearly to the right and the d-t graph increases parabolically to the right. This signifies that the body is “speeding up” in the positive direction. If the object is moving in the negative direction, positive acceleration may instead mean it is slowing down. 6. For a uniformly accelerated motion moving in the positive direction with negative acceleration, the v-t graph decreases linearly to the right and the d-t graph decreases parabolically to the right. This signifies that the body is “slowing down.” If the object is moving in the negative direction, negative acceleration may instead mean it is speeding up in the negative direction. 	<p><i>Notes for Teachers: Utilize the graphs made by the learners to emphasize the points. This provides a concrete connection between the previous activities, the current simulation, and the lesson points. Do this by grouping all Graph 1 graphs (showing them side by side) from the previous activities. Do the same for Graph 2, Graph 3, and Graph 4 graphs. Graph 1 and Graph 2 graphs show uniform motion (positive velocity and negative velocity), while Graph 3 and Graph 4 graphs show uniformly accelerated motion (positive acceleration and negative acceleration).</i></p>
<p>C. Demonstrating Knowledge and Skills</p>	<p>1. Finding Practical Applications</p> <p>ACTIVITY 1: MATCHING SCENARIOS TO GRAPHS</p> <p>The teacher randomly assigns ten learners to each hold a Situation Card showing a photo and a description. These learners will stand in front of them.</p> <ol style="list-style-type: none"> 1. Situation Card 1: Runner (a runner speeding up uniformly forward at the start of the race) 2. Situation Card 2: Falling fruit (a fruit falling from its branch) 3. Situation Card 3: Tricycle (a tricycle running at constant speed in a straight line) 4. Situation Card 4: Car (a car running in reverse direction at constant speed in a straight line) 	<p><i>Alignment to IDF: The scenarios are related to SHS curriculum exits.</i></p> <p><i>Scenario 1: Middle-level skills</i> <i>Scenario 2: Entrepreneurship</i> <i>Scenario 3: Employment</i> <i>Scenario 4: Entrepreneurship</i> <i>Scenario 5: Higher education</i> <i>Scenario 6: Entrepreneurship</i> <i>Scenario 7: Employment</i> <i>Scenario 8: Middle-level skills</i> <i>Scenario 9: Entrepreneurship</i> <i>Scenario 10: Higher education</i></p>

	<ol style="list-style-type: none"> 5. Situation Card 5: Passenger (a passenger standing still while waiting for a bus) 6. Situation Card 6: Truck (a delivery truck from a logistics business starts from rest and speeds up at a constant rate while leaving the warehouse to begin its delivery route) 7. Situation Card 7: Bus (a bus driver applying brakes at a constant rate to smoothly slow down the bus as it approaches a designated stop) 8. Situation Card 8: Conveyor Belt (a trainee technician rides a conveyor platform in a training facility that moves forward at a steady speed while they practice assembling parts) 9. Situation Card 9: Forklift (a warehouse worker operating a forklift that moves backward at a steady speed to transport goods away from a loading area) 10. Situation Card 10: Professor (a university professor standing still in front of a classroom while delivering a lecture to students) <p>The teacher then calls other random learners to each hold a Graph Card containing a graph representing the Situation Cards. Each learner holding a Graph Card takes turns approaching the learner holding the Situation Card which corresponds to their Graph Card. Refer to the TSM for the cards (Finding Practical Applications – Activity 1: Matching Scenarios to Graphs).</p> <p>The teacher processes each card pair made by asking questions to the learners holding the Graph Cards: “What feature of the graph helped you decide the match?” Other processing questions may be asked to these learners and to the class.</p>	<p><i>Notes for Teachers: The teacher may utilize other Situation Cards as may be necessary and emphasize their relevance to the SHS curricular exits.</i></p>
--	---	--

	<p>ACTIVITY 2: INTERPRETING CAR ACCIDENT MOTION</p> <p>Using the same pairs in Developing Mastery, learners investigate a realistic car accident scenario using only graphs as their data. The worksheet is available in the TSM (Finding Practical Applications – Activity 2: Interpreting Car Accident Motion Graphs and Predicting Motion).</p> <p>After doing the activity for ten to fifteen minutes, the teacher tells the learners to exchange worksheets with other pairs. Afterwards, for the processing part, the teacher will call random pairs to present and explain their work and answer the guide questions. The teacher processes each presentation by asking and letting the class ask questions.</p> <p>ACTIVITY 3: CREATING MOTION GRAPHS FROM A STORY</p> <p>In the same pairs, learners create motion graphs from a commute story. The worksheet is available in the TSM (Finding Practical Applications – Activity 3: Creating Motion Graphs from a Story).</p> <p>After doing the activity for five to ten minutes, the teacher tells the learners to exchange worksheets with other pairs. Afterward, for the processing part, the teacher will call random pairs to present and explain their work and answer the guide questions. The teacher processes each presentation by asking and letting the class ask questions.</p> <p>2. Making Generalizations</p> <p>OPTION 1: CONCEPT MAPPING</p> <p>In pre-defined groups, the learners create a concept map to show connections through lines between words to be provided to them: displacement, velocity, acceleration, uniform motion, uniformly accelerated motion, slope, area.</p> <p>After doing the activity for 10 to 15 minutes, they tack their outputs on the board and present them by explaining the relationships shown by the connecting lines. The teacher</p>	<p><i>Alignment to IDF: Investigating a car accident scenario using only graphs and creating graphs based on a narrative directly operationalizes the competency and performance standard emphasis on analyzing motion in practical contexts. It strengthens learners' ability to infer events from graphical data—skills aligned to authentic performance expectations (realistic, competency-based assessment preparation). Presentations and class questioning produce evidence of progress and allow immediate correction, aligning with IDF's feedback-and-monitoring role (refine strategies, address gaps).</i></p> <p><i>Notes for Teachers: In Activities 2 and 3, one of the skills to be emphasized is predicting motion based on motion graphs.</i></p> <p><i>Alignment to IDF: Concept mapping forces learners to articulate connections among displacement, velocity, acceleration, uniform motion, uniformly accelerated motion, slope, and area—core conceptual links repeatedly used in your instruction and required by the competency. This matches the IDF expectation that generalization is achieved through</i></p>
--	---	--

	<p>processes each presentation by asking and letting the class ask questions. Misconceptions are directly addressed at this point.</p> <p>OPTION 2: REFLECTIVE QUESTIONS</p> <p>Individually, the learners answer the following questions on a piece of paper or their notebook:</p> <ol style="list-style-type: none">1. Write down at least five key concepts you learned in this lesson.2. Write down at least two points that still confuse you or that you still do not understand.3. What steps can you take to clarify these confusions or points not yet understood? <p>After doing the activity, learners share their reflections with each other. Afterward, the teacher calls on random learners to share their answers to reflective questions.</p>	<p><i>summarizing, discussion, or mapping. Presentations plus addressing misconceptions operationalize reflection and feedback as continuous improvement within the lesson.</i></p> <p><i>Alignment to IDF: Asking learners to list key concepts, identify confusions, and plan steps to clarify them directly supports the IDF’s reflective principle (goal-oriented, metacognitive) and reinforces feedback for continuous improvement. It also generates actionable information for the teacher’s next instructional moves.</i></p>
<p>VI. ASSESSMENT (Assessing Learnings)</p>	<p>The learners individually answer the following activities. They may use their notebook, separate sheets of paper, graphing papers, or other writing materials. The answer key is in the TSM.</p> <ol style="list-style-type: none">1. A Shinkansen “bullet train” runs on Japan’s Tōkaidō Shinkansen, the major high-speed line linking the Tokyo–Nagoya–Osaka corridor. Suppose an N700-series Shinkansen (a common train type used on the Tōkaidō Shinkansen) is leaving a station and then preparing to stop at the next station. The N700 series is documented as having a maximum acceleration rate of 0.72 m/s^2. To keep the graphing clean, the train’s motion is approximated using constant acceleration over exact time intervals. Your job is to create the velocity–time (v–t) graph based on the following data:<ol style="list-style-type: none">a. The train starts from rest at $t = 0 \text{ s}$.b. From $t = 0 \text{ s}$ to $t = 100 \text{ s}$, the train accelerates at a constant $+0.72 \text{ m/s}^2$.c. From $t = 100 \text{ s}$ to $t = 340 \text{ s}$, the train travels at constant velocity.d. From $t = 340 \text{ s}$ to $t = 440 \text{ s}$, the train decelerates at a constant -0.60 m/s^2.e. From $t = 440 \text{ s}$ to $t = 465 \text{ s}$, the train decelerates at a constant -0.48 m/s^2.f. From $t = 465 \text{ s}$ to $t = 480 \text{ s}$, the train remains stopped	

2. Interpret the following motion graphs of a falling coconut to answer the questions that follow.



- What is the coconut displacement at $t=2.0 \text{ s}$?
- What is the coconut's velocity at $t=2.5 \text{ s}$?
- What is the coconut acceleration at $t=1.0 \text{ s}$?
- On the **d - t** graph, what does the slope represent?
- On the **v - t** graph, what does the slope represent?
- What does the area under the **v - t** graph represent?
- What does the area under the **a - t** graph represent?
- Is acceleration constant or changing? How can you tell from the graphs?
- Why is the value of velocity negative during the fall?

	<ol style="list-style-type: none"> 3. Show the similarity between the derived formula for average velocity and the slope of the d-t graph. 4. Show the similarity between the derived formula for average acceleration and the slope of the v-t graph. 5. Show the similarity between the derived formula for displacement and the area under the v-t graph. 6. Show the similarity between the derived formula for change in velocity and the area under the a-t graph. 7. Differentiate uniform motion and uniformly accelerated motion in one or two sentences.
VII. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p>LEARNER'S REFLECTION</p> <p>Ask the learners to complete the following sentences on a piece of paper.</p> <ol style="list-style-type: none"> 1. In this lesson, the most significant lesson I learned is _____. 2. I can apply what I learned by _____. 3. I am still confused about _____. 4. My learning experience could have been better if _____. <p>TEACHER'S REFLECTION</p> <ol style="list-style-type: none"> 1. Were the objectives achieved? What evidence do I have that learning took place? _____ 2. What went well in this unit or lesson? What contributed to it? _____ 3. What challenges did I encounter? How did I handle them? _____ 4. How can I improve my teaching practice to better support learners' understanding? _____
VIII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft 365 Copilot and ChatGPT in order to search for realistic values of motion quantities, generate graphs and photos, help create guide questions for some activities, generate recall questions based on relevant competencies from previous grade levels, and provide rationalization for the answers to these questions. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	6
---------------	-----------	-----------------	---

I. OBJECTIVES		
A. Content Standard	<i>The learners learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>	
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>	
C. Learning Competencies	<i>The learners derive the four kinematic equations and their various forms through algebraic methods to solve various cases of uniformly accelerated motion (horizontal and vertical).</i>	
II. REFERENCES and MATERIALS (Selecting Resources and Material)	Teacher's Supplementary Material: tinyurl.com/P1LE6TSM Teaching Resources: Meta cards, manila paper/cartolinas, markers, sticky tapes, printed worksheets, printer, laptop, projector/TV	
III. CONTENT (Sequencing Content)	The Four Kinematic Equations	
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	1. Algebraically derive the four kinematic equations from basic definitions of velocity and acceleration 2. Solve various cases of horizontal and vertical uniformly accelerated motion problems using the derived kinematic equations	
V. PROCEDURES (Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)		ANNOTATIONS
A. Activating Prior Knowledge	1. Activating Prior Knowledge OPTION 1: MATCH MADE IN PHYSICS	<i>Note for Teachers: It is recommended to call the learners in this sequence: symbols, delta formulas, broken-down formulas, and units.</i>

	<p>1. The teacher calls 21 random or volunteer learners to each hold a piece of card with the following words, symbols, formulas, and units.</p> <table border="1"> <tr> <td>time</td> <td>t</td> <td></td> <td></td> <td>s</td> </tr> <tr> <td>position</td> <td>x</td> <td></td> <td></td> <td>m</td> </tr> <tr> <td>displacement</td> <td>d</td> <td>Δx</td> <td>$x_f - x_i$</td> <td>m</td> </tr> <tr> <td>velocity</td> <td>v</td> <td>$\frac{\Delta d}{\Delta t}$</td> <td>$\frac{d_f - d_i}{t_f - t_i}$</td> <td>m/s</td> </tr> <tr> <td>acceleration</td> <td>a</td> <td>$\frac{\Delta v}{\Delta t}$</td> <td>$\frac{v_f - v_i}{t_f - t_i}$</td> <td>m/s²</td> </tr> </table> <p>2. The learners holding the words stand facing the class.</p> <p>3. The teacher tells the class to help the learners holding the other cards to look for their match among the words.</p> <p>4. The teacher then asks other learners to summarize each group of cards by explaining their relationships.</p> <p>OPTION 2: YOU COMPLETE ME</p> <p>1. The learner presents a chart like that in Option 1 but with blanks. The missing elements are written on separate cards.</p> <p>2. The teacher will call random or volunteer learners to stick the cards to the appropriate parts of the chart.</p> <p>3. When the chart is complete, the teacher then asks other learners to summarize each row by explaining the relationships among the elements in the row.</p> <p>2. Establishing the Purpose of the Lesson</p> <p>The teacher says, “In the previous lesson, we were able to predict the motion of an object by looking at patterns from graphs. In real life, how important are accurate predictions?”</p> <p>The teacher may anchor on the importance of accurate predictions on market trends, organizational planning, agricultural decisions, and many more. The teacher then asks, “With regards to motion, how important is accurate</p>	time	t			s	position	x			m	displacement	d	Δx	$x_f - x_i$	m	velocity	v	$\frac{\Delta d}{\Delta t}$	$\frac{d_f - d_i}{t_f - t_i}$	m/s	acceleration	a	$\frac{\Delta v}{\Delta t}$	$\frac{v_f - v_i}{t_f - t_i}$	m/s ²	<p><i>Alignment to IDF: Match Made in Physics elicits and refreshes prerequisite concepts (variables, symbols, units, and basic definitions) needed to derive kinematic equations. By matching “time/position/displacement/velocity/acceleration” with symbols, units, and definition forms, learners reactivate core relationships ($\Delta d/\Delta t$, $\Delta v/\Delta t$) that are explicitly required for the lesson’s derivation objective.</i></p> <p><i>Alignment to IDF: You Complete Me offers a responsive alternative strategy that achieves the same prerequisite recall as Match Made in Physics but with lower movement/cognitive load control and clearer scaffolding. Completing a partially blank chart supports learners who need more structure while still ensuring everyone revisits the same pre-derivation knowledge (variables, symbols, units, and definitions) essential for algebraic derivation of the kinematic equations.</i></p> <p><i>Alignment to IDF: Establishing Purpose connects prior to learning (predicting motion from graphs) to the new focus (predicting motion using equations) and clarifies intended learning outcomes. The guiding prompts on “importance of accurate predictions” and the bridge from previous graph-based prediction to real-world forecasting contexts provide</i></p>
time	t			s																							
position	x			m																							
displacement	d	Δx	$x_f - x_i$	m																							
velocity	v	$\frac{\Delta d}{\Delta t}$	$\frac{d_f - d_i}{t_f - t_i}$	m/s																							
acceleration	a	$\frac{\Delta v}{\Delta t}$	$\frac{v_f - v_i}{t_f - t_i}$	m/s ²																							

	<p>predictions?” The teacher may ask questions that lead to the importance of accurate predictions in weather forecasts that use data from predicted movements of storms, for example.</p> <p>Then, the teacher presents the unit objectives for the learners to read together.</p>	<p><i>relevance and motivation, then orient learners to the unit objectives they will work on.</i></p>
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>OPTION 1: GROUP SEATWORK</p> <ol style="list-style-type: none"> 1. In pre-defined groups (ideally four groups), the learners work on an activity involving solving four kinematic problems. The activity is in the attached Teacher’s Supplementary Material (TSM), the link to which is provided in Part III (References and Materials) of this lesson exemplar. Please find the Presenting Examples worksheet in the TSM. 2. Each problem needs five to ten minutes to finish. In this activity, the learners are expected to realize the necessity of the kinematic equations based on the given and/or missing values in word problems involving horizontal and vertical one-dimensional motion. 3. In the worksheet, they are also guided in deriving the kinematic equations from the basic definitions and formulas of displacement, velocity, and acceleration. 4. The final outputs of the activity are the kinematic equations which are written by the learners on a manila paper or cartolina as a springboard for the next activities. <p>OPTION 2: GALLERY WALK</p> <p>This option involves more movement and uniform time pressure for each problem to be solved.</p> <ol style="list-style-type: none"> 1. Four problems are posted on each of the four walls or corners of the classroom. These problems are the same as those in Option 1. 2. The learners, in pre-defined groups (ideally four groups), are given five to ten minutes to work on each problem, 	<p><i>Alignment to IDF: Group Seatwork uses guided problem situations to help learners discover the need for kinematic equations and begin structured derivation from basic definitions. Learners analyze given/ missing quantities in horizontal/ vertical motion problems and are guided toward deriving equations from velocity/ acceleration definitions, directly targeting Objective #1 (derive) and preparing for Objective #2 (solve).</i></p> <p><i>Notes for Teachers: In some scenarios, the given values are implied and not explicitly given (for example, “at rest” means v_i is zero). Explain to the learners to take note of signal words. These signal words may be emphasized as they are encountered during the lesson.</i></p> <p><i>Alignment to IDF: Gallery Walk is a responsive delivery option that keeps the same conceptual targets while increasing engagement, movement, and time-structured collaboration. Rotating among posted problems preserves alignment to the same derivation and “missing quantity” analysis outcomes, while the uniform</i></p>

	<p>taking turns among the four walls or corners of the classroom where the problems are posted.</p> <p>3. The final outputs of the activity are the kinematic equations which are written by the learners on a manila paper or cartolina as a springboard for the next activities.</p> <p>2. Discussing New Concepts</p> <p>OPTION 1: ALL FOR ALL</p> <p>The learners present their group outputs. Each group presents their outputs for all four problems. This option allows for mastery by repetition but can also be time-consuming.</p> <p>OPTION 2: ONE BY ONE</p> <p>The learners present their group outputs. Each group is assigned to present their output for one problem only. This is more efficient than Option 1 but risks complete understanding of the derivation of all four kinematic equations.</p> <p>The teacher processes each presentation by asking questions and allowing the class to ask questions too. The step-by-step process of derivation is emphasized, as well as how the final formulas are derived from the basic definitions and formulas of velocity and acceleration. Moreover, the teacher highlights the necessity of the kinematic equations based on the given and missing quantities in real-world problems.</p> <p>3. Developing Mastery</p> <p>OPTION 1: COMPLETE THE TABLE</p> <p>The teacher distributes tables to the same groups. The table is available in the Developing Mastery – Activity 1: Complete the Table worksheet in the TSM. The table shows the given and missing quantities and the kinematic formula to be used in each case. The answer key is also given on a separate page.</p>	<p><i>time pressure and station-based work ensure consistent exposure to examples across groups.</i></p> <p><i>Alignment to IDF: All for All maximizes mastery through repetition and multiple explanations of derivation steps across all equations/ problems. Having each group present answers for all problems supports deeper procedural fluency and strengthens conceptual grounding (how each final equation follows from velocity/ acceleration definitions), which is central to the competency on algebraic derivation.</i></p> <p><i>Alignment to IDF: One by One offers an efficiency-focused variant that maintains whole-class processing but distributes presentation load to manage time. Assigning each group with a single problem reduces redundancy while still allowing teacher-led processing that emphasizes step-by-step derivation and the rationale for choosing equations based on what is given/missing.</i></p> <p><i>Note for Teachers: The step-by-step process of deriving the four kinematic equations is also given in the TSM</i></p>
--	---	--

	<p>The learners present their group outputs. The teacher processes each presentation by asking questions and allowing the class to ask questions too.</p> <p>OPTION 2: MORE PROBLEMS</p> <p>The teacher gives four more problems to all groups. These problems are available in the Developing Mastery – Activity 2: More Problems worksheet in the TSM. The learners list down the given and missing quantities based on the problems and identify the kinematic equation to be used.</p> <p>The teacher emphasizes that the kinematic equation to be used in solving word problems involving motion depends on the missing, required, and given quantities. The teacher may opt to let the learners solve the problems or just settle with identifying the kinematic equation to be used for the meantime.</p> <p>ACTIVITY 1: DERIVING FORMULAS FROM THE KINEMATIC EQUATIONS</p> <ol style="list-style-type: none"> The teacher shows a problem to the class, one that cannot be solved using the usual form of the kinematic equations. Instead, additional derivation is needed by rearranging the variables in the appropriate equations to solve the missing quantity. <ol style="list-style-type: none"> A commuter train enters a straight braking section of track at a constant deceleration of 1.2 m/s^2. It comes to a complete stop after traveling 180 m. What was the train's initial speed as it entered the braking section? The teacher asks the learners how to go about the problem, using leading questions to guide learners to think about rearranging the equations to solve the missing quantity or value. <ol style="list-style-type: none"> Sample leading questions: In mathematics, what do we do if the equation does not immediately solve the 	<p><i>(Derivation of the Kinematic Equations).</i></p> <p><i>Alignment to IDF: Complete the Table offers structured practice in selecting the appropriate kinematic equation given known and unknown quantities. The table format explicitly trains learners to identify given/missing variables and match them to the correct equation—an essential skill for Objective #2 (solving UAM problems) and for later independent assessment tasks.</i></p> <p><i>Alignment to IDF: More Problems extends practice breadth and strengthens transfer by increasing variety of cases while keeping the same decision process (given/missing → choose equation). Additional problems reinforce the analytic routine of extracting quantities from word problems and selecting a suitable kinematic equation, building fluency before higher-stakes tasks in the Practical Applications and Assessment sections.</i></p> <p><i>Alignment to IDF: Deriving Formulas from the Kinematic Equations deepens algebraic manipulation/derivation skills beyond the “usual form” of equations to address non-routine problem constraints. By prompting learners to rearrange equations to solve a missing variable, this segment directly reinforces the competency’s</i></p>
--	--	--

	<p>missing quantity? What do we do to make the missing quantity appear on the left side of the equation? What do we do to make the other non-missing quantities appear on the right side of the equation?</p> <ol style="list-style-type: none"> The teacher calls on a learner to solve the problem or demonstrates how to do it. The teacher guides the learners on the steps in solving word problems. <ol style="list-style-type: none"> Identifying the given quantities (explicitly and implicitly given). Identifying the missing or required quantity. Identifying the formula or equation to be used. Deriving the final formula or equation to be used, if necessary. Substituting the given quantities. Defining the solution or answer. Afterwards, the teacher shows four additional problems that also need rearranging of the equations, one for each kinematic equation. However, the teacher is free to use other problems or add more. <ol style="list-style-type: none"> A motorcycle speeds up from 12 m/s to 30 m/s in 4.5 s. Find the acceleration. A ball is thrown straight upward with initial speed 20 m/s. Gravity provides acceleration -9.8 m/s^2. How long after release is the ball at a height of 12 m above the launch point? A car traveling at 26 m/s brakes with constant acceleration -4.0 m/s^2 until it slows to 10 m/s. How far does it travel while braking? A runner covers 180 m in 15 s and finishes with a speed of 18 m/s, accelerating uniformly. What was the runner's initial speed? The teacher allows the learners to work in pairs to solve these problems, then calls for random pairs to solve on the board and present their process. 	<p><i>“various forms through algebraic methods” requirement and supports flexible problem solving in later tasks.</i></p> <p><i>Note to Teacher: While the teacher may choose between options, those labelled as “Activity #” are nonnegotiable activities to be implemented to make the lesson flow more effective.</i></p> <p><i>Note to Teacher: The answer key to the problem in item 1 and the four problems in item 5 of Activity 1 is in the TSM (Developing Mastery – Activity 1: Deriving Formulas from the Kinematic Equations).</i></p>
--	--	--

	<p>7. The teacher processes each presentation by asking questions and allowing the class to ask questions.</p> <p>The teacher highlights that the topics so far are limited to uniformly accelerated motion (only one a in all examples). While real-world motions are generally not uniformly accelerated, they can be approximated to be so. This helps simplify calculations and enhance understanding of motion. The teacher states that it is still possible to solve kinematic quantities in situations involving non-uniformly accelerated motion, but it is not covered in this lesson and will be taught in the higher levels.</p>	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Applications</p> <p>ACTIVITY 1: SOLVING REAL-WORLD PROBLEMS</p> <p>The teacher shows one real-world problem involving kinematic equations. The teacher emphasizes the importance of the problem in the real world, particularly in road safety regulations and investigations and the design of vehicles. Then, the learners work in pairs to collaboratively solve the problem.</p> <ol style="list-style-type: none"> 1. A jeepney is moving at 50 km/h on a wet road when the driver sees a pedestrian crossing 35 m ahead and immediately applies the brakes. Jeepney experiences a constant deceleration of 4.5 m/s^2. will the jeepney come to a complete stop before reaching the crossing? If not, how far past the crossing will it stop? <p>The teacher calls on two pairs to solve the problem on the board, present their answers, and compare their process and results after. The teacher processes the activity by asking questions and allowing the class to ask questions.</p>	<p><i>Alignment to IDF: Solving Real-World Problems is an explicit application of kinematic equations to realistic contexts, emphasizing why the skill matters. The jeepney braking scenario anchors the mathematics in road safety and investigation contexts, requiring learners to model and decide whether stopping distance is sufficient—authentic application aligned to the performance standard and Objective #2 (solve real cases).</i></p> <p><i>Note for Teachers: The answer key to the problem of Activity 1 is in the TSM (Finding Practical Applications – Activity 1: Solving Real-World Problems).</i></p>

	<p>ACTIVITY 2: READING, SHARING, AND REFLECTING</p> <ol style="list-style-type: none">1. The teacher groups the learners into groups of three members.2. The teacher distributes the Finding Practical Applications – Activity 2: Reading, Sharing, and Reflecting reading materials in the TSM.3. Each member of the group reads one material, then the members take turns sharing their insights with others in the group. After doing so, the learners individually write a reflection on the importance of understanding kinematic equations. Reading takes five to eight minutes, sharing takes eight to ten minutes, and reflection writing takes ten to fifteen minutes. <p>The teacher calls on random or volunteer learners to read their reflections. The teacher processes these by asking questions and allowing learners to ask questions also, then gives a summary of the activity highlighting practical applications of the topic.</p> <p>2. Making Generalizations</p> <p>OPTION 1: DECISION TABLE</p> <p>In groups, in pairs, or individually, the learners fill in this table which is useful in deciding which kinematic equation to use in different scenarios. The learners identify and write the kinematic equation to be used based on the given and missing quantities.</p> <table><tr><th>d</th><th>v_i</th><th>v_f</th><th>a</th><th>t</th><th>Kinematic Equation</th></tr><tr><td></td><td>/</td><td>/</td><td>/</td><td>/</td><td></td></tr><tr><td>/</td><td>/</td><td></td><td>/</td><td>/</td><td></td></tr><tr><td>/</td><td>/</td><td>/</td><td>/</td><td></td><td></td></tr><tr><td>/</td><td>/</td><td>/</td><td></td><td>/</td><td></td></tr></table>	d	v_i	v_f	a	t	Kinematic Equation		/	/	/	/		/	/		/	/		/	/	/	/			/	/	/		/		<p><i>Alignment to IDF: Reading, Sharing, and Reflecting comes with a reflective consolidation—broadens relevance across fields and strengthens meaning-making. The read–share–reflect routine connects kinematics to multiple real applications and has learners articulate personal understanding through reflection writing, reinforcing conceptual value and supporting the LE’s feedback-and-improvement orientation.</i></p> <p><i>Alignment to IDF: Decision Table synthesizes learning into a reusable decision tool for equation selection. Filling in which equation applies given specific known/unknown quantities generalizes the entire lesson into a meta-strategy (how to choose an equation efficiently), preparing learners for independent problem solving and the assessment tasks.</i></p> <p><i>Alignment to IDF: Decision Lines offers a visual schema that supports different learners by offering an alternate representation of the same “selection logic.” Linking each kinematic equation to required quantities externalizes the decision-making process and helps learners “see” why an equation is applicable; the teacher’s wrap-up about uniform acceleration further clarifies scope and conditions, strengthening conceptual boundaries.</i></p>
d	v_i	v_f	a	t	Kinematic Equation																											
	/	/	/	/																												
/	/		/	/																												
/	/	/	/																													
/	/	/		/																												

	<p>OPTION 2: DECISION LINES</p> <p>The teacher shows the following diagram. In groups, in pairs, or individually, the learners write the four kinematic equations inside the blank boxes to draw a line from the kinematic equations to the quantities which are needed to be able to use the respective equation.</p> <div><div></div><div></div><div><div>d</div><div>v_i</div><div>v_f</div><div>a</div><div>t</div></div><div></div><div></div></div> <p>The teacher calls on learners to explain the Decision Table or Decision Lines. The teacher then asks learners if there are still questions before the test.</p>	<p><i>Note for Teachers: The answer key to Making Generalizations are in the TSM (Making Generalizations).</i></p>
<p>VI. ASSESSMENT <i>(Assessing Learnings)</i></p>	<p>The learners individually answer the following activities. They may use their notebook, separate sheets of paper, or other writing materials. The answer key is in the TSM.</p> <ol style="list-style-type: none">1. Choose two kinematic equations. Show how the chosen kinematic equations are derived from the basic definitions and formulas for velocity and acceleration.2. On a straight, flat road, a delivery rider on a scooter is already moving at 6.0 m/s when the lane clears ahead. The rider accelerates at a constant rate of 1.5 m/s² for 8.0 s. Find the displacement (how far the scooter travels) during those 8 seconds.3. A student throws a basketball straight upward from ground level during PE class. The teacher wants the ball to just reach the height of the backboard, which is 3.0 m above the release point. Assume constant acceleration due to gravity -9.8 m/s². At the highest point (right when it just reaches the backboard height), the ball speed is momentarily 0 m/s. Find the minimum initial speed the student must throw the ball upward.	
<p>VII. REFLECTION <i>(Feedback and Continuous Improvement)</i></p>	<p>LEARNER’S REFLECTION</p> <p>Ask the learners to complete the following sentences on a piece of paper.</p> <ol style="list-style-type: none">1. In this unit, the most significant lesson I learned is _____.2. I will apply what I learned by _____.3. I am still confused about _____.4. My learning experience could have been better if _____.	

	<p>TEACHER'S REFLECTION:</p> <ol style="list-style-type: none"> 1. Were the objectives achieved? What evidence do I have that learning took place? 2. What went well in this unit or lesson? What contributed to it? 3. What challenges did I encounter? How did I handle them? 4. How can I improve my teaching practice to better support learners' understanding?
VIII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft 365 Copilot and ChatGPT in order to generate essays on the importance of understanding kinematic equations in different fields, generate word problems, and solve word problems as a triangulation mechanism. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	7
----------------------	-----------	------------------------	---

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>
B. Performance Standard	<i>At the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Carry out first-hand investigations involving two-dimensional projectile and circular motion to investigate factors, such as speed, radius, and centripetal force.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<p>Department of Education Philippines. 2025. <i>Strengthened Senior High School Curriculum: General Physics 1 (Grade 11)</i>. Pasig City: Department of Education.</p> <p>Henderson, Tom. 2020. "Physics Tutorial." <i>The Physics Classroom</i>. https://www.physicsclassroom.com/class.</p> <p>Hewitt, Paul G. 2015. <i>Conceptual Physics</i>. 12th ed. Boston: Pearson Education, Inc.</p> <p>McCullough, Jodi, and Roy McCullough. 2001. <i>Constructing Physics Understanding</i>. Edited by Al Mari. Armond, New York: The Learning Team.</p> <p>Newitt, Barb. 2026. "Uniform Circular Motion." <i>GeoGebra</i>. https://www.geogebra.org/m/suk8p6Je.</p> <p>Silverio, Angelina A., and John Donnie A. Ramos. 2017. <i>Exploring Life Through Science: General Physics 1</i>. Quezon City: Phoenix Publishing House.</p> <p>University of Colorado Boulder. 2026. "Projectile Motion." <i>PhET Interactive Simulations</i>. https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html.</p> <p>Varsity Physics OBHS. 2020. <i>Making a Projectile Motion Launcher</i>. https://www.youtube.com/live/zLoMgH-78Lw.</p> <p>Young, David, and Shane Stadler. 2018. <i>Cutnell & Johnson Physics</i>. 11th ed. Hoboken, New Jersey: John Wiley & Sons, Inc.</p> <p>Wolfe, Gregg, Erika Gasper, John Stoke, Julie Kretchman, David Anderson, Nathan Czuba, Sudhi Oberoi, Liza Pujji, Irina Lyublinskaya, and Douglas Ingram. 2022. "Projectile Motion." <i>OpenStax</i>. https://openstax.org/books/college-physics-ap-courses-2e/pages/3-4-projectile-motion.</p>

III. CONTENT <i>(Sequencing Content)</i>	<i>Two-Dimensional Motion: Projectile Motion and Circular Motion</i>	
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	<p><i>By the end of the lesson, the learners should be able to:</i></p> <ol style="list-style-type: none"> 1. differentiate projectile motion and circular motion in terms of path, forces involved, and motion characteristics.; 2. explain the independence of the horizontal and vertical components of projectile motion through observation and investigation; 3. conduct investigations to determine the effects of angle of projection and initial velocity on the range and maximum height of a projectile; 4. identify the type of force that causes an object to move in circular motion; and 5. investigate the relationship between speed, radius, mass, and centripetal force of an object moving in a circular motion. 	
IV. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge</p> <p>OPTION 1: Roll It, Toss It, Spin It!</p> <p>Tell learners to predict the path and type of motion that will occur before performing each of the following activities:</p> <ol style="list-style-type: none"> 1. Roll a ball across the floor. 2. Toss the ball diagonally upward. 3. Spin a cork attached to a string. <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which scenario depicts one-dimensional motion? Which scenarios show a two-dimensional motion? 2. How can you differentiate one-dimensional motion from two-dimensional motion? 3. What type of motion (linear, projectile, or circular) is shown in each scenario, and why? <p>OPTION 2: Motion Sort Challenge</p> <p>Provide learners with cards describing various scenarios (e.g., a car turning a corner, a ball dropped from a building, a bullet</p>	

IDF Relevance:
It elicits learners' prior knowledge of motion and connects it to new concepts in two-dimensional motion. It also helps assess misconceptions and prepares learners for a deeper understanding of projectile motion and circular motion.

Notes to the Teacher:
Select one activity based on time and class of readiness, explain the task clearly, and guide students to observe, predict, sort, or reflect. Use the guide for questions to elicit prior ideas, address misconceptions, and connect responses to 1D and 2D motions.

Ensure that learners understand that linear motion occurs in one dimension (1D), while projectile motion and circular motion occur in two dimensions (2D).

fired horizontally). Learners categorize them into "Linear," "Projectile," or "Circular."

Guide Questions:

1. Which of the motions are 1D and which are 2D?
2. Why is it impossible for a 1D path to be a curve or a circle?

OPTION 3: Know-Wonder-Learn Chart

Divide the class into groups. Instruct learners to fill out the "What I Know" and "What I Wonder" first, and then the "What I learned" will be done at the end of the lesson.

Concept	What I Know	What I Wonder	What I Learned
1D Motion			
Path			
Coordinates			
Direction			
Example			
2D Motion			
Path			
Coordinates			
Direction			
Example			

2. Establishing the Purpose of the Lesson

(This is a continuation of the activity on "Activating Prior Knowledge")

OPTION 1: Roll It, Toss It, Spin It!

Guide Questions:

1. Why does the tossed ball move in a curved path?
2. What keeps the cork moving in a circle?
3. Which motion involves gravity only?
4. What do you think keeps the object moving in a circular path?

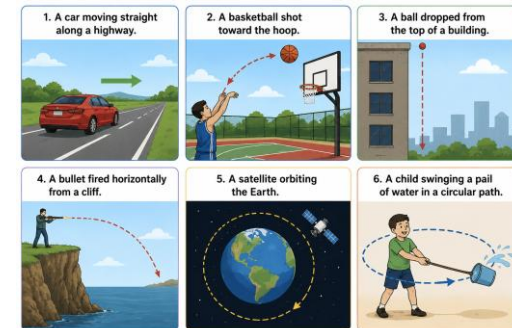
Materials Needed:

OPTION 1:

- Ball
- String with cork/washer
- Stopwatch

OPTION 2:

Motion Cards (see sample below)



OPTION 3:

- KWL Chart

IDF Relevance:

It helps learners connect prior observations to the concepts of projectile and circular motion. It also develops critical thinking and understanding of how gravity and centripetal force affect motion.

Notes to the Teacher:

Choose the same option number used in the previous activity.

In this part, introduce **centripetal force** as the inward force that keeps an object moving in a circular path, and emphasize that **gravity** acts downward on projectiles throughout their motion.

	<p>OPTION 2: Motion Sort Challenge</p> <p>Guide Questions:</p> <ol style="list-style-type: none">1. Why do projectiles move in a curved, parabolic path called a trajectory?2. What causes an object to move in a circular path?3. What distinguishes projectile motion from circular motion, other than the path followed by the object? <p>OPTION 3: Spot-the-Difference</p> <p>Let learners complete the table below by comparing the characteristics of projectile motion and circular motion. Discuss with your group how the forces involved affect the path and motion of the object.</p> <table><tr><th>Projectile Motion</th><th>Circular Motion</th></tr><tr><td>curved path</td><td></td></tr><tr><td>gravity acts downward</td><td></td></tr><tr><td></td><td>velocity changes in direction</td></tr></table> <p>Guide Questions:</p> <ol style="list-style-type: none">1. What causes the object in projectile motion to follow a curved path?2. Why does an object in circular motion continuously change direction?3. How do the forces acting on the object differ in projectile and circular motion?	Projectile Motion	Circular Motion	curved path		gravity acts downward			velocity changes in direction	
Projectile Motion	Circular Motion									
curved path										
gravity acts downward										
	velocity changes in direction									
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p><u>PROJECTILE MOTION</u></p> <p>OPTION 1: Drop and Launch</p> <p>Materials:</p> <ul style="list-style-type: none">• Flat table or desk• Measuring tape or ruler• Chalk• Two steel balls	<p>IDF Relevance:</p> <p>The activities use hands-on examples, simulations, and guided questions to make projectile and circular motion easier to visualize. They promote active, and inquiry-based learning as learners analyze motion through observation.</p> <p>By highlighting motion components and forces, this part deepens conceptual understanding and connects theory to real-world situations.</p>								

- Projectile and Free-Fall Apparatus Kit (*shown on the annotation*)

Procedure:

1. Place the *Projectile and Free-Fall Apparatus Kit* securely at the edge of a table.
2. Insert the two steel balls properly:
 - One ball in the launcher
 - One ball on the drop holder
3. Pull the trigger/release mechanism.
4. Observe the motion of the two balls.
5. Repeat the activity at least three times.

Observation Table:

Trial	Path of Launched Ball	Path of Dropped Ball	Did the balls hit the floor at the same time?
1			
2			
3			

Guide Questions:

1. How do the paths followed by the launched ball and the dropped ball differ?
2. Which ball reached the floor first? What does this suggest about their vertical motion?
3. Is the vertical motion of the launched ball accelerated? Why?
4. Is the horizontal motion of the launched ball accelerated? Why?
5. Based on the activity, what can you conclude about the horizontal and vertical components of projectile motion?

Notes to the Teacher

In the “Instituting New Knowledge” part, discuss all activities related to projectile motion first before proceeding to circular motion to help learners distinguish the concepts clearly and avoid confusion.

PROJECTILE MOTION



Projectile and Free-Fall Apparatus Kit from Lazada

If the said apparatus is not available, the teacher can simultaneously:

- Drop one ball vertically
- Launches another ball horizontally from the same height.

Guide learners to understand the following key concepts:

- Projectile motion has two independent motions, horizontal and vertical.
- Horizontal motion does not affect vertical motion.
- Horizontal motion is uniform, while vertical motion is accelerated due to gravity, similar to free fall.

Possible Answers:

OPTION 1 (Projectile Motion)

1. The launched ball moved in a curved path while the dropped ball moved straight downward.

OPTION 2: Breaking Down the Path

Present a diagram of a projectile motion to the class, similar to the one on the right. Ask learners to carefully observe the labels and the directions of the velocity and acceleration vectors in the diagram.

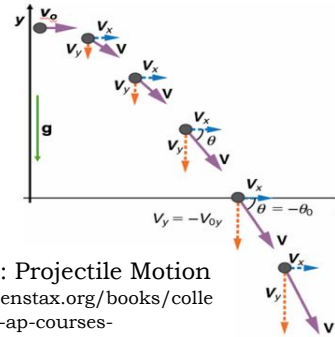


Figure 1: Projectile Motion
<https://openstax.org/books/college-physics-ap-courses-2e/pages/3-4-projectile-motion>

Guide Questions:

1. What kind of path does the projectile follow as it moves through the air?
2. What do violet arrows represent? orange? blue? green?
3. What happens to the horizontal velocity as the projectile moves through the air? Is it accelerating? Why?
4. How does the vertical velocity change as the projectile falls? Is it accelerating? Why?
5. At which point is the vertical velocity equal to zero?
6. What can you infer from the diagram about the relationship between horizontal and vertical components in projectile motion?

CIRCULAR MOTION

ACTIVITY 1: Where Will It Go?

OPTION 1:

1. Demonstrate circular motion using a battery-operated toy car attached to a fixed point by a string, with the string tied at a right angle to the side of the toy car.
2. Ask: What will happen to the object if the rope is suddenly cut?
3. Cut the rope and let them observe what happens to the motion of the toy car.

2. Both balls reached the floor at the same time.
3. Yes, because gravity pulls it downward.
4. No, because no horizontal force acts on it.
5. Horizontal and vertical motions are independent.

OPTION 2 (Projectile Motion)

1. A curved or parabolic path.
2. Violet – total velocity;
orange – vertical velocity;
blue – horizontal velocity;
green – gravity.
3. It remains constant because no horizontal force acts on it.
4. It increases downward because of gravity.
5. At the highest point.
6. The horizontal and vertical motions are independent.

CIRCULAR MOTION

Guide learners to understand the following key concepts:

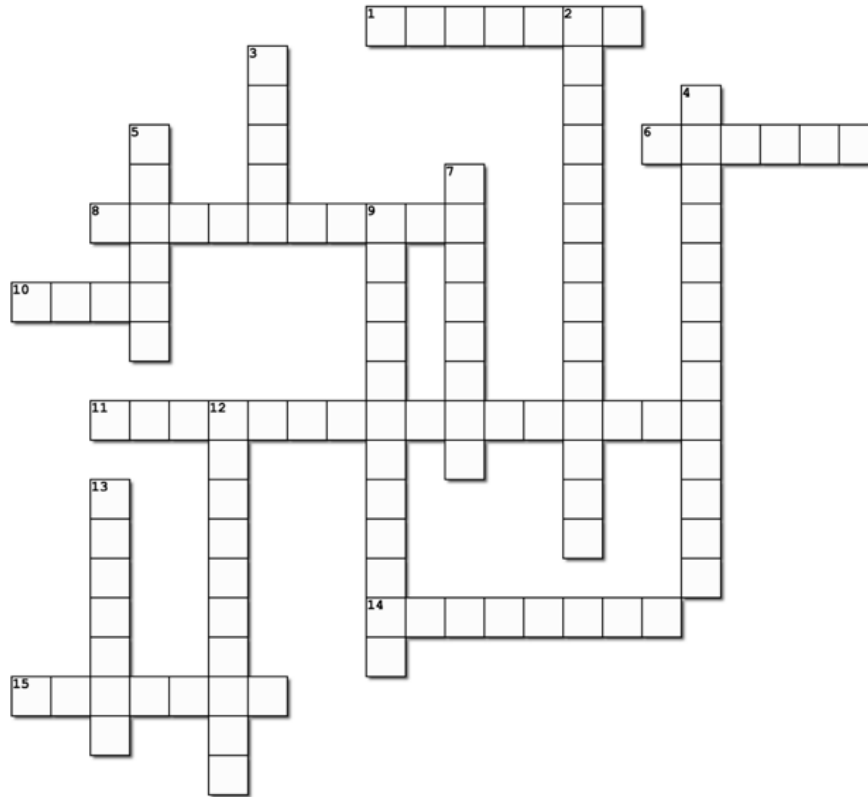
- Circular motion occurs because of a centripetal force directed toward the center of the path.
- Any force can produce circular motion as long as it acts as a centripetal (inward-directed) force.
- When the force is removed, the object travels in a straight, tangential path.

	<p>OPTION 2:</p> <ol style="list-style-type: none"> 1. Open the GeoGebra simulation on circular motion using this link: https://www.geogebra.org/m/suk8p6Je. 2. Click “Start” and observe how the object moves along a circular path. Take note of the directions of velocity and centripetal force. 3. Ask: What will happen to the object if the rope is suddenly cut? 4. Click “Cut the Rope” and observe what happens to the motion of the object. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What path did the object follow before the rope broke? 2. What force kept the object moving along a circular path? 3. What happened to the motion of the object when the rope broke? In what direction did it move? 4. Why did the object move in a tangential path instead of continuing in a circular motion? 5. What does the activity depict about the role of centripetal force in circular motion? <p>ACTIVITY 2: What Keeps It Turning? Directions: Analyze the situations where circular motion is observed. Then, answer the questions.</p> <ol style="list-style-type: none"> 1. A flying swing ride in an amusement park spins rapidly, causing the chairs to move outward while rotating in a circular path. As the ride speeds up, the chains tilt at an angle, and the riders feel pushed away from the center. What force keeps the riders moving in a circular path instead of flying off in a straight line? 2. Why do Earth and other planets remain in their orbits and tend to keep revolving within their respective orbits forever? 3. When a car goes around a curved road at high speed, what force keeps the car moving along the curved path instead of continuing in a straight line? 	<p>Possible Answers</p> <p>ACTIVITY 1 (Circular Motion)</p> <ol style="list-style-type: none"> 1. A circular path. 2. Centripetal force. 3. It moved in a straight tangential path. 4. Because the centripetal force disappeared. 5. Centripetal force keeps objects moving in a circle. <p>ACTIVITY 2 (Circular Motion)</p> <ol style="list-style-type: none"> 1. Tension in the chains. 2. Gravity keeps them in orbit. 3. Friction between the tires and the road. <p>IDF Relevance: The activities help learners build a foundational understanding of projectile and circular motions through guided discussion of key concepts. The crossword puzzle promotes active recall of key terms, while the label and explain activity strengthens learners’ conceptual understanding. These activities prepare learners for the succeeding inquiry, investigation, and application tasks.</p> <p>Notes to the Teacher: Use the activities to facilitate a guided discussion of the key concepts in projectile motion and circular motion.</p> <p>Projectile motion occurs when an object is launched into the air and moves under the influence of gravity alone. It follows a</p>
--	---	---

2. Discussing New Concept

OPTION 1: Two-Dimensional Motion Crossword Puzzle

Tell learners to fill in the crossword puzzle using the clues. The words are related to two-dimensional motion, projectile motion, and circular motion.



Across

1. The sole force is acting on a projectile that causes vertical acceleration.
6. The distance from the center of a circle to the moving object.
8. Motion of an object thrown into the air.
10. Acceleration along the horizontal component of projectile motion.

Down

2. Motion in a plane involving both horizontal and vertical movement.
3. The horizontal distance traveled by a projectile.
4. The highest point reached by a projectile.
5. The time factor used to calculate speed in circular motion investigations.

curved path called a trajectory because the object experiences both horizontal and vertical motion simultaneously.

Mathematical Representations

Horizontal Motion: $x = v_x t$

Vertical Motion: $y = v_y t - \frac{1}{2} g t^2$

where:

x = horizontal displacement

v_x = horizontal velocity

t = time

y = vertical displacement

v_y = vertical velocity

g = acceleration due to gravity

Ways to launch a projectile:

- **Horizontally launched projectile** – the object is launched with an initial horizontal velocity, while its initial vertical velocity is zero.
- **Projectile launched at an angle** – the object is launched with an initial velocity that has both horizontal and vertical components.

Other key quantities used to describe a projectile's motion:

- **Angle of projection (θ)** – the angle between the initial velocity vector and the horizontal direction.
- **Range (R)** – the horizontal distance traveled by the projectile from the launch point to the landing point.

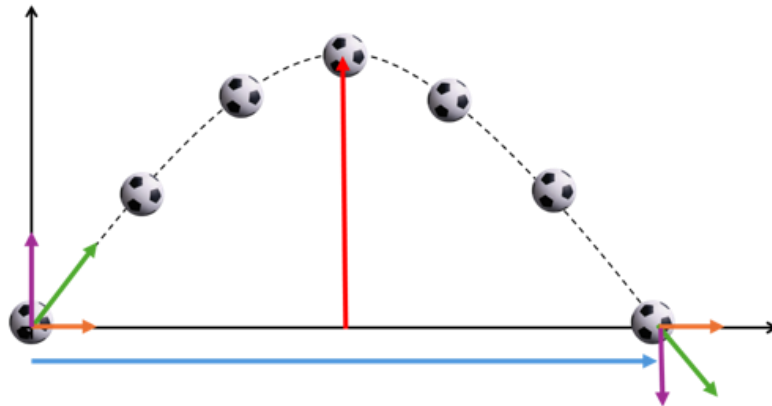
11. The force that keeps an object moving in a circular path.
14. The horizontal velocity in projectile motion.
15. Force providing centripetal motion in a string investigation.

7. The component of projectile motion that changes due to gravity.
9. The principle that horizontal motion does not affect vertical falling time.
12. The path followed by a projectile.
13. The direction of an object in circular motion would travel if the centripetal force suddenly vanished.

OPTION 2: Label and Explain

Tell learners to complete the illustrations by correctly labeling the vectors (arrows) and briefly explain how it affects projectile motion or circular motion.

A. Target the Trajectory



- **Maximum height (H)** – the greatest vertical displacement reached by the projectile relative to its launch point.

Circular motion requires an inward force called the centripetal force.

Mathematical Representations

Tangential Speed: $v = \frac{\Delta x}{\Delta t} = \frac{2\pi r}{T}$

Centripetal Acceleration: $a = \frac{\Delta v}{\Delta t} = \frac{v^2}{r}$

Centripetal Force: $F_c = \frac{mv^2}{r}$

where:

F_c = centripetal force

a = centripetal acceleration

m = mass of the object

v = velocity of the object

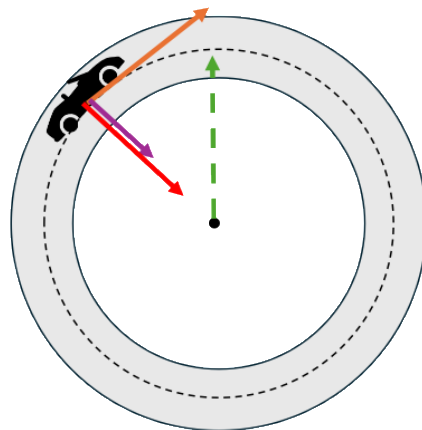
r = radius (distance from the object to the axis of rotation)

T = period (time to complete one revolution)

IDF Relevance:

The activities promote inquiry-based, experiential, and learner-centered learning through hands-on investigations, simulations, and data analyses. It allows learners to manipulate variables, observe relationships, collect evidence, and draw conclusions about projectile and circular motions. It also develops scientific process skills, critical thinking, and conceptual understanding by engaging learners in experimentation, interpretation of data, and application of physics concepts in real-world situations.

B. Turn Around



3. Developing Mastery

PROJECTILE MOTION

OPTION 1: Investigating Projectile Motion Using PhET Simulation

PART A: Which Angle Goes Farthest?

1. Open the PhET Projectile Motion simulation.
2. Choose pumpkin as the projectile and keep air resistance off.
3. Set the following values:
 - Height = 0 m
 - Initial velocity = 15 m/s.
4. Change the launch angle to 15°, 30°, 45°, 60°, and 75°.
5. Launch the projectile for each angle and record the range it reaches.

PART B: How Does Speed Affect Motion?

1. Keep the following values constant:
 - Height = 0 m
 - Launch angle = 60°

Notes for Teachers:

- The various activity options in this lesson can be set up as **learning stations** within the classroom.
- Students should work in groups at each station, collaborating to complete the assigned tasks.
- Each group is responsible for collecting data, conducting analyses, and drawing conclusions based on their activity.
- Groups will present their findings—data, analyses, and conclusions—to the class, foster discussion and deeper understanding.

PROJECTILE MOTION

Materials Needed:

OPTION 1:

- Computer/Tablet
- Internet Access
- PhET Projectile Motion Simulation (https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html)

OPTION 2:

- DIY projectile launcher (rubber band, board, clips) <https://www.youtube.com/live/zLoMgH-78Lw?app=desktop>
- paper ball, ping pong ball, rubber ball, marble, clay ball
- Protractor
- Meter stick
- Masking tape or chalk

2. Choose pumpkin as the projectile.
3. Change the initial velocity to 5 m/s, 10 m/s, 15 m/s, 20 m/s, and 25 m/s for each trial.
4. Launch the projectile and observe its motion.
5. Record the maximum height and range reached for every trial.

PART C: Does Mass Matter?

1. Keep the following values constant:
 - Height = 0 m.
 - Launch angle = 60°
 - Initial velocity = 15 m/s
2. Change the projectile object for each trial (e.g., pumpkin, baseball, car, human, piano).
3. Launch the projectile for each object.
4. Record the mass and the corresponding range.

Data and Analysis:

PART A: Effect of Launch Angle on Projectile Range

Trial	Object	Mass of the Projectile	Initial Velocity (m/s)	Launch Angle (°)	Range (m)
1					
2					
3					
4					
5					

Guide Questions

1. Which launch angle produced the greatest range?
2. Which pairs of angles produced similar ranges?
3. How does the angle of projection affect the range in projectile motion?

Possible Answers (Projectile Motion)

Part A

1. 45°
2. 15° and 75°, 30° and 60°
3. As the angle increases to 45°, the range increases. Beyond 45°, the range decreases.

Part B

1. Keeping other variables constant makes the test accurate and ensures that only the initial velocity affects the projectile range and maximum height.
2. When the initial velocity increased, the projectile traveled farther and reached a higher height.
3. Initial velocity is directly proportional both to projectile's range and maximum height.

Part C

1. No
2. Mass has no effect on projectile motion when air resistance is ignored.

Notes to the Teacher on the Data and Analysis for Option 2

Use the same tables and guide questions found in Option 1. However, apply the following modifications for the DIY Projectile Launcher activity:

- Replace “Initial Velocity” with “Pulling Distance” of the launching force.

PART B: Effect of Initial Velocity on Range and Maximum Height

Trial	Mass of the Projectile	Initial Velocity (m/s)	Launch Angle (°)	Range (m)	Maximum Height (m)
1					
2					
3					
4					
5					

Guide Questions

1. Why do we need to keep other variables constant while studying the effect of initial velocity on a projectile range and maximum height?
2. How did increasing the initial velocity affect the projectile range? maximum height?
3. What relationships can you infer between initial velocity and the projectile range and maximum height?

PART C: Effect of Mass on Projectile's Range

Trial	Object	Mass of the Projectile	Initial Velocity (m/s)	Launch Angle (°)	Range (m)
1					
2					
3					
4					
5					

Guide Questions

1. Did changing the mass affect the range of the projectile?
2. What can you conclude about the effect of mass on projectile motion?

- There is no need to indicate the exact mass of the projectile. Instead, identify the projectile used.
- In Part C, rank the projectiles according to mass, with 1 as the heaviest and 5 as the lightest.
- Use the same guide questions provided in Option 1 for analysis and interpretation.

OPTION 2: Investigating Projectile Motion Using a DIY Projectile Launcher

PART A – Angle and Range: Which Angle Goes Farthest?

1. Place the DIY projectile launcher on a flat surface.
2. Mark the launching point using masking tape or chalk.
3. Keep the launching force constant by pulling the launcher to the same distance each time.
4. Set the launcher at the following angles: 15° , 30° , 45° , 60° , and 75° .
5. Launch the projectile for each angle.
6. Measure and record the horizontal distance (range) traveled by the projectile from the launching point to the landing point.

PART B – How Does Speed Affect Motion?

1. Keep the following conditions constant:
 - Launch angle = 45°
 - Same projectile object
2. Change the launching force by pulling the launcher at different distances (e.g., 5 cm, 10 cm, 15 cm, 20 cm, and 25 cm).
3. Launch the projectile for each trial.
4. Measure and record the range and estimated maximum height reached by the projectile.

PART C – Mass and Range: Does Mass Matter?

1. Keep the following conditions constant:
 - Launch angle = 45°
 - Pulling distance/launching force = constant
2. Use projectiles with different masses (e.g., paper ball, ping pong ball, rubber ball, marble, clay ball).
3. Launch each projectile using the same force.
4. Measure and record the range reached by each projectile.

CIRCULAR MOTION

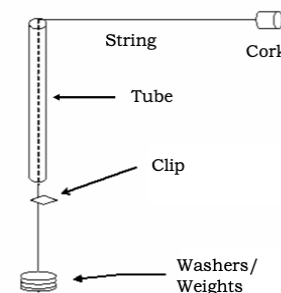
Materials Needed:

OPTION 1:

- Computer, laptop, or tablet
- Internet connection
- GeoGebra Circular Motion Simulation (<https://www.geogebra.org/m/suk8p6Je>)

OPTION 2:

Centripetal Force Apparatus Setup (shown below)



Possible Answers (*Circular Motion*)

1. Greater mass requires greater centripetal force.
2. A larger radius results in a smaller centripetal force.
3. When the speed increased, both the centripetal force and centripetal acceleration increased rapidly. The change was faster than linear because speed is squared in the formula.
4. Centripetal force increases with greater mass and higher speed but decreases with a larger radius. Among these factors, speed has the greatest

	<p><u>CIRCULAR MOTION</u></p> <p>OPTION 1: Exploring Circular Motion Using GeoGebra Simulation</p> <ol style="list-style-type: none"> 1. Open the GeoGebra circular motion simulation. 2. Set constant values for radius and speed. 3. Change the mass of the object for each trial. 4. Record the centripetal force and centripetal acceleration shown in the simulation. 5. Keep mass and speed constant. 6. Change the radius and record the changes in centripetal force and acceleration. 7. Keep mass and radius constant. 8. Change the speed and record the effects on centripetal force and acceleration. 9. Organize the collected data in tables. 10. Analyze the relationships between mass, radius, speed, and centripetal force. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What happened to the centripetal force when the mass of the object is changed? 2. How did the centripetal force change when you changed the radius while keeping mass and speed constant? Explain the trend you observe. 3. When you increase the speed, how do the centripetal force and centripetal acceleration change? Does the change appear linear or faster than linear? 4. Based on your findings, what are the relationships among mass, radius, speed, and centripetal force? Which factor has the greatest effect on the required centripetal force? <p>OPTION 2: Exploring Circular Motion Using Centripetal Force Apparatus</p> <ol style="list-style-type: none"> 1. Prepare the Centripetal Force Apparatus according to the set-up given (<i>see materials needed on annotation</i>). 	<p>effect on centripetal force because it is squared.</p> <p>For the Analysis in Option 2, use the same guide questions in Option 1.</p>
--	---	--

	<ol style="list-style-type: none"> Adjust the string position so that the cork is 30 cm away from the tip of the tube, and the clip is 1 cm away from the other end of the tube. Whirl the cork while holding the tube. Regulate the speed so that the distance between the clip and the tube remains at the initial 1 cm distance. This ensures that the radius of the stopper's circular path is the same radius you measured before. Once you have reached a steady rate, your partner can begin timing. Do not pull the string up or down with the other hand. Take note of the time to make 20 complete revolutions of the rubber stopper using a stopwatch. While doing this, be sure to monitor the speed of the stopper so that the mark does not move off the lip. Record the time to complete 20 revolutions. Do this for at least 3 trials. Increase the speed of whirling the cork. Repeat steps 4-5. Next, increase the radius (distance between the cork and the tube) to 50 cm and 70 cm. Then repeat steps 3-5. This time, keep the radius and speed constant while increasing the hanging mass. Repeat steps 3-5. 	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>1. Sports Strategy Proposal Learners act as sports analysts and recommend strategies for athletes based on projectile motion principles. Output: Written recommendation or presentation.</p> <p>2. Public Safety Campaign Learners create road safety campaigns using the concept of circular motion to explain:</p> <ul style="list-style-type: none"> safe turning speeds dangers of over speeding on curves importance of proper road design <p>Output: Brochure, slogan, or video campaign.</p>	<p>IDF Relevance: The activities engage students in authentic, real-world problem solving where physics concepts are used to optimize sports performance and ensure road safety. The generalization tasks guide learners to identify patterns and articulate relationships among motion variables based on their investigations. The exit ticket option serves as checking understanding, promoting reflection, and informing instructional decisions.</p>

2. Making Generalization

OPTION 1: Motion Concept Map

Directions: Create a concept map that shows the relationships among the different factors affecting projectile motion and circular motion.

OPTION 2: Complete the Table

Directions: Draw conclusions from the investigations conducted by completing the table below.

Motion Type	Factor Investigated	Observation	Scientific Explanation	Generalization
Projectile	Speed	Greater speed increased range		
Projectile	Angle	Different angles changed the trajectory		
Circular	Radius	Larger radius changed motion		
Circular	Speed	Faster motion required a greater centripetal force		

OPTION 3: Exit Ticket: “3-2-1 Motion Check”

Directions: Write (1) three things you learned about motion, (2) two factors that affect projectile or circular motion, and (3) one question you still have.

V. ASSESSMENT (Assessing Learnings)

PART 1: Multiple Choice Test

Directions: Read and analyze each question carefully. Choose the letter of the best answer and write it on your answer sheet.

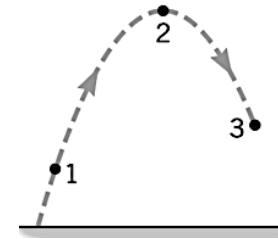
1. A projectile is fired into the air, and it follows the parabolic path as it lands on the right. There is no air resistance. At any instant, the projectile has a velocity, $\mathbf{v}$ and an acceleration, $\mathbf{a}$. Which of the drawings could represent the directions for $\mathbf{v}$ and $\mathbf{a}$ at any point on the trajectory?



For items 2-3, refer to the diagram on the right.

2. The diagram shows a projectile moving along a curved trajectory at three different points labeled, with corresponding speeds v_1 , v_2 , and v_3 . Assuming there is no air resistance, how do the speeds at the three points compare with one another

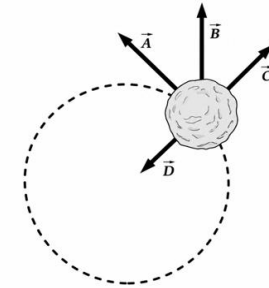
- A. $\mathbf{v_1 > v_3 > v_2}$.
- B. $\mathbf{v_1 > v_2 > v_3}$
- C. $\mathbf{v_2 > v_3 > v_1}$
- D. $\mathbf{v_2 > v_1 > v_3}$



3. At which point along the projectile path does the projectile have zero vertical velocity?
- A. At point 1
 - B. At point 2
 - C. At point 3
 - D. None of the above
4. A projectile is launched at the same speed at angles of 30° and 60° . Which statement is correct?
- A. Both projectiles have the same range.
 - B. The 60° projectile has a greater range.
 - C. The 30° projectile stays longer in the air.
 - D. Both projectiles have the same maximum height.
5. Two balls are projected at the same angle, but one is launched at a greater initial speed. How does the greater initial speed affect the projectile range and maximum height?
- A. Both range and maximum height increase.
 - B. Range increases while maximum height decreases.
 - C. Range decreases while maximum height increases.
 - D. Both range and maximum height remain the same.

- | | |
|--|--|
| | <p>6. Two projectiles are launched horizontally from the same height. One projectile has twice the mass of the other. Assuming air resistance is negligible, what will happen?</p> <ul style="list-style-type: none">A. The lighter projectile lands first.B. The heavier projectile lands first.C. Both projectiles land at the same time.D. The heavier projectile travels a shorter distance. <p>7. A projectile is launched with increasing angles while keeping the initial speed constant. Which angle generally produces the greatest horizontal range?</p> <ul style="list-style-type: none">A. 15°B. 30°C. 45°D. 75° <p>8. A stone tied to a string is whirled in a circle. If the string suddenly breaks, the stone will:</p> <ul style="list-style-type: none">A. Stop immediately.B. Move toward the center.C. Continue in a circular path.D. Move tangentially to the circle. <p>9. A satellite orbits Earth because of which force?</p> <ul style="list-style-type: none">A. TensionB. FrictionC. Magnetic ForceD. Gravitational force <p>10. Which factor would increase centripetal force the most?</p> <ul style="list-style-type: none">A. Doubling the speedB. Doubling the radiusC. Reducing the mass by halfD. Reducing the radius by half <p>11. If the radius of circular motion decreases while speed remains constant, centripetal force will:</p> <ul style="list-style-type: none">A. DecreaseB. IncreaseC. Become zeroD. Remain constant |
|--|--|

For items 12-13, consider the situation: A man swings a stone attached to a rope in a circle at constant speed. The figure on the right represents the path of the rock looking down from above.



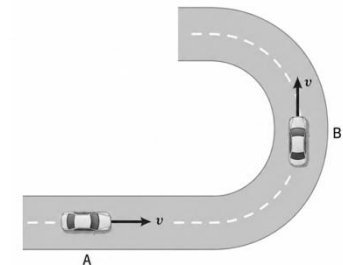
12. Which of the vectors could represent the velocity of the stone?

- A. Vector A
- B. Vector B
- C. Vector C
- D. Vector D

13. Which could represent the acceleration?

- A. Vector A
- B. Vector B
- C. Vector C
- D. Vector D

For items 12-13, consider the situation: Two cars are traveling at the same constant speed, as shown in the diagram.



14. Which car experiences centripetal acceleration?

- A. Car A only
- B. Car B only
- C. Both cars A and B
- D. Neither car A nor B

15. Which statement correctly describes their motion?

- A. Both cars experience the same type of motion.
- B. Car A changes direction continuously while car B does not.
- C. Both cars have the same velocity because they have the same speed.
- D. Car B changes direction continuously while car A moves in a constant direction.

PART 2: Design Your Own Investigation

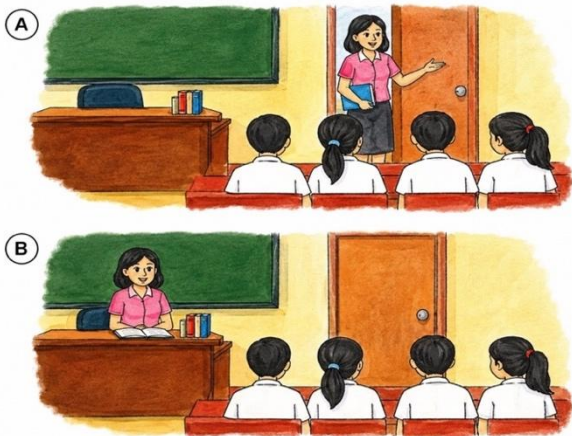
Task Overview: Each group will design and conduct their own experiment about projectile motion or circular motion. They will gather data, analyze results, and present their findings through a laboratory report.

Required Components for Laboratory Report: 1) Problem/question; 2) Hypothesis; 3) Variables; 4) Procedure; 5) Data Collection and Analysis; and 6) Conclusion.

	<table><tr><th>Criteria</th><th>4</th><th>3</th><th>2</th><th>1</th></tr><tr><td>Problem, Hypothesis, and Variables</td><td>Problem, hypothesis, and variables are clear and correct</td><td>Most parts are clear and correct</td><td>Some parts are unclear or incomplete</td><td>Most parts are missing or incorrect</td></tr><tr><td>Procedure and Investigation</td><td>Procedure is complete, organized, and properly followed</td><td>Procedure is mostly complete and followed</td><td>Procedure lacks some important steps</td><td>Procedure is incomplete or unclear</td></tr><tr><td>Data Collection and Organization</td><td>Data are complete, accurate, and well-organized</td><td>Data are mostly complete and organized</td><td>Data are incomplete or poorly organized</td><td>Very little or inaccurate data collected</td></tr><tr><td>Data Analysis and Scientific Explanation</td><td>Results are correctly analyzed and clearly explained using scientific concepts</td><td>Results are analyzed with acceptable explanation</td><td>Limited analysis and explanation</td><td>Incorrect or missing analysis</td></tr><tr><td>Conclusion and Presentation</td><td>Conclusion is strongly supported by data and presentation is clear and confident</td><td>Conclusion is supported and presentation is understandable</td><td>Weak conclusion or unclear presentation</td><td>Conclusion and presentation are incomplete or unclear</td></tr></table>	Criteria	4	3	2	1	Problem, Hypothesis, and Variables	Problem, hypothesis, and variables are clear and correct	Most parts are clear and correct	Some parts are unclear or incomplete	Most parts are missing or incorrect	Procedure and Investigation	Procedure is complete, organized, and properly followed	Procedure is mostly complete and followed	Procedure lacks some important steps	Procedure is incomplete or unclear	Data Collection and Organization	Data are complete, accurate, and well-organized	Data are mostly complete and organized	Data are incomplete or poorly organized	Very little or inaccurate data collected	Data Analysis and Scientific Explanation	Results are correctly analyzed and clearly explained using scientific concepts	Results are analyzed with acceptable explanation	Limited analysis and explanation	Incorrect or missing analysis	Conclusion and Presentation	Conclusion is strongly supported by data and presentation is clear and confident	Conclusion is supported and presentation is understandable	Weak conclusion or unclear presentation	Conclusion and presentation are incomplete or unclear
Criteria	4	3	2	1																											
Problem, Hypothesis, and Variables	Problem, hypothesis, and variables are clear and correct	Most parts are clear and correct	Some parts are unclear or incomplete	Most parts are missing or incorrect																											
Procedure and Investigation	Procedure is complete, organized, and properly followed	Procedure is mostly complete and followed	Procedure lacks some important steps	Procedure is incomplete or unclear																											
Data Collection and Organization	Data are complete, accurate, and well-organized	Data are mostly complete and organized	Data are incomplete or poorly organized	Very little or inaccurate data collected																											
Data Analysis and Scientific Explanation	Results are correctly analyzed and clearly explained using scientific concepts	Results are analyzed with acceptable explanation	Limited analysis and explanation	Incorrect or missing analysis																											
Conclusion and Presentation	Conclusion is strongly supported by data and presentation is clear and confident	Conclusion is supported and presentation is understandable	Weak conclusion or unclear presentation	Conclusion and presentation are incomplete or unclear																											
<div>VI. REFLECTION</div> <div>(Feedback and Continuous Improvement)</div>	<div>For Learners:</div> <div><div>1. How would you explain the difference between projectile motion and circular motion in your own words, and how did the activities help you understand these concepts better?</div><div>2. Which investigation or activity helped you understand projectile motion or circular motion the most? Explain why.</div><div>3. What difficulties did you encounter while conducting investigations on projectile or circular motion, and how did you overcome them?</div></div> <div>For Teachers:</div> <div><div>1. Which instructional strategy most effectively helped learners differentiate projectile motion and circular motion? Why?</div><div>2. What common misconceptions did learners show about projectile motion or circular motion, and how were these addressed during the lesson?</div><div>3. What challenges did you encounter in facilitating the investigations and discussions, and how can these be improved in future lessons?</div></div>																														
<div>VII. USE OF GENERATIVE AI</div>	<div>In preparing this Learning Exemplar (LE), the author(s) used ChatGPT and Microsoft Copilot to assist in the design of instructional tasks, the formulation of some guide questions, the development of a scoring rubric, and the generation of supporting images or illustrations. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.</div>																														

Learning Area	PHYSICS 1	Lesson Exemplar	8
----------------------	-----------	------------------------	---

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Explain concepts of moving reference frames and relative motion.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<p>Department of Education Philippines. 2025. <i>Strengthened Senior High School Curriculum: General Physics 1 (Grade 11)</i>. Pasig City: Department of Education.</p> <p>Henderson, Tom. 2020. "Physics Tutorial." <i>The Physics Classroom</i>. https://www.physicsclassroom.com/class.</p> <p>Hewitt, Paul G. 2015. <i>Conceptual Physics</i>. 12th ed. Boston: Pearson Education, Inc.</p> <p>Jon White. 2020. <i>Motion - Relative Velocity Example</i>. https://www.youtube.com/watch?v=ExZGkhZYHIY.</p> <p>Serway, Raymond A., and John W. Jewette Jr. 2019. <i>Physics for Scientists and Engineers with Modern Physics</i>. Boston, MA: Cengage.</p> <p>SHArPEdgeGlobal. 2013. <i>Relative Motion of Objects</i>. https://www.youtube.com/watch?v=lQ_tQYLbVwE.</p> <p>Silverio, Angelina A., and John Donnie A. Ramos. 2017. <i>Exploring Life Through Science: General Physics 1</i>. Quezon City: Phoenix Publishing House.</p> <p>University of Colorado Boulder. 2026. "Projectile Motion." <i>PhET Interactive Simulations</i>. https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html.</p> <p>Young, David, and Shane Stadler. 2018. <i>Cutnell & Johnson Physics</i>. 11th ed. Hoboken, New Jersey: John Wiley & Sons, Inc.</p> <p>Young, Hugh D., and Roger A. Freedman. 2020. <i>University Physics with Modern Physics</i>. London: Pearson Education.</p>
III. CONTENT (Sequencing Content)	<i>Relative Motion</i>

<p>IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)</p>	<p>By the end of the lesson, the learners should be able to:</p> <ol style="list-style-type: none"> 1. define reference frame and relative motion; 2. explain how motion changes when observed from different frames; 3. describe motion of real-life scenarios (e.g., moving vehicles, walking inside a bus) using the concept of relative velocities; 4. present real-life scenarios that explain relative motion in moving reference frames; and 5. demonstrate appreciation for the importance of relative motion in promoting safety, teamwork, and informed decision-making in some real-life situations.
IV. PROCEDURES	ANNOTATIONS
<p>A. Activating Prior Knowledge</p>	<p>1. Activating Prior Knowledge</p> <p>OPTION 1: Who is Moving?</p> <p>Tell learners to consider the situations shown in the pictures.</p> <div>  </div> <p style="text-align: center;"><i>AI-Generated Illustration</i></p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What is happening in picture A? picture B? 2. Who is moving in picture A? picture B? 3. Are the students moving? Why or why not? 4. Is the teacher moving in both pictures? Explain.

IDF Relevance:

The activities elicit learners' prior ideas about motion by having them describe, classify, and justify motion in different situations.

Notes to the Teacher:

Select one activity that best fits your learners' needs, abilities, and interests for every stage of the lesson. Guide learners as they analyze or reflect on the situations presented.

In this part, encourage learners to openly share their ideas and observations. **Accept all reasonable responses and focus on how learners describe the motion of objects.** Do not require them to identify reference frames at this stage of the lesson.

Materials Needed:

Pictures of the presented situations

OPTION 2: In Motion or At Rest?

1. Provide situation cards such as:
 - riding an elevator,
 - standing on Earth,
 - sitting in a moving car,
 - walking on a treadmill.
2. Learners classify each as “Moving” or “At Rest.”

Guide Question: What was your basis or reference for determining whether the objects were in motion or at rest?

OPTION 3: Who’s the fastest?

Present three images: a person on a treadmill, a person on an escalator, and a person walking on a sidewalk.

Guide Questions:

1. Who appears to be moving the fastest in the given situations?
2. Would your answer change if you were standing beside the treadmill/escalator/sidewalk instead of viewing from afar? Why?

2. Establishing the Purpose of the Lesson

OPTION 1: Is Motion Absolute or Relative?

1. Divide the class into four groups. Assign one guide question to each group.
2. Give each group 5 minutes to prepare their arguments, examples, and explanations.
3. Have each group present their arguments, examples, and explanations to the class.

OPTION 2:

SITUATION CARDS



OPTION 3:



IDF Relevance:

The activities engage learners in inquiry, discussion, and analysis of real-life motion situations. Also, they promote communication, team work and critical thinking as learners explain and defend their ideas. The activities develop a deeper understanding of relative motion and reference frames through reflective questioning.

	<p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Is it possible for an object to be at rest and moving at the same time? 2. Is it possible for two people to describe the same object's motion differently? 3. Is it possible for the Earth to be moving even if we do not feel it moving? 4. Is it possible for an object to have zero relative velocity even if both objects are moving? <p>OPTION 2: What if Analysis</p> <p>Present the situation: You put your book on the left side of the stationary table and find it later on the right side of the table.</p> <div> </div> <p style="text-align: center;"><i>AI-Generated Illustration</i></p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Are you certain that the book underwent motion? Why? 2. Suppose the table was not there. How would you describe or determine the motion of the book? 	<p>Note to the Teacher:</p> <p>At this point, learners should recognize that an object's motion may be described differently depending on the observer's point of view.</p> <p>Possible Answers:</p> <p>OPTION 1:</p> <ol style="list-style-type: none"> 1. Yes / A student inside a moving bus is at rest to the passengers but moving to people on the sidewalk. 2. Yes / A passenger inside a car may say another passenger is not moving, while a person outside the car sees both moving. 3. Yes / The sun revolves around the sun. 4. Yes / Two cars moving side by side at the same speed appear still to each other. <p>OPTION 2:</p> <ol style="list-style-type: none"> 1. Yes. The book changed its position from the left side of the table to the right side. 2. We would need another reference point, such as the ground or the Earth, to describe the motion of the book.
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>Activity 1: Describing Motion</p> <p>Instructions for Learners:</p> <ol style="list-style-type: none"> 1. Read and study the selection. 2. Answer the guide questions. 3. Draw conclusions based on the guide questions. 	<p>IDF Relevance:</p> <p>This part develops learners' understanding of relative motion and frames of reference through a familiar, real-life context (observer on the roadside vs. observer inside the bus) and a follow-up classification task. The activities require learners</p>

	<p>Selection:</p> <p>You were standing by the roadside when a bus passed by. Inside the bus, you saw your classmate Pedro traveling from Monumento to Pasay City. From your point of view, Pedro was moving because his position changed over time. This shows that motion is the change in an object's position with respect to a reference point.</p> <p>Now, let us look at the same situation from inside the bus. Pedro is sitting in his seat, and his position inside the bus does not change. To another passenger on the bus, Pedro appears at rest. This situation shows that motion depends on the observer or reference frame. An object may appear moving to one observer but at rest to another.</p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Where were you standing when the bus passed by? 2. Who did you see inside the bus? 3. Was your classmate seated inside the bus? 4. From your point of view, can you say that your classmate was in motion? Why? 5. Did the observer inside the bus notice that your classmate was just seated? 6. Why do you think your observation and the observer's observation inside the bus were not the same? 7. What is the difference between your frame of reference and the frame of reference of the observer inside the bus? 8. Can an object be at rest and in motion at the same time? Explain how. 9. What is a reference frame (frame of reference)? 10. What is relative motion? 	<p>to observe, compare perspectives, justify answers, and draw conclusions, and build the key idea that motion depends on the chosen reference frame.</p> <p>Note to the Teacher</p> <p>Divide the class into four. Two groups will perform Activity 1, and the other two will do Activity 2.</p> <p>Materials Needed:</p> <p>Pen and Worksheet</p> <p>Possible Answers:</p> <p>Activity 1:</p> <ol style="list-style-type: none"> 1. On the roadside. 2. Pedro 3. Yes 4. Yes. His position changed relative to me on the roadside as the bus moved. 5. Yes 6. We used different frames of reference. 7. My reference frame is the ground/road; the inside observer's reference frame is the bus. 8. Yes. An object can be at rest in one frame but moving in another (e.g., seated in a moving bus). 9. It is the viewpoint (reference point) used to describe position and motion. 10. It is the motion of an object that depends on the observer's point of view or reference frame.
--	---	---

Activity 2: Complete Me

Let the students check the appropriate motion of the object in each situation based on the frame of reference of the observer.

Situation	Observer's Frame of Reference	Motion of the Object	
		At Rest	In Motion
A passenger in a helicopter	with respect to the ground		
	with respect to the helicopter		
A crow on a cow	with respect to the ground		
	with respect to the cow		
A child standing on the ground	with respect to the ground		
	with respect to the Sun		

Guide Questions:

1. How does the motion of an object change when viewed from different frames of reference?
2. Which objects appear at rest to one observer but in motion to another?
3. Why is it important to identify the observer's frame of reference before describing motion?
4. What can you conclude about the state of motion based on the given situations?

2. Discussing New Concept**Activity 1: Picture Analysis**

Tell learners to study the pictures showing the different situations. Then, let them answer the questions that follow.

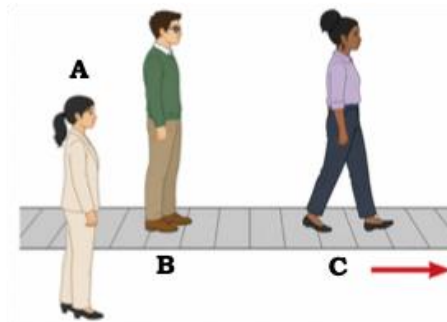
Activity 2:

1. It can appear different—the same object may be at rest in one frame but moving in another, depending on what the observer uses as the reference.
2. Examples:
 - passenger in a helicopter (at rest with respect to the helicopter, in motion w.r.t. ground);
 - crow on a cow (at rest w.r.t. cow, in motion w.r.t. ground);
 - child standing on Earth (at rest w.r.t. ground, in motion w.r.t. Sun).
3. Because motion is described relative to a reference frame, without stating it, a motion description can be confusing or incorrect.
4. In motion and at rest are relative, not absolute—whether something is “moving” depends on the observer's frame of reference.

IDF Relevance:

The activities deepen understanding of relative motion through picture and video analyses. They develop critical thinking, problem-solving, and analytical skills by requiring learners to interpret motion from different frames of reference.

Situation 1: Two observers (A and B) are watching a woman walking on a moving beltway at an airport.

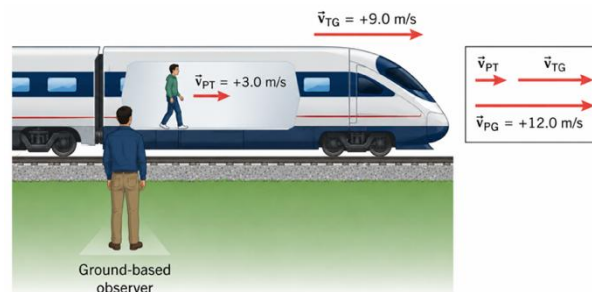


AI-Generated Illustration

Guide Questions:

1. How would Observer A describe the woman's motion relative to the ground?
2. How would Observer B describe the woman's motion relative to the moving beltway?
3. How would the woman's speed appear to differ to Observers A and B? Explain briefly.
4. What does this situation show about motion and frames of reference?

Situation 2: A passenger is walking inside a moving train. Analyze and describe the passenger's motion relative to a ground-based observer.



Notes to the Teacher:

Use these activities to guide learners toward the general formula for relative velocity, as shown below:

$$v_{AB} = v_{AC} + v_{CB}$$

where: v_{AB} = velocity of object A relative to object B
 v_{AC} = velocity of object A relative to object C
 v_{CB} = velocity of object C relative to object B

Emphasize also that $v_{AB} = -v_{BA}$.

Use Activity 1-Situation 1 to let learners understand the difference between **at rest reference frame** and **moving reference frame**.

An **at-rest reference frame** is when the observer is not moving, so objects that stay in the same position are considered at rest.

A **moving reference frame** is when the observer is moving, so the motion of objects may appear different depending on the observer's movement.

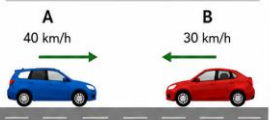
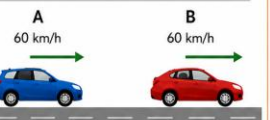
Materials Needed:

- Pen and Paper
- Pictures and Videos

	<p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What is the velocity of the train relative to the ground? the passenger relative to the train? the passenger relative to the ground? 2. What expression gives the passenger's velocity relative to the ground? 3. How would your answer change if the passenger walked opposite the train's motion? 4. Based on the illustration, what general conclusion can you state about finding relative velocity in one dimension? <p>Activity 2 – Option 1: Video Analysis</p> <p>Have the learners watch the video clips using the provided links for them to learn how relative motion is determined in moving reference frames.</p> <ul style="list-style-type: none"> • https://www.youtube.com/watch?v=lQ_tQYLbVwE • https://www.youtube.com/watch?v=ExZGkhZYHIY <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. If two objects move in the same direction, how can you determine their relative motion with respect to each other? 2. If two objects move in opposite directions, how does their relative speed change? 3. What happens to the relative motion when both objects move at the same speed and in the same direction? 4. How do you decide whether to add or subtract velocities when finding relative velocity in moving reference frames? 5. What does a relative velocity of zero mean? Give an example from the clips (or from daily life). 	<p>Possible Answers:</p> <p>Activity 1-Situation 1:</p> <ol style="list-style-type: none"> 1. The woman is moving forward because her position changes relative to the ground. 2. The woman is moving away from him because her position changes relative to beltway. 3. The woman appears faster to Observer A because she uses the ground as the reference frame (at rest reference frame). To Observer B, her speed appears slower because he uses the moving beltway as the reference frame (moving reference frame). 4. Motion depends on the observer's frame of reference. Different observers may describe the same motion differently. <p>Activity 1-Situation 2:</p> <ol style="list-style-type: none"> 1. $\mathbf{v_{TG}} = 9.0 \text{ m/s, east}$ $\mathbf{v_{PT}} = 3.0 \text{ m/s, east}$ $\mathbf{v_{PG}} = 12.0 \text{ m/s, east}$ 2. $\mathbf{v_{PG}} = \mathbf{v_{PT}} + \mathbf{v_{TG}}$ 3. The passenger's velocity relative to the ground would become smaller because the passenger moves against the train's direction. $\mathbf{v_{PG}} = \mathbf{v_{PT}} + \mathbf{v_{TG}}$ $\mathbf{v_{PG}} = \frac{-3m}{s} + \frac{9m}{s} = 6 \frac{m}{s}, \text{east}$ 4. Relative velocity in one dimension is found by adding or subtracting velocities depending on the direction of motion.
--	--	--

Activity 2 – Option 2: Motion Diagram Analysis

In case of connectivity issues, provide learners with motion diagrams that summarize different scenarios for determining relative velocities in moving reference frames, as shown below:

1 Same Direction	2 Opposite Directions	3 Same Speed, Same Direction
Relative velocity = subtract When two objects move in the same direction, subtract the smaller velocity from the larger velocity.	Relative velocity = add When two objects move in opposite directions, add their velocities.	Relative velocity = zero When two objects move in the same direction with the same speed, their relative velocity is zero.
$v_{AB} = v_A - v_B$ (A relative to B)	$v_{AB} = v_A + v_B$ (A relative to B)	$v_{AB} = 0$ (A relative to B)
 <p>A 60 km/h B 50 km/h</p> <p>Both move to the right.</p>	 <p>A 40 km/h B 30 km/h</p> <p>They move toward each other.</p>	 <p>A 60 km/h B 60 km/h</p> <p>Both move to the right at the same speed.</p>
$v_{AB} = 60 - 50 = 10 \text{ km/h}$ (to the right) A relative to B: 10 km/h to the right	$v_{AB} = 40 + 30 = 70 \text{ km/h}$ (to the right) A relative to B: 70 km/h to the right	$v_{AB} = 60 - 60 = 0 \text{ km/h}$ A relative to B: 0 km/h (no motion)
$v_{BA} = v_B - v_A = 50 - 60 = -10 \text{ km/h}$ B relative to A: 10 km/h to the left	$v_{BA} = v_B + v_A = 30 + 40 = 70 \text{ km/h}$ B relative to A: 70 km/h to the left	$v_{BA} = 60 - 60 = 0 \text{ km/h}$ B relative to A: 0 km/h (no motion)
Direction of A relative to B: → right Direction of B relative to A: ← left	Direction of A relative to B: → right Direction of B relative to A: ← left	Direction of A relative to B: none (no motion) Direction of B relative to A: none (no motion)

Use the same guide questions from Activity 2 – Option 1.

3. Developing Mastery

1. Divide the class into six groups. Assign two groups to each activity option for comparison of outputs.
2. Each group will present and explain their output to the class, showing how the concept of relative motion is used to determine the velocities in the given scenarios.

OPTION 1: Drawing Motion Diagrams

Situation: Three cars, A, B, and C, are moving along a straight highway. The velocity of A relative to B is $\mathbf{v_{AB}}$, the velocity of A relative to C is $\mathbf{v_{AC}}$, and the velocity of C relative to B is $\mathbf{v_{CB}}$.

Activity 2:

1. Subtract the velocity of one object from the other. The result tells how fast one object appears to move relative to the other.
2. Their relative speed becomes greater because the velocities are added together.
3. Their relative velocity becomes zero, so they appear not moving relative to each other.
4. Subtract velocities when the objects move in the same direction. Add velocities when they move in opposite directions.
5. It means two objects have the same velocity, so they appear at rest relative to each other.

IDF Relevance:

The activities allow learners to develop mastery of relative motion through varied methods such as diagrams, role-play, and creative scenarios, addressing different learning styles. It promotes collaboration, critical thinking, and creativity while enabling students to express understanding through diverse outputs. By connecting concepts to real-life situations, it enhances meaningful and engaging learning.

Task: Construct motion diagrams for each situation and use them to analyze the motion of the cars. Determine the missing relative velocities and explain how the motion changes when viewed from another moving car.

	v_{AB}	v_{AC}	v_{CB}
A	?	+40 m/s	+30 m/s
B	?	+50 m/s	-20 m/s
C	+60 m/s	+20 m/s	?
D	-50 m/s	?	+10 m/s

OPTION 2: Role Play Activity

Scenarios: Each group will choose one real-life situation involving moving reference frames and relative motion.

1. Two students ride an escalator. One student walks upward while the other remains standing still on the escalator.
2. A police motorcycle chases a speeding car along the highway.
3. Inside a moving train, two students walk in opposite directions while the train continues moving forward.
4. A passenger inside a moving jeepney throws a ball backward while the jeepney moves forward.

Task: Prepare a 3-5 minute role-play to demonstrate the concept of relative motion using reference frames. The presentation should identify the objects in motion; show the point of view of different observers or reference frames; and describe the relative motion involved in the situation.

OPTION 3: Create-a-Scenario Challenge

Task: Create your own real-life scenario that demonstrates relative motion. Clearly describe the situation, identify the observer or reference frame, and explain how the motion appears different from each point of view. Present your scenario creatively through a short story, illustration, tiktok video or actual demonstration.

Notes to the Teacher:

- Emphasize that *relative motion depends on the observer's reference frame*.
- Guide learners in using the formula: $v_{AB} = v_A + v_B$ when analyzing velocities in Option 1.
- Check for misconceptions, such as confusion with direction signs (+/-) and interpreting velocities correctly.
- Encourage equal participation within groups and assign roles (leader, recorder, presenter) if needed.
- Remind students to clearly explain in their presentation who is observing in each scenario.
- Allow creativity but ensure outputs remain scientifically accurate and clearly explained.

Possible answers

OPTION 1:

- a. +70 m/s
- b. +30 m/s
- c. +40 m/s
- d. -60 m/s

<p>C. Demonstrating Knowledge and Skills</p>	<p>1. Finding Practical Application</p> <ol style="list-style-type: none"> 1. Divide the class into small groups. 2. Each group will choose one situation (option) below. 3. Instruct them to analyze the situation using the concept of relative motion or relative velocity. 4. For the output, let them prepare a 3-minute presentation using any of the following formats: mini-poster presentation, short oral report, or quick role-play with explanation <p>OPTION 1: Transportation Safety — Air and Sea Navigation Task: Discuss how pilots and ship captains use relative motion to travel safely and efficiently. Explain why understanding wind and water currents is important in protecting passengers, cargo, and crew members.</p> <p>OPTION 2: Responsible Driving and Safe Overtaking Task: Analyze how relative velocity helps drivers decide the safest time to overtake another vehicle. Discuss how understanding motion can help prevent road accidents and promote responsible driving behavior.</p> <p>OPTION 3: Teamwork and Coordination in Sports Task: Explain how relative motion helps athletes coordinate accurate passes while moving. Discuss how understanding motion contributes to teamwork, cooperation, and success in sports.</p> <p>2. Making Generalization OPTION 1: Concept Map: Understanding Relative Motion Let learners create a concept map that summarizes the lesson by linking the following keywords using arrows and <i>linking phrases</i> (e.g., “depends on,” “is measured by,” “is described relative to”):</p> <ul style="list-style-type: none"> • reference frame • observer 	<p>IDF Relevance:</p> <p>This activities allow learners to recognize that the concepts of moving reference frames and relative motion are not only used in solving physics problems but are also essential in ensuring safety, teamwork, and proper decision-making in real-life situations. Through collaborative presentations, learners will connect physics concepts with positive values and responsible actions in daily life.</p> <p>The generalization activities help learners organize ideas and articulate the key principle that motion depends on the chosen reference frame.</p>
---	---	---

	<ul style="list-style-type: none"> • relative motion • velocity • vector subtraction <p>Remind learners to place relative motion or relative velocity at the center and include the relationship, $v_{AB} = v_{AC} + v_{CB}$ (in words or symbols) Somewhere on the map.</p> <p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which terms/concepts must be identified first before you can correctly describe an object’s motion? 2. How does changing the reference frame/observer change the measured velocity and the description of relative motion? 3. Where does vector subtraction appear in your map, and why is it needed to find relative velocity? <p>OPTION 2: “Rule-Example-Nonexample (REN) Generalization Ask learners to write: (1) one clear general rule about relative motion, (2) one example that supports the rule, and (3) one nonexample that looks similar but does not fit the rule. Learners must briefly justify why the nonexample does not apply.</p> <p>OPTION 3: One-Minute “Claim–Evidence–Reasoning” (CER) Ask learners to write a CER response to the prompt: “Motion is not absolute.” Their output must include a claim, one piece of evidence from today’s activities, and a reasoning statement that connects the evidence to the role of a reference frame and relative velocity.</p>	
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>OPTION 1: Explain the Phenomena (Open-Ended Test)</p> <p>Directions: Read and analyze each question carefully. Answer in complete sentences and explain your ideas clearly using the concepts of reference frames and relative motion. Support your explanations with relevant examples or real-life situations whenever possible.</p> <ol style="list-style-type: none"> 1. Why do people on Earth usually feel that the Earth is not moving even though it continuously rotates and revolves? Explain using the concepts of reference frames and relative motion. 	

2. If the Earth suddenly stopped rotating, what changes would people observe in the movement of the Sun and the sky? Explain your answer.
3. Why do stars appear to move across the night sky even though many of them remain nearly fixed relative to one another? Explain using Earth's motion.

Scoring Rubric:

Criteria	5 Points	3 Points	1 Point
Accuracy of Explanation	The answers show a correct and complete understanding of reference frames and relative motion. Scientific ideas are accurate and well explained.	The answers show partial understanding. Some ideas are correct, but there are minor errors or missing details.	The answer shows little understanding. Explanations are unclear, incorrect, or unrelated to the concepts.
Use of Reference Frame	Clearly identifies and explains the role of the reference frame in the situation. Correctly relates motion to the observer's point of view.	Mentions the reference frame but explanation is incomplete or somewhat unclear.	Does not mention or incorrectly uses the concept of reference frame.
Clarity of Reasoning	Ideas are organized, logical, and easy to follow. Uses clear examples or real-life situations to support the explanation.	Ideas are somewhat clear but may lack organization or sufficient examples.	Ideas are confusing, incomplete, or difficult to understand. Little to no supporting example is given.

OPTION 2: Frame of Reference Justification

Prompt: "A person sitting in a moving bus is at rest." Do you agree or disagree? Answer in 4–5 sentences by (1) naming two reference frames, (2) stating the person's motion in each frame, and (3) using the phrase *relative to* correctly at least once.

OPTION 3: Relative Motion Concept Test

Directions: Read and analyze each question carefully. Choose the letter of the best answer and write it on your answer sheet.

1. Which statement best explains why two observers may disagree about the motion of the same object?
 - A. Motion depends on mass and weight.
 - B. Objects change velocity randomly.
 - C. Distance affects only stationary objects.
 - D. Observers may use different reference frames.

For items 2-3, consider the situation: A passenger is sitting inside a bus moving at 15 m/s east.

2. The passenger's velocity relative to the bus is:
- A. 15 m/s east
 - B. 15 m/s west
 - C. Zero (at rest)
 - D. Less than 15 m/s
3. What is the passenger's velocity relative to an observer outside the bus?
- A. 15 m/s east
 - B. 15 m/s west
 - C. Zero (at rest)
 - D. Greater than 15 m/s
4. Two cars move side by side at the same speed in the same direction. The relative velocity of one car with respect to the other is:
- A. Equal to their common speed
 - B. Twice their common speed
 - C. Zero or at rest
 - D. Always negative
5. Two cars move side by side at the same speed in opposite directions. What is the relative velocity of one car with respect to the other?
- A. Equal to their common speed
 - B. Twice their common speed
 - C. Zero or at rest
 - D. Always negative

For items 6-7, consider the situation: A girl is standing inside a bus moving at constant velocity. She tosses a ball vertically upward.

6. To an observer standing at the roadside, how does the ball appear to move?
- A. move straight upward and downward only
 - B. move backward because of air resistance
 - C. follow a curved path while moving forward
 - D. remain above the girl at all times
7. To an observer inside the bus, the ball appears to _____.
- A. move straight upward and downward only
 - B. move backward because of air resistance
 - C. follow a curved path while moving forward
 - D. remain above the girl at all times
8. Which situation would most likely produce the greatest relative speed?
- A. Two runners moving side by side at equal speeds
 - B. Two cars moving in opposite directions at high speeds.
 - C. Two bicycles parked beside each other.
 - D. Two boats drifting with the same river current.

	<p>9. A person standing on a platform sees rain falling vertically downward, while a passenger inside a moving train sees the rain slanting backward. Which statement best explains this difference?</p> <p>A. The rain changes direction for each observer. B. The observers are using different frames of reference. C. Gravity acts differently inside the train. D. The train changes the velocity of the rain.</p> <p>10. Which situation best demonstrates the addition of relative velocities?</p> <p>A. A person sitting inside a parked car B. A runner moving inside a moving train C. A building standing beside a road D. A book resting on a table</p>
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p><i>For Learners:</i></p> <ol style="list-style-type: none"> 1. How would you explain the concepts of reference frame and relative motion in your own words, and how did the activities help you understand them better? 2. Which activity helped you understand relative motion the most? Explain why. 3. What difficulties did you encounter while analyzing or presenting scenarios involving relative motion, and how did you overcome them? <p><i>For Teachers:</i></p> <ol style="list-style-type: none"> 1. Which instructional strategy most effectively helped learners understand reference frames and relative motion? Why? 2. Which learning activity encouraged the greatest participation, collaboration, and critical thinking among learners? Explain your observations. 3. What common misconceptions did learners show and how were these addressed during the lesson? 4. What challenges did you encounter in teaching the lesson and how can these be improved in future lessons?
VII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used ChatGPT and Microsoft Copilot to assist in the design of instructional tasks, the formulation of some guide questions, the development of a scoring rubric, and the generation of supporting images or illustrations. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	9
----------------------	------------------	------------------------	----------

I. OBJECTIVES	
A. Content Standard	The learners learn that qualitative, quantitative, and graphical analysis of motion provide complementary ways to understand, describe, and predict motion.
B. Performance Standard	By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.
C. Learning Competencies	The learners solve physics problems involving uniformly accelerated motion (horizontal and vertical), projectile, circular, and relative motion in one- and two-dimensions in various contexts, such as moving vehicles, riverboat problems, aircraft, and spacecraft navigation.
II. REFERENCES and MATERIALS (<i>Selecting Resources and Material</i>)	<p>Young, Hugh D., and Roger A. Freedman. <i>University Physics</i>. Boston: Addison-Wesley, 2012.</p> <p>PhET Interactive Simulations. <i>Projectile Motion</i>. Boulder: University of Colorado Boulder. Accessed May 20, 2026. https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html.</p> <p>Not_boring_video. <i>Projectile Motion Short Video</i>. YouTube video accessed May 20, 2026. https://www.youtube.com/shorts/U_wyl1Jo2YI.</p> <p>Runway Action. <i>Crosswind at Gatwick</i>. YouTube video accessed May 20, 2026. https://www.youtube.com/shorts/OZ7LYsluqsc.</p>
III. CONTENT (<i>Sequencing Content</i>)	Kinematics

<p>IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i></p>	<p>Session 1</p> <ol style="list-style-type: none"> 1. Solve physics problems involving uniformly accelerated motion (horizontal and vertical) such as moving vehicles and aircrafts using the four kinematic equations. 2. Break down a velocity vector of a projectile into horizontal and vertical components using trigonometric functions. 3. Reconstruct the resultant velocity of a projectile by adding its horizontal and vertical components. 4. Solve physics problems involving projectile motion. <p>Session 2</p> <ol style="list-style-type: none"> 1. Solve physics problems involving circular motion. 2. Solve physics problems involving relative motion in one- and two-dimensions in various contexts, such as riverboat problems and spacecraft navigation.
<p>IV. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i></p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p>(Each part shall have 2-3 varied activities)</p>	<p>ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>

<p>A. Activating Prior Knowledge</p>	<p>1. Activating Prior Knowledge</p> <p>Option 1: True or False Post these statements on the board. Ask the students to write T for true and F for false on a small sheet of paper or in their notebooks.</p> <p>Give these statements at the start of Session 1</p> <ol style="list-style-type: none"> 1. A ball thrown straight upwards will have an upward acceleration. 2. A ball, upon reaching the highest point will have zero acceleration 3. When a vehicle moves to the right, its acceleration is always positive. 4. The direction of the acceleration of an idealized projectile cannot be straight downward and will follow the direction of its velocity. 5. In a position vs time graph, a straight, diagonal line indicates a positive acceleration. <p>Give these statements at the start of Session 2</p> <ol style="list-style-type: none"> 1. A body moving in a circle at constant speed has zero acceleration. 2. The acceleration of a body moving in a circle at constant speed is directed outward. 3. A body moving in a circle is an example of uniformly accelerated motion. 4. When two observers measure the velocity of a moving body, they will always get the same results regardless of their motion relative to the other. 5. Relative velocity is always equal to the algebraic sum of the velocities of two objects 	<p>APK Option 1</p> <ul style="list-style-type: none"> • This true or false activity helps surface prior knowledge. It is designed to help the teacher easily evaluate the responses and spot misconceptions. • All of the statements are false. Any item/s where multiple students answer true will become a priority for discussion. There is a risk that some students may recognize that all answers are all false but if they do it only means they have a concrete understanding of the required concepts. • During the discussion select students to correct the statements for a deeper conceptual understanding. • The teacher provides feedback while discussing the answers and recalling previous terms and concepts and prime students for detailed discussion of the lesson ahead. This directly supports the IDF principle of connecting new learning to prior understanding.
---	---	---

	<p>Option 2. Think-Pair-Share</p> <p>Session 1 Simulation</p> <p>Think: Show idealized projectile (zero drag) using PhET. Copy this link to the address bar to access PhET simulation https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_all.html.</p> <p>Learners with internet access on their mobile devices may perform the following steps independently. Otherwise, the teacher may present the simulation to the whole class using a TV or projector.</p> <ol style="list-style-type: none"> 1. Check the box for the velocity and acceleration components and make sure to uncheck the box for drag for simplicity. 2. Set the launch elevation to zero, launch angle at 45° and initial speed to 15m/s. 3. Click the launch button. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Describe the arrow representing the horizontal and the vertical components of the velocity as the projectile moves from its initial position to its landing point. 2. What happens to the horizontal and vertical components of the velocity of a projectile as it moves? 3. How does each component of a projectile's velocity (horizontal and vertical) change throughout its motion? 4. Describe the arrow representing the acceleration as the projectile moves from its initial position to its landing point. 5. What happens to the acceleration of a projectile as it moves? <p>Pair: Learners discuss their answers with a partner.</p> <p>Share: The teacher calls volunteers to share their answers to the entire class.</p>	<p>APK Option 2</p> <p>This allows students to think independently and value their own knowledge while the teacher acts as facilitator. The students become active constructors of knowledge as emphasized in the IDF.</p> <p>Answers to APK Option 2 Session 1 Guide Questions.</p> <ol style="list-style-type: none"> 1. Velocity Arrows (Horizontal and Vertical Components) The horizontal velocity arrow stays the same length and direction throughout the motion (constant to the right or left). The vertical velocity arrow: Gets shorter as the projectile rises., becomes zero at the highest point, gets longer downward as the projectile falls 2. Horizontal component: remains constant (no change). Vertical component: changes continuously. 3. Horizontal velocity ($\mathbf{v_x}$): Does not change Vertical velocity ($\mathbf{v_y}$): Its magnitude decreases upward, becomes zero at the top, increases downward 4. Acceleration Arrow (as the projectile moves)
--	---	--

	<p>Session 2A Teacher Demonstration</p> <p>Think: Wrap a strong string around the neck of a water bottle (just under the cap). Tie a strong knot and make sure the bottle cannot slip out. Hold the free end of the string tightly. This will act as the center of the circular motion. Swing the bottle until it slowly makes a circular motion. Increase the speed.</p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Assuming that the bottle is undergoing uniform circular motion, how will you describe its speed and velocity? 2. Is the bottle undergoing acceleration? Describe the nature of its acceleration and explain 3. Explain the difference between period and frequency in uniform circular motion and describe how they are related. <p>Pair: Learners discuss their answers with a partner.</p> <p>Share: The teacher calls volunteers to share their answers to the entire class.</p> <p>Session 2B HOTS Question</p> <p>Think Ask this question: While riding a bus you observe that another bus moves backward. When you looked around you realized that it was stationary and it was your bus which moved forward.</p> <p>Guide Question/Instruction to the Student</p> <ol style="list-style-type: none"> 1. Write an explanation of this phenomenon in a piece of paper. <p>Pair: Learners discuss their answers with a partner.</p> <p>Share: The teacher calls volunteers to share their answers to the entire class.</p>	<p>The acceleration arrow always points straight downward. Its length remains constant throughout the motion.</p> <p>5. What happens to the acceleration of a projectile?</p> <p>The acceleration remains constant in magnitude and direction. It is always equal to gravity ($\approx 9.8 \text{ m/s}^2$ downward).</p> <p>Answers to APK Option 2 Session 2A Guide Questions.</p> <p>1. Speed and Velocity in Uniform Circular Motion</p> <ol style="list-style-type: none"> a. The speed of the bottle is constant (it does not change). b. The velocity is not constant because its direction is continuously changing as the bottle moves in a circle. c. At any point, the velocity is tangent to the circular path. <p>2. The bottle is undergoing acceleration.</p> <p>Nature of acceleration:</p> <ol style="list-style-type: none"> a. The acceleration is called centripetal acceleration. b. It always points toward the center of the circle. c. Its magnitude remains constant (if speed and radius are constant). <p>Why it is considered accelerating:</p>
--	--	--

<p>2. Establishing the Purpose of the Lesson Use this script as transition statement “In Lesson 6 and 7, we focused on building a strong conceptual understanding of the uniformly accelerated motion and projectile motion—examining the key ideas, definitions, and underlying principles. Now we will take that knowledge a step further by applying it through computational methods, allowing us to see how these concepts work in actual problem-solving situations.”</p> <p>Option 1 Session 1. Play this video www.youtube.com/shorts/U_wyl1Jo2YI from YouTube. The video shows a fire suppression helicopter dumping fire retardant off target. It landed a few meters in front of the fire.</p> <p>Guide Questions</p> <ol style="list-style-type: none">1. Considering the helicopter’s horizontal velocity relative to the ground, explain why the released fire retardant was off target?2. Is it possible to determine the approximate moment when to release the retardant? Explain. <p>Learners may arrive at different yet valid explanations, drawing from concepts like projectile motion, Newton’s First Law or relative motion. The key takeaway is that real-world problems like this can be understood and solved using fundamental physics concepts, especially kinematics</p> <p>Option 1 Session 2 Play this video www.youtube.com/shorts/OZ7LYsIuqsc from YouTube. The video shows a pilot successfully landing in spite of a strong crosswind. Guide Questions:</p>	<p>a. Acceleration is the change in velocity, and velocity includes direction.</p> <p>b. Even though the speed is constant, the direction keeps changing, so the velocity changes.</p> <p>c. Because of this continuous change in direction, the bottle is accelerating.</p> <p>3. Difference between Period and Frequency</p> <table><tr><th>Concept</th><th>Definition</th></tr><tr><td>Period (T)</td><td>Time taken for one complete revolution</td></tr><tr><td>Frequency (f)</td><td>Number of revolutions per second</td></tr></table> <p>Relationship:</p> $f = \frac{1}{T}$ <p>a. Period is measured in seconds Frequency is measured in Hertz (Hz)</p> <p>Answers to APK Session 2B Guide Questions.</p> <p>a. When you are sitting in a bus that is moving forward, your brain often uses your own bus as the reference frame instead of the ground.</p> <p>b. Since <i>you</i> are moving forward, the distance between you and the other bus increases in the opposite direction.</p> <p>c. Your brain interprets this change as the other bus moving backward,</p>	Concept	Definition	Period (T)	Time taken for one complete revolution	Frequency (f)	Number of revolutions per second
Concept	Definition						
Period (T)	Time taken for one complete revolution						
Frequency (f)	Number of revolutions per second						

		<p>Option 2 Covers Session 1 and 2</p> <p>Kinematics allows us to describe, analyze and predict motion. This has wide applications in safety, transportation, sports and entertainment. This matches the emphasis of The Instructional Design Framework (IDF) of DepEd on learner-centered, meaningful, and contextualized learning. One of its core ideas is that learning becomes deeper and more lasting when lessons are connected to real-world examples and experiences familiar to learners.</p>
--	--	--

<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples Script: “You will further explore how our knowledge about kinematics can be useful in many situations”</p> <p>PhET Simulation: Let the students access this simulation: https://phet.colorado.edu/sims/html/projectile-motion/latest/projectile-motion_en.html</p> <p>Instruction to the learners:</p> <ol style="list-style-type: none"> 1. Access the simulation and set the initial speed at 16.0 m/s and direction at 50.0° above the horizontal. 2. Set the height to 0 m while making sure the air resistance is unchecked. 3. Drag the target mark to where you think the cannonball will land and hit the fire button. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Were you able predict where the cannonball landed? 2. Explain how you obtained the answer. <p>The teacher may then ask someone who solved and got the correct answer. If no learner obtained the correct answer, the teacher may solve it on the board to show how kinematics can be used in finding different quantities.</p> <p>Solution can be accessed through this link https://tinyurl.com/5m6e29y3.</p> <p>The teacher may include additional examples for the other types of motion by revisiting Lessons 6, 7, and 8 to cover the remaining topics. However, it is important to manage time effectively and avoid spending too much time on this section since examples have been presented extensively in the previous lessons. The priority of this lesson exemplar is to provide additional problem-solving exercises.</p>	<p>1. Presenting examples Option 1 Session 1</p> <ol style="list-style-type: none"> 1. In this part, the learners do not have to get the answers correctly. <ol style="list-style-type: none"> a. They may even say that they just guessed. b. The teacher only needs to emphasize that it is possible to get the correct answer the first time by using kinematics concepts. c. Exercise caution when introducing this section. Assess your students’ readiness, as the material may be too demanding for those still developing their computational skills in physics. If most students are having trouble with the calculations, it may be more effective to postpone or omit this section and focus instead on strengthening their foundational skills. <p>Real-world problems make lessons relevant to learners’ daily lives, communities, and future careers. This aligns with DepEd’s push for contextualized learning under the K–12 curriculum. IDF used by DepEd pushes for learner-centered and contextualized instruction.</p>
--	--	---

	<p>2. Discussing New Concept</p> <p>Group Activity</p> <ol style="list-style-type: none"> 1. Divide the class into groups of 5 members. 2. Distribute a copy of the Learning Activity Sheet (LAS) to each learner. While learners may collaborate in groups to complete the tasks, everyone is required to submit their own output. The LAS can be accessed through this link https://tinyurl.com/nhknbk9k. 3. There are five problem situations to be solved. Situations 1 to 3 may be completed during Session 1, while the remaining situations can be addressed in Session 2. The teacher may adjust this distribution based on available time and the learners' progress. 4. During the discussion, allow Group 1 to select a representative who will answer the first guide question for Situation 1. Then, a student from a different group will answer the next question. Continue this process, alternating groups, until all the guide questions have been answered. 5. For the solution, you may ask a volunteer from each group to discuss their answer then provide feedback. <p>Solutions to LAS problem situation can be accessed here https://tinyurl.com/33ws74ez</p> <p>3. Developing Mastery</p> <p>For Session 1 and 2</p> <p>Gallery Walk</p> <p>Instruction for the teacher:</p> <ol style="list-style-type: none"> 1. Divide the class into 4 groups. 	
--	---	--

	<ol style="list-style-type: none"> 2. Prepare 4 physics problems with intentionally erroneous solutions. 3. Write it in a manila paper and post in the classroom wall. Provide at least 3 meters distance between each manila paper. 4. Assign each group to start at a different station. 5. Give 5 minutes per station to read, discuss, and spot as many errors as they can and write it in a piece of paper. 6. Give a signal once it is time to move. 7. Groups rotate clockwise until they have visited each station. 8. Have representatives from each group to share the errors they have found, explain why it is an error and provide the correct answer. 9. Provide feedback and discuss how to correctly obtain what is asked. 	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application Have students solve the word problems individually first. Afterward, allow them to compare and discuss their answers with a seatmate. Circulate around the room to monitor their progress, provide immediate feedback, and address any questions. Encourage students who demonstrate excellent work to present their solutions to the class.</p> <p>Session 1:</p> <ol style="list-style-type: none"> 1. A new airport is planned to be built in your town. Your team has been tasked with identifying a flat parcel of land that can be used as a runway. The aircraft to be accommodated has a minimum constant acceleration of 3.00 m/s^2 during takeoff and must reach a takeoff speed of 65.0 m/s. Determine the minimum runway length to help you choose the piece of land long enough to serve this purpose. 2. Instruction to the teacher: 	<p>Making Generalization While students' answers may vary, consider the following as possible responses to facilitate discussion.</p> <p>Question 1</p> <ol style="list-style-type: none"> a. Objects follow predictable patterns of motion (straight-line motion, free fall, projectile motion). b. Position, velocity, and acceleration are related and can be connected through equations. c. Knowing an object's initial conditions (starting position, speed, and direction) allows us to predict its future motion. d. The same physical principles apply to many situations—from

	<p>a. Throw a small piece of outside the classroom making sure not to hit a learner.</p> <p>b. Have a student record the time of flight using a phone timer.</p> <p>c. Have another measure the range using a steel tape measure. Let the student find the initial velocity of the projectile.</p> <p>d. Let the learners compute for the initial velocity based on data obtained.</p> <p>Session 2</p> <p>3. The bus you are riding moves East at 2.00 m/s. You decide to transfer seat and walk towards the rear of the bus at 0.500 m/s. What is your velocity relative to the ground?</p> <p>4. A car travels at a constant speed of 9.00 m/s while moving along a circular curve with a radius of 15.0 m. Assuming uniform circular motion, determine the magnitude of the car's acceleration at this instant.</p> <p>Solutions to these real life and word problems can be accessed through this link https://tinyurl.com/33mpph2d.</p> <p>2. Making Generalization</p> <p>I. Ask these questions at the end of session 2:</p> <p>1. What have you realized after learning about the kinematics topics we have covered in this lesson?</p> <p>2. In what ways are uniformly accelerated motion, projectile motion, circular motion, and relative motion connected in real-life transportation systems, such as cars, airplanes, and trains?</p> <p>II. Let the students discuss their answer with a pair.</p> <p>III. Select learners who will volunteer to share their insights to the class.</p>	<p>falling objects to vehicles, sports, and engineering systems.</p> <p>e. In everyday terms, kinematics helps us understand and anticipate how things move, which is essential for science, engineering, transportation, and even daily activities like driving or throwing a ball.</p> <p>Question 2</p> <p>Uniformly Accelerated Motion This occurs when an object changes its velocity at a constant rate. Car speeding up from a stoplight or slowing down at a stop sign, or a train accelerating as it leaves a station</p> <p>Projectile Motion. This describes the motion of an object launched into the air under the influence of gravity. Objects released from moving vehicles (e.g., cargo drops from aircraft)</p> <p>Circular Motion. This involves movement along a curved or circular path. Cars going around curves or roundabouts Trains turning on curved tracks Airplanes banking while turning</p> <p>Relative Motion This describes how motion is observed differently depending on the observer's frame of reference.</p>
--	---	--

		In transportation: Passengers inside a moving train may feel at rest, while an outside observer sees them moving. Two cars moving side-by-side may appear stationary relative to each other.
V. ASSESSMENT <i>(Assessing Learnings)</i>	<p>Instruction to the learners: Solve the following word problems on a separate sheet of paper. Show your solution.</p> <p>1. Uniformly Accelerated Motion (Straight Line) A car starts from rest and accelerates uniformly at 2.00 m/s^2. What is its velocity after 6.00 seconds?</p> <p>2. Projectile Motion A ball is thrown at an angle of 45.0° with an initial speed of 20.0 m/s. Use $g = 9.80 \text{ m/s}^2$. Find the range of the projectile.</p> <p>3. Uniform Circular Motion A cyclist moves in a circular track of radius 10.0 m at a constant speed of 5.00 m/s. Find the centripetal acceleration of the cyclist.</p> <p>4. Relative Velocity A boat can move at 6.00 m/s in still water. The river flows at 2.00 m/s east. If the boat moves north, What is the magnitude of the boat's velocity relative to the shore? Access the answer key and rubric for grading through this link https://tinyurl.com/bd8rt4aj.</p>	
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p>For the Learners Ask the students to answer these reflection questions at the end of the lesson, you may give this to them in google form format so that they can answer it in their convenient time.</p>	

	<p>1. What part of the lesson helped you learn the most, and what difficulties did you experience during the unit?</p> <p>2. What could your teacher do differently to help you understand the lessons better?</p> <p>For the Teachers:</p> <p>1. What were the most effective teaching strategies you used, and what challenges did you face during the lesson?</p> <hr/> <hr/> <p>2. What adjustments did you make to improve student understanding, and how effective were these changes?</p> <hr/> <hr/>
VII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used MS Copilot to improve sentence construction and check the solution to word problems. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	10
----------------------	-----------	------------------------	----

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that Newton's Laws of Motion, work, energy, power, and the conservation of energy are essential for understanding the behavior of objects and systems;</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners conduct simple experiments on forces using standard and alternative measuring tools to measure length, mass, volume, and time quantitatively</i>
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<p>Young, Hugh D., and Roger A. Freedman. <i>University Physics</i>. Boston: Addison-Wesley, 2012.</p> <p>oPhysics. "Forces in One Dimension." Accessed May 21, 2026. https://ophysics.com/f1.html.</p> <p>The Science Lens. <i>Why you should be doing experiments</i>. YouTube video accessed May 20, 2026. https://www.youtube.com/watch?v=Vs7rbRhkhMk</p> <p>Justin Bimbrahw.<i>How to Analyze Video Kinematic Data in FizziQ</i>. YouTube video accessed May 20, 2026. https://www.youtube.com/watch?v=kUESCYRpENI</p>
III. CONTENT (Sequencing Content)	<i>Translational dynamics 1. Types of forces 2. Newton's Laws of Motion and their applications 3. Work and power 4. Energy 5. Momentum</i>
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	<ol style="list-style-type: none"> <i>1. Differentiate balanced and unbalanced forces.</i> <i>2. Explain that balanced forces result to no change in motion and unbalanced forces cause a change in motion.</i> <i>3. Discuss how calibration, repeated trials, and careful observation reduce measurement errors.</i> <i>4. Show correct handling and reading of instruments for length, mass, volume, and time.</i> <i>5. Conduct experiments on forces using standard and alternative measuring tools to measure length, mass, volume, and time.</i>

<p>IV. PROCEDURES</p> <p><i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i></p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p>(Each part shall have 2-3 varied activities)</p>	<p>ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>
<p>A. Activating Prior Knowledge</p>	<p>1. Activating Prior Knowledge Option 1: True or False: Read each statement carefully. Write T if the statement is TRUE and F if the statement is FALSE. A. Choose the best answer based on your understanding of proper scientific experimentation.</p> <ol style="list-style-type: none"> 1. It is acceptable to change multiple variables at the same time in an experiment. 2. Measurements do not need to be repeated if the first result looks correct. 3. Safety rules can be ignored if the experiment seems simple. 4. Using non-standard measuring tools always gives more accurate results than standard tools. 5. Recording data after the experiment is finished is better than recording it during the experiment. <p>B. Choose the best answer based on your understanding of forces.</p> <ol style="list-style-type: none"> 1. Only living things can push or pull therefore, forces can only be associated with them. 2. Constant motion requires continuous application of force. 3. There are no forces acting on a stationary object.

APK Option 1 Show these statements to the learners and give the instructions. They may use a $\frac{1}{4}$ piece of yellow paper. The activities provided include topics in conducting an experiment. The statements provided checks students' prior knowledge on how to make precise measurements as well as basic concepts on forces. It is designed to elicit students prior understanding and misconceptions. All answers are false. If learners recognize the pattern early, it is a good indicator of a strong foundational knowledge of the topic. If some answers are false, the teacher may use that as a springboard for discussion

- The statements are **short, clear, and familiar**, reducing cognitive overload.

	<p>4. Faster moving objects are acted upon by a proportionally large force.</p> <p>5. Moving objects are always acted upon by forces.</p> <p>Option 2</p> <p>A. Divide the class into groups of 5. Distribute identical metersticks to each group. A meterstick has markings down to the millimeter (mm), which is 0.001 meter.</p> <ol style="list-style-type: none"> 1. Give a pre-measured (about 0.5000m) stick to the first group. Give them 5 minutes to measure and record the length of the meterstick. 2. After 5 minutes, pass the stick to the next until all groups are to have their turn measuring the stick. 3. Move around the classroom and record each group's measurements of the length from each group. 4. Write their measurements on the board, you do not have to indicate which group made the measurements. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. Are there differences in the recorded measurements? Explain 2. Which measurements are close to each other? 3. Which measurement(s) are closest to the actual length (teacher's value)? 4. Can a measurement be precise but not accurate? Explain. 5. What could cause a measurement to be inaccurate? 6. Based on the markings of the meterstick, how many significant figures should be used when reporting its length? <p>B. Think-Pair-Share.</p> <p>A. Direct the attention of the class to any object resting on the table. Ask the following question;</p> <ol style="list-style-type: none"> 1. The object is not moving. Are forces acting on it? 2. Imagine a moving asteroid away from any effect from other planets. Are forces acting on it? Explain. <p>B. Ask a student to gently roll a ball across the classroom floor until it hits the wall.</p>	<ul style="list-style-type: none"> • Learners are challenged to analyze and judge, not just recall facts. • IDF emphasis that learners with varying confidence and academic levels can actively participate is followed. <p>APK Option 2 A</p> <ol style="list-style-type: none"> 1. Students may measure differently, estimate differently, or misread the scale. 2. Yes, these are precise measurements (they are consistent). 3. Yes, these are accurate measurements. 4. Yes. A group may have very similar measurements, but all of them could be far from the true value. 5. Human error, incorrect reading, parallax error, or starting from the wrong point. 6. The length should be reported at 4 significant figures. The meterstick gives you precision to 0.001 m. You estimate one extra digit (0.0001 m) So, your measurement includes four meaningful digits <p>APK Option 2 B</p> <ul style="list-style-type: none"> • The questions about a stationary object and a moving asteroid are conceptual and curiosity-driven, encouraging students to think rather than recall facts. • Allowing students to think first on their own reduces pressure on learners who need more processing time.
--	--	--

	<p>1. At what instant or instances was the ball being acted upon by a force or forces? 2. Explain why the ball moved? 3. Explain why it stopped?</p> <p>B. Ask a student to gently roll a ball across the classroom floor. It should move slow enough so that it stops before touching the wall</p> <p>C. 1. Explain why it stopped? Do this activity in a Think-Pair-Share format.</p> <ul style="list-style-type: none"> Let the students think of the answer then share it with a seatmate. Afterward, discuss each procedure.. Ask some volunteers to share their ideas to the entire class. <p>2. Establishing the Purpose of the Lesson Option 1</p> <p>A. Play the video on your TV screen about why we perform experiments www.youtube.com/watch?v=Vs7rbRhkhMk. Have each group come up with a unified answer and have a representative give their answers to the following questions.</p> <p>1. Why is it important to conduct an experiment? Discuss the answer to this question, the main idea is Science is based on evidence, not opinions. We perform experiments to test our ideas and support our conclusions with observations and measurements. Experiments are essential because they provide evidence and help ensure that conclusions are based on facts, not just assumptions.</p> <p>2. Why are accuracy and precision important in scientific experiments? The key idea; an experiment must be both accurate (correct) and precise (consistent) to produce dependable and meaningful results.</p>	<ul style="list-style-type: none"> Pair discussion helps students build confidence before sharing with the whole class. <p>A.1. Forces are acting on the object, but they are balanced. For example, gravity pulls it downward while the table exerts an equal upward force (normal force), so it stays at rest.</p> <p>2. Since there is nothing interacting with the asteroid there is no force acting on it. Bodies may move even without forces acting on it.</p> <p>B. 1. Forces were acting on the ball all the time. 2. The applied force of the student is greater than friction – Unbalanced force</p> <p>3. The wall pushes on the ball, another unbalanced force, resulting to another change in motion.</p> <p>C. 1. The wall pushes on the ball, another unbalanced force, resulting to another change in motion.</p> <p>Establishing the purpose of the lesson A</p> <p>A. HOTS questions are emphasized in the Instructional Design Framework (IDF) by embedding them throughout the different stages of lesson planning and delivery to promote deeper thinking and active learning.</p> <p>B. Forces are acting on the object, but they are balanced. For example, gravity pulls it downward while the table exerts an equal upward force (normal force), so it stays at rest.</p>
--	--	---

B. Let the students access oPhysics simulation through this link <https://ophysics.com/f1.html>. Have a stopwatch, pen and paper in hand ready.

Learners with internet access on their mobile devices may perform the following steps independently. The learners may work together with the same groupmates while performing the activity. Otherwise, the teacher may present the simulation to the whole class using a TV or projector with the assistance of some learners. Give a run-through of the procedure and have the group write their prediction on a piece of paper.

1. Set the tension force to 25.0 N. Set the coefficient of static friction to 0.500 and the coefficient of kinetic friction to 0.100, with the angle at 0.00°.
2. Set the timer at 5.00s press the start button while another learner from the group presses the start button in the simulation. This should be done simultaneously.
3. Have the other members take note of what's happening to the acceleration and velocity
4. Press Stop after 5s have elapsed. Have another learner from the group record the final velocity.
5. Set the force to 50.0 N. Keeping everything else the same. Repeat steps 2 to 4. Do the same thing with force set at 100 N
6. Use the table below to record your data.

Net Force (N)	Acceleration (m/s ²)	Velocity (m/s)

Guide questions:

1. How does increasing the net force (25 N → 50 N → 100 N) affect the acceleration?
2. How does increasing the net force affect the final velocity?

Establishing the purpose of the lesson B

1. As the net force increases, the acceleration also increases. When the force changes from 25 N to 50 N to 100 N, the object experiences a stronger pull. This causes it to speed up more quickly, which means greater acceleration. Acceleration is directly proportional to the net force (more force → more acceleration).

2. Increasing the net force results in a higher final velocity after 5 seconds. A larger force produces greater acceleration. Greater acceleration means the object gains speed faster over the same period. Therefore, the final velocity increases as force increases.

3. The experiment shows that force and acceleration are directly proportional. Acceleration affects how quickly velocity increases. Velocity increases more when acceleration is higher.

More force → more acceleration → higher velocity (over time)

	3. Based on your data, what relationship can you infer between force, acceleration, and velocity?	
D. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>Use this script: In the previous lesson you learned to describe motion, in this lesson we will be exploring what causes changes in motion – Forces. You have observed through simulation how force is connected to motion, we will now explore the concept of force using actual experiments”</p> <p>Divide the class into groups of 5. Distribute the procedure for the experiment they are going to perform.</p> <p>You can access the procedure through this link https://tinyurl.com/yvdr9wzu.</p> <p>The students present the table and the graph of the result of their experiment on a manila paper and post it in front.</p> <p>Guide questions:</p> <ol style="list-style-type: none"> 1. How can you increase the accuracy of your measurement of time? 2. Graph the result. Put the masses on the x-axis and the travel time of the toy car on y-axis. What does the graph tell you about the motion of the cart? 3. The different masses correspond to different magnitudes of unbalanced forces. What relationship is there between the speed of the toy car and the unbalanced force? 4. What does the graph of the travel time and mass tell you about the relationship of motion and mass of the load? 5. How did your results compare to each other when using standard measuring tools vs using alternative measuring tools? 	<p>Presenting Examples</p> <p>These are the possible answers to some of the most important questions to ask and discuss after the activity.</p> <ol style="list-style-type: none"> 1. Use a reliable timing device, such as a stopwatch or digital timer, instead of estimating time. 2. Repeat the measurement several times and take the average to reduce random errors. 3. Start and stop the timer at the same reference point (for example, when the object crosses a marked line) to be consistent. 4. Assign one person only to operate the timer to avoid differences in reaction time. <p>2. The graph indicates that the greater the mass that pulls the toy car, the lesser the time needed for the it to travel from the first line to the second.</p> <p>3. Greater unbalanced force pulling on the toy car results in greater speed.</p> <p>4. The graph indicate that more massive load would move slower when the same force act on it.</p>

	<p>2. Discussing New Concept</p> <p>Discuss the answer to the guide questions in the activities. During the discussion, allow Group 1 to select a representative who will answer the first guide question for Situation 1. Then, a student from a different group will answer the next question. Continue this process, alternating groups, until all the guide questions have been answered.</p> <p>Important points:</p> <ul style="list-style-type: none"> • Unbalanced forces cause a change in the state of motion of an object. In the experiment the toy car at rest moves when released. • Greater force often results to greater change in state of motion. • When an object is stationary it does not automatically mean that no force is acting on it. Balanced forces may be acting on it. • More massive bodies tend to resist change in its state of motion more compared to lighter bodies. • Forces can be investigated through simple experiments <p>Students learn that a force (push or pull) can be studied using everyday classroom experiments, not only through formulas.</p> <ul style="list-style-type: none"> • Force affects motion and physical quantities. Students understand that force can change an object's motion, position, or behavior, which can be observed and measured. • Measurement is essential in scientific investigation. Accurate measurement of length, mass, volume, and time is necessary to describe and compare the effects of forces quantitatively. • Standard measuring tools provide precise data. Tools such as rulers, balances, graduated cylinders, 	<p>5. The results using the alternative tool show a wide variation of data compared to the standard tools.</p> <ul style="list-style-type: none"> • During the activity measurements are specified but the teacher may adjust depending on the resources available <p>With the IDF in mind the activity;</p> <ul style="list-style-type: none"> • aligns with DepEd's emphasis on learning from experience first, then concept formation. • matches DepEd's stress on observable evidence and scientific thinking. The activity reinforces scientific inquiry, a key feature of inclusive, meaningful curriculum design. • In the activity learners can express understanding through doing, measuring, speaking, and recording, removing barriers for students with writing or language difficulties.
--	---	--

	<p>and stopwatches give consistent and reliable measurements.</p> <ul style="list-style-type: none"> • Alternative measuring tools can be used when standard tools are unavailable Students recognize that non-standard tools (e.g., hand spans, cups, coins, counting seconds) are useful, though less precise, and can still support scientific inquiry. • Scientific skills are developed through hands-on activities Students practice observing, measuring, recording data, and drawing conclusions based on evidence. • Consistency and fairness matter in experiments Students learn to keep conditions the same (except for the variable being tested) to ensure valid results. <p>3. Developing Mastery</p> <p>Balanced or Unbalanced</p> <p>The following words or phrases are descriptions, effects and examples of balanced or unbalanced forces.</p> <p>Flash these phrases one by one on the screen or write them on the board. The students are to classify whether the word or phrase belong to unbalanced or balanced forces by writing balanced or unbalanced after number.</p> <ul style="list-style-type: none"> • Equal in size, Opposite in direction • Net force = 0 • Object stays at rest • OR moves at a constant speed in a straight line • A book resting on a table • Tug-of-war with equal pulls • Cart pulled equally from both sides • Not equal in size • Net force $\neq$ 0 	
--	--	--

	<ul style="list-style-type: none"> • Object starts to move • Object speeds up • Object slows down • Object changes direction • Kicking a ball • Cutting one string on a cart system • Pushing a box and it starts moving 	
E. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Option 1</p> <p>Place a free-wheeling toy car on the teacher's table. Ask one learner to gently push the car so that it moves smoothly from one side of the table to the other. While this is happening, have another student record the motion using a smartphone with the FizziQ app installed. Perform the same procedure again except let the same student push harder. After recording, let them use the app to perform a motion analysis of the car's movement on both videos. You may do this several times until at least one member from each group have their own video if time permits.</p> <p>Access the tutorial video on how to use the app through this link www.youtube.com/watch?v=kUESCYRpENI.</p> <p>Prior to the activity ask the following questions, let them write their answer on their notebook.</p> <ol style="list-style-type: none"> 1. What do you predict will happen when the toy car is pushed gently? 2. What do you think will change when the car is pushed harder? 3. What factors might affect how far or how fast the car travels? <p>Ask these after data from the motion analysis is obtained.</p> <ol style="list-style-type: none"> 4. When pushed harder, how quickly does the car speed up compared to the gentle push? 	<p>Answer to Finding Practical Application Option 1</p> <ol style="list-style-type: none"> 1. When the toy car is pushed gently, it will move slowly and travel a shorter distance. Its acceleration at the start will be small because only a small force is applied. 2. When the car is pushed harder, it will move faster, accelerate more quickly, and travel a longer distance. The greater force causes a greater change in motion. 3. Factors include: <ul style="list-style-type: none"> • The amount of force applied (how hard it is pushed) • Friction between the car and the table • The mass of the toy car • Air resistance (though small) 4. The car speeds up more quickly when pushed harder. The motion analysis shows a steeper increase in speed at the beginning, indicating greater acceleration compared to the gentle push.

	<p>5. Using the app compare the acceleration when the car was pushed gently and when it was pushed hard. What did you learn about the relationship between force and acceleration from this activity?</p> <p>Discuss the answer to the guide questions above in the activity.</p> <p>During the discussion, allow Group 1 to select a representative who will answer the first guide question for Situation 1. Then, a student from a different group will answer the next question. Continue this process, alternating groups, until all the guide questions have been answered.</p> <p>Option 2. You may perform option 2 along with option 1 if there is still enough time.</p> <p>Have each group set up the toy car in such a way that 2 strings of equal length are tied to both ends of the toy car. Attach 100 g mass on each end.</p> <p>Guide questions:</p> <ol style="list-style-type: none"> 1. Are there forces acting on the cart? 2. If there were, why is it that the cart is not moving? 3. If we remove both strings, will there be force or forces acting on the toy car? <p>Instruct the learners to cut one string to release the mass.</p> <p>Guide questions:</p> <ol style="list-style-type: none"> 4. Explain what happened to the toy car. <p>2. Making Generalization</p> <p>Exit Ticket</p> <p>Ask the students to write all that they have learned about balanced and unbalanced forces and how they are related to motion. You may use the 3-2-1 exit assessment</p> <p>Students respond to three prompts:</p> <ul style="list-style-type: none"> • 3 things they learned 	<p>5. The motion analysis shows that the acceleration is greater when the car is pushed harder. This demonstrates that force and acceleration are directly related—as the applied force increases, the acceleration also increases. This supports one of Newton’s laws of motion, which states that acceleration is proportional to force when mass is constant. This will be explored further in the next lessons.</p> <p>Answers to the questions for option 2.</p> <ol style="list-style-type: none"> 1. Yes, there are forces acting on the cart. The two hanging masses pull the cart in opposite directions through the strings. Normal force and weight are also acting on it. 2. The cart does not move because the forces are equal in magnitude and opposite in direction. These balanced forces cancel each other out, resulting in a net force of zero, so the cart remains at rest. 3. If the strings were removed simultaneously, the forces will still be balanced and there will be no acceleration. 4. The forces acting on it used to be balanced cutting one end disrupts the balance, so the toy car
--	--	---

	<ul style="list-style-type: none"> • 2 things they found interesting or want to know more about • 1 question they still have (or one thing they didn't understand) 	accelerates in the direction of the net force.
V. ASSESSMENT <i>(Assessing Learnings)</i>	<p>Directions: Provide each student with a questionnaire and let them shade the letter that correspond to the correct answer in a separate answer sheet.</p> <ol style="list-style-type: none"> 1. A book is resting on a table and does not move. What type of forces acts on the book? A. Unbalanced forces B. Balanced forces C. Magnetic forces D. No forces act on the book 2. Which situation shows balanced forces? A. A ball being kicked B. A cart moving faster after being pushed C. Tug-of-war with equal pulls on both sides D. A box sliding on the floor 3. What happens when forces acting on an object are unbalanced? A. The object stays at rest B. The object moves in a straight line at constant speed C. There is no net force D. The motion of the object changes 4. Two students push a box from opposite sides with equal force. What is the net force on the box? A. Greater than zero B. Less than zero C. Zero D. Unbalanced 5. When one string pulling a cart is cut, the cart moves. This happens because the forces become: A. Balanced B. Equal C. Zero D. Unbalanced 6. Which situation best describes accuracy? A. Repeating measurements and getting similar results each time B. Measuring a value very close to the true or accepted value C. Using the same tool for all measurements D. Recording results in a table 7. Which action improves both accuracy and reliability of an experiment? A. Performing the experiment only once B. Estimating measurements without tools C. Repeating trials and averaging results D. Changing variables randomly 8. Why is it important to report measurements using the correct number of significant figures? A. To make the measurement look more detailed and complicated B. To reflect the precision and reliability of the measuring instrument C. To ensure all numbers are written with many decimal places D. To make calculations easier regardless of accuracy 9. Why is it important to follow safety precautions when performing experiments? 	

	<p>A. To make the experiment more complicated</p> <p>B. To avoid wasting materials</p> <p>C. To prevent accidents and ensure the safety of everyone involved</p> <p>D. To finish the experiment more quickly</p> <p>10. Why is it important to perform experiments in science?</p> <p>A. To memorize scientific facts more easily</p> <p>B. To prove that all ideas are correct</p> <p>C. To test hypotheses and gather evidence to support or refute ideas</p> <p>D. To avoid using observations in science</p>
<p>VI. REFLECTION <i>(Feedback and Continuous Improvement)</i></p>	<p>For the Learners</p> <p>Ask the students to answer these reflection questions at the end of the lesson, you may give this to them in Google Form format so that they can answer it in their convenient time. You may also just let them write their answers in their notebooks.</p> <p>1. What part of the lesson helped you learn the most, and what difficulties did you experience during the unit?</p> <p>2. What could your teacher do differently to help you understand the lessons better?</p> <p>For the Teachers:</p> <p>1. What were the most effective teaching strategies you used, and what challenges did you face during the lesson?</p> <hr/> <hr/> <p>2. What adjustments did you make to improve student understanding, and how effective were these changes?</p> <hr/> <hr/>
<p>VII. USE OF GENERATIVE AI</p>	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot in order to improve sentence construction and grammar. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

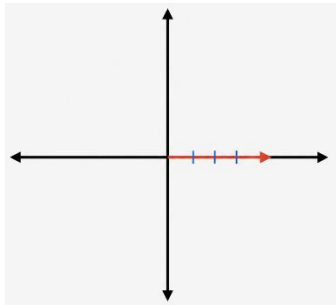
Learning Area	PHYSICS 1	Lesson Exemplar	11
----------------------	-----------	------------------------	----

I. OBJECTIVES	
A. Content Standard	The learners learned that the resultant vector represents the single, combined effect of two or more acting together.
B. Performance Standard	The learners demonstrate their ability to solve resultant vectors in one dimension and two dimensions.
C. Learning Competencies	The learners determine the resultant of one- to two-dimensional vectors using analytical methods.
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<ul style="list-style-type: none"> • BYJU'S. 2019. "Vector Addition—Analytical Method." February 18, 2019. https://byjus.com/physics/vector-addition/. • CK-12 Foundation. n.d. "Vector Addition: Analytical Method." CK-12 CBSE Physics Class 11. https://flexbooks.ck12.org/cbook/ck-12-cbse-physics-class11/section/3.5/primary/lesson/vector-addition-analytical-method/. • OpenStax. 2020. "5.2 Vector Addition and Subtraction: Analytical Methods." Physics. March 25, 2020. https://openstax.org/books/physics/pages/5-2-vector-addition-and-subtraction-analytical-methods. • The Physics Classroom. n.d. "Vector Addition." Vectors: Fundamentals and Operations. https://www.physicsclassroom.com/class/vectors/Lesson-1/Vector-Addition. • Miss Martins Maths and Science. 2024. "Grade 11 Vector in Two Dimensions Physics LEVEL EASY." YouTube video, January 17, 2024. https://www.youtube.com/watch?v=LT_0pICM7Ns. • Miss Martins Maths and Science. 2024. "Grade 11 Vectors in 2D Finding the Resultant Using the Component Method." YouTube video, January 27, 2024. https://www.youtube.com/watch?v=oUUVHs-JHTM.
III. CONTENT (Sequencing Content)	Resultant Vectors in One and Two Dimensions
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	<ol style="list-style-type: none"> 1. Define a resultant vector as the sum of two or more vectors that are added together. 2. Solve for resultant vectors in one dimension using algebraic addition. 3. Determine the final magnitude and direction of the resultant vector in two dimensions by applying the Pythagorean theorem and the inverse tangent function.

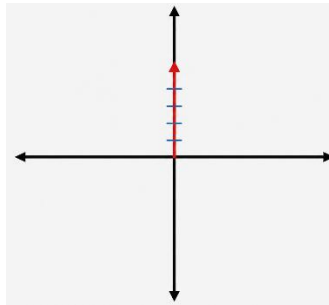
V. PROCEDURES		ANNOTATIONS																		
A. Activating Prior Knowledge	<p>1. Activating Prior Knowledge</p> <p>Option 1: Scalar vs. Vector Classification</p> <p>Present the idea to the class that a scalar is defined simply as "how much", whereas a vector is defined as "how much plus which way". Then, ask the students to classify given quantities in various scenarios as either scalar or vector quantities.</p> <table border="1"> <thead> <tr> <th>Scenario</th><th>S / V</th><th>Justification</th></tr> </thead> <tbody> <tr> <td>1. The car travels at 80 km/h.</td><td></td><td></td></tr> <tr> <td>2. The wind blows at 30 km/h South.</td><td></td><td></td></tr> <tr> <td>3. The box has a mass of 15 kg.</td><td></td><td></td></tr> <tr> <td>4. The room temperature is 25°C.</td><td></td><td></td></tr> <tr> <td>5. A 50 N force acts downward.</td><td></td><td></td></tr> </tbody> </table> <p>Guide Questions</p> <ol style="list-style-type: none"> Why is direction essential? What is the common trait of all vectors? How does a scalar represent the measurement of quantities without direction? How does a vector represent the measurement of quantities with direction? Which physical quantities can be represented as vectors, and which cannot? <p>Option 2: Representing Vectors with Diagrams</p> <p>Carefully examine the given diagram and determine the magnitude and direction of each vector. Use the given scale to measure the magnitude based on the length of the arrow and identify the direction according to the arrow's orientation.</p>	Scenario	S / V	Justification	1. The car travels at 80 km/h.			2. The wind blows at 30 km/h South.			3. The box has a mass of 15 kg.			4. The room temperature is 25°C.			5. A 50 N force acts downward.			<p>Annotation:</p> <p>Start the lesson by recalling the difference between scalar and vector quantities. Connect this to the previous lesson on measurement of physical quantities by emphasizing that scalars are measurements without direction (e.g., mass, temperature), while vectors are measurements with direction (e.g., velocity, force). Instruct students to apply the logic below in classifying the scenarios:</p> <ul style="list-style-type: none"> If they can draw an arrow to represent the quantity effectively, it is a vector. If an arrow is impossible because direction is missing, it is a scalar. <p>After classifying, let them justify their answers and reflect on why some quantities can be represented as vectors while others cannot.</p> <p>Relevance to IDF:</p> <p>This activity follows the IDF by aligning the lesson goal, class discussion, and classification task so students learn the scalar–vector concept in a clear, purposeful way. It is also learner-centered and relevant because it uses familiar real-life examples and checks understanding through guided questions.</p> <p>Annotation:</p> <p>Activate students' knowledge about vector by letting them determine the magnitude and direction of each vector using the given scale and diagram.</p> <p>Clarify that vectors can be represented in three complementary ways:</p> <ul style="list-style-type: none"> Graphically (arrows with scale and orientation) Numerically (values with units, e.g., 20 N east) Textually (written descriptions, e.g., "a force of 20 N acting eastward") <p>For vectors acting at an angle, discuss quickly how to read directions using cardinal convention.</p>
Scenario	S / V	Justification																		
1. The car travels at 80 km/h.																				
2. The wind blows at 30 km/h South.																				
3. The box has a mass of 15 kg.																				
4. The room temperature is 25°C.																				
5. A 50 N force acts downward.																				

Record both the magnitude and direction for every vector shown.

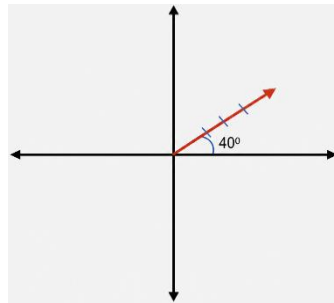
a. Scale: 1 cm = 5 N



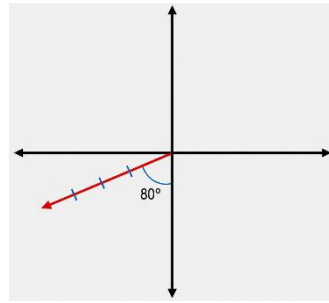
b. Scale: 1 cm = 10 N



c. Scale: 1 cm = 15 N



d. Scale: 1 cm = 25 N



2. Establishing the Purpose of the Lesson

Activity: Walking to the Resultant (Group Activity)

The task is to carefully follow the directions stated on the activity sheet, observe, and answer the guide questions after each part of the activity.

Part 1: Walking in the Same Direction



Relevance to IDF:

This activity is learner-centered because students actively interpret diagrams using a scale rather than just definitions. It is reflective because they explain how magnitude and direction are shown, and responsive because it connects graphical representation to numerical and textual forms, ensuring continuity from the previous lesson on measurement of physical quantities.

Annotation:

Emphasize that vectors are used to describe motion of objects because they represent both magnitude and direction. This ensures a seamless transition from the previous activity on scalar vs. vector classification.

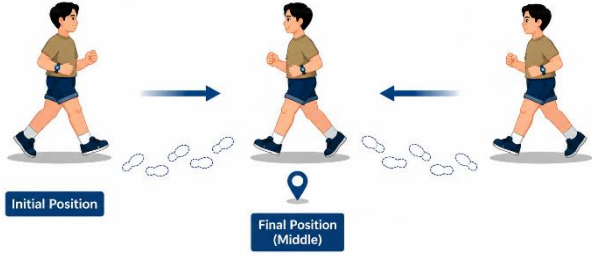
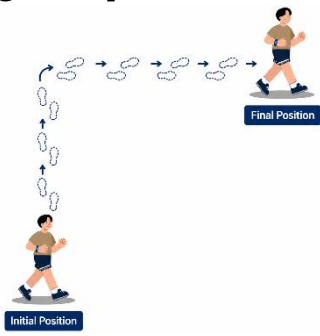
Guide students to notice that:

- The initial position and final position are connected by the resultant vector, which represents the single straight-line displacement.
- When vectors are in the same direction, the resultant equals the sum of their magnitudes.
- When vectors are in opposite directions, the resultant is the difference, pointing toward the larger vector.
- When vectors are perpendicular, the resultant is a diagonal that combines both magnitude and direction.

Note: Do not use calculations to present the ideas mentioned above. Use arrows to show that resultant vectors: (a) have bigger value than the individual vectors when acting in the same direction and perpendicular; and (b) smaller than or equal to the individual vectors when acting in opposite directions.

Relevance to IDF:

This activity is learner-centered and reflective, as students observe their own movement and connect it to the concept of resultant vectors. It also ensures continuity by tying back to the earlier lesson on measurement of physical quantities, showing how scalars and vectors differ in describing motion.

	<p>Part 2: Walking in Opposite Directions</p>  <p>Part 3: Walking in Perpendicular Directions</p>  <p>Guide Questions</p> <ol style="list-style-type: none"> 1. In your own words, what is a resultant vector? 2. How are the initial and final positions related to the resultant vector? 3. In which case does the resultant equal the sum of the two values? 4. Why is it important to describe motion using both magnitude and direction? 	
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>Sample Scenario</p> <p>When doing a general cleaning in the house, family members often move furniture and appliances to new positions. Sometimes, it takes two people to move a heavy object, such as a cabinet or a refrigerator. The push they exert on the object represents the applied force, and the combined force used to move the object to a new position represents the resultant force, also known as the resultant vector.</p>	<p>Annotation:</p> <p>To strengthen the instructional sequence, learners should first engage in a graphical representation activity before transitioning to analytical computation. By drawing arrows to scale and applying the head-to-tail method, students visualize how forces combine into a single resultant vector.</p> <p>It should be emphasized that vectors are used to describe motion of objects because they incorporate both magnitude and direction. The resultant vector represents the direct connection between the initial and final positions, thereby</p>

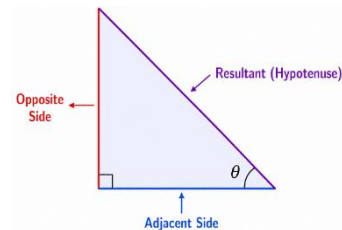
	<p>Activity (Graphical Representation)</p> <ul style="list-style-type: none"> Suppose the mother pushes the cabinet with a force of 40.0 N east, while the daughter pushes with a force of 30.0 N east. Learners will use the given scale (e.g., 1 cm = 10.0 N) to draw arrows representing each force. They will apply the head-to-tail method to construct the resultant vector, showing how the combined forces act as a single equivalent force. Learners will then determine the magnitude and direction of the resultant vector from their diagram. <p>2. Discussing New Concept</p> <p>Resultant Vectors in One and Two Dimensions</p> <ul style="list-style-type: none"> Vectors in one dimension lie along a straight line (e.g., east–west or north–south). Example of vectors in one dimension: <i>A football player is pushed forward by two teammates. One pushes with a force of 60.0 N forward, and the other pushes with 90.0 N forward.</i> <p>Note: The problem above shows vectors in one dimension since both forces are acting in the same direction, forming a straight line.</p> <ul style="list-style-type: none"> Example of vectors in two dimensions: <i>Paul walks 120.0 m east through the mall, then 90.0 m north up the escalator to the food court.</i> <p>Note: This scenario is two-dimensional because Paul's displacements, 120 m east along the x-axis and 90.0 m north along the y-axis are perpendicular directions within a single plane.</p> <p>Vectors in One Dimension</p> <p>In solving for resultant vectors in one dimension, follow the steps below:</p> <ol style="list-style-type: none"> Identify the vectors acting on the object. Determine the positive direction. e.g. Right = positive, North = positive Write the resultant vector equation. $\mathbf{R} = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \dots$	<p>providing a meaningful description of displacement or combined force.</p> <p>Annotation:</p> <p>Before beginning the discussion on solving resultant vectors, the teacher should first differentiate vectors in one dimension from vectors in two dimensions. Clarify that:</p> <ul style="list-style-type: none"> One-dimensional vectors lie along a straight line (e.g., east–west or north–south). Two-dimensional vectors act perpendicularly or at angles within a plane. <p>To visualize vector addition, use the head-to-tail method:</p> <ul style="list-style-type: none"> The first vector is drawn. The second vector begins at the head of the first. The resultant vector is the line drawn from the starting point to the endpoint. If the vectors lie on the same line, the problem is one-dimensional; otherwise, it is two-dimensional. <p>This part of the lesson should be conducted as a board work activity with student participation rather than a pure lecture. Learners should:</p> <ul style="list-style-type: none"> Come to the board to draw arrows representing forces or displacements. Label magnitudes and directions using a given scale. Work in pairs or small groups to solve short problems, then present their diagrams and solutions. Compare graphical results with analytical calculations to validate understanding. <p>Relevance to IDF:</p> <p>This part of the lesson applies the Instructional Design Framework by making the discussion structured and interactive.</p> <ul style="list-style-type: none"> Learners first see the difference between one-dimensional vectors (collinear) and two-dimensional vectors (perpendicular or angled). The head-to-tail method is used to visualize vector addition, making the concept concrete.
--	---	--

	<p>4. Substitute values with correct signs. 5. Add the vectors algebraically. 6. Write the resultant with direction.</p> <p>Vectors in Two Dimensions - Perpendicular For vector problems in two dimensions - perpendicular, it is helpful to break the movement into two parts: <ul style="list-style-type: none"> ✓ the horizontal component or net vector in the x-direction ✓ the vertical component or net vector in the y-direction </p> <p>Follow the steps below to solve the resultant of perpendicular vectors:</p> <ol style="list-style-type: none"> 1. Identify the horizontal and vertical components. 2. Draw a Head-to-Tail diagram. 3. Calculate the magnitude using Pythagorean Theorem. $\mathbf{R} = \sqrt{F_x^2 + F_y^2}$ 4. Locate the angle, place theta θ in the corner of a triangle with no arrowheads. 5. Identify opposite and adjacent sides. $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$ 6. Use a tangent to work out the angle and identify the direction. 7. Write the final answer. <p>Vectors in Two Dimensions – Component Method The component method is used to find resultant vectors in 2D when dealing with vectors that are acting at an angle. Sample problem <i>Two men are pulling a heavy crate across a frictionless surface. One man pulls with a force of 50.0 N at an angle of 70.0° above the positive x-axis, while the second man pulls with a force of 40.0 N at an angle of 20.0° below the positive x-axis. Calculate the magnitude and direction of the resultant force acting on the crate.</i> </p>	<ul style="list-style-type: none"> • The teacher demonstrates sample problems step by step, while learners actively draw diagrams and perform calculations in their notes or on the board. • Negative results are clarified by flipping to positive magnitude with opposite direction, and same-direction vectors are grouped before subtracting opposites to avoid errors. • Students participate through board work and guided practice, ensuring they connect the initial position and final position with the resultant vector. <p>This approach follows IDF by starting with simple cases, gradually moving to more complex ones, and engaging learners in both visual representation and analytical computation. It ensures active involvement, clear sequencing, and meaningful application of concepts.</p>
--	--	--

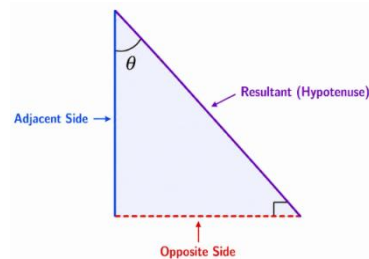
Note: The component method is required because the applied forces of the two men are neither collinear nor perpendicular but acting at an angle.

The steps involved in adding vectors using the component method are as follows:

1. Begin by sketching the vectors on a Cartesian plane to visualize their orientation.
2. Resolve the given vectors into their horizontal (x) and vertical (y) components using trigonometry.
3. Locate the reference angle and identify sides. Examine the diagram to see if θ is measured from the horizontal (x) axis or vertical (y) axis.
 - ✓ From horizontal axis:
Adjacent side = horizontal (x) component;
Opposite side = vertical (y) component.



- ✓ From vertical axis:
Adjacent side = vertical (y) component;
Opposite side = horizontal (x) component.



4. Apply Trigonometric Ratios

✓ Adjacent: $\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}} \rightarrow \text{component} = F \cos \theta$

✓ Opposite: $\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}} \rightarrow \text{component} = F \sin \theta$

5. Choose your positive directions.

e.g. Right = positive, North = positive

6. Calculate the net vector of horizontal and vertical components.

7. Calculate the net vector of vertical components.

8. Do a head-to-tail vector diagram with the net x and net y vectors and draw the resultant vector (hypotenuse).

9. Use Pythagorean Theorem to find the magnitude of the resultant vector.

10. Locate the angle, place theta θ in the corner of a triangle with no arrowheads.

Option 1: Exploring Resultant Vectors in 1D and 2D Through Problem Solving

Learners are expected to record their complete solutions in their notebooks. Each solution should begin with a diagram of the vectors, with arrows drawn to scale to represent both magnitude and direction. Following the diagram, the equations used to solve the problem must be written, accompanied by a step-by-step calculation of the resultant vector. The final answer should then be presented clearly, including the magnitude, unit, and direction.

Sample Problem 1

A couple, riding a motorcycle that has run out of gas, begin pushing it along an east-west road. One person pushes with a force of 200.0 N to the east, while the other pushes with 150.0 N to the east. What is the resultant force vector?

Given:	Direction	Equation:
$F_1 = 200.0 \text{ N east}$	East = positive	
$F_2 = 150.0 \text{ N east}$	West = negative	$R = F_1 + F_2$

Annotation:

Use this activity to assess learners' understanding of vectors in one and two dimensions through problem-solving exercises that progress from simple to complex word problems. Demonstrate first the steps using a sample problem and let students solve the problems in the activity.

In the activity, present situations involving displacement, force, or velocity, and require learners to identify known and unknown quantities, draw clear diagrams, resolve vectors into components, and apply appropriate operations and formulas to determine magnitude and direction.

Instruct learners to show complete, organized solutions with proper units and labels, then carefully check their work and provide specific feedback, tips, and reminders on how to structure their solutions and avoid common errors in vector problem solving.

Relevance to IDF:

This activity uses the instructional design framework in a simple, step-by-step way. First, the analysis stage identifies that students need help understanding how vectors combine, so the problems start with everyday examples.

The design stage arranges the tasks from easy to hard, beginning with one-dimensional addition, then perpendicular vectors, and finally angled forces with components.

In development, clear sample problems, diagrams, and equations are prepared to guide learners.

During implementation, the teacher leads the first problems, then lets students work individually, encouraging them to draw diagrams and calculate.

Finally, in evaluation, student answers and explanations are checked to see if they can solve and interpret resultant vectors correctly.

Solution:
 $R = F_1 + F_2$
 $R = 200.0 \text{ N} + 150.0 \text{ N}$
 $R = 350.0 \text{ N East}$

Note: The combined effect of the two smaller pushes is equal to 350 N in the eastward direction. Even if the motorcycle is being pushed by two people, it behaves as if a single agent is pushing it.

Sample Problem 2

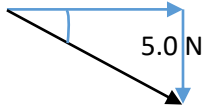
A boat moves 10.0 m/s east, but the current flows at 4.0 m/s west. What is the resultant velocity?

Given: $\mathbf{v}_1 = 10.0 \text{ m/s east}$ $\mathbf{v}_2 = 4.0 \text{ m/s west}$	Direction East = positive West = negative	Equation: $R = \mathbf{v}_1 + \mathbf{v}_2$
Solution: $R = \mathbf{v}_1 + \mathbf{v}_2$ $R = 10.0 \text{ m/s} + (-4.0 \text{ m/s})$ $R = 6.0 \text{ m/s eastward}$		

Note: The boat moves in the eastward direction because its propulsion velocity of 10.0 m/s east exceeds the opposing current of 4.0 m/s west. The greater eastward component results in a net velocity of 6.0 m/s east.

Sample Problem 3

Anna pushes a box with 10.0 N to the right, and her friend pushes the same box with 5.0 N down. Calculate the net force acting on the box.

Components $F_x = 10.0 \text{ N}$ right $F_y = 5.0 \text{ N}$ down	Head-to-Tail Diagram 	Opposite side = $F_y = 5.0 \text{ N}$ Adjacent side = $F_x = 10.0 \text{ N}$
--	--	---

	<p>Solution - Magnitude</p> $R = \sqrt{Fx^2 + Fy^2}$ $R = \sqrt{10.0^2 + 5.0^2}$ $R = \sqrt{100.0 + 25.0}$ $R = \sqrt{125.0}$ $R = 11.2 \text{ N}$	<p>Solution – Direction</p> $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$ $\tan\theta = \frac{5.0}{10.0}$ $\theta = 26.6$	
	<p>Final Answer</p> <p>11.18 N, 26.6° South of East</p>		
	<p>Note: Instead of treating the two pushes separately, physics combines them into one equivalent push amounting to 11.2 N. Because the push to the right is stronger than the push downward, the combined force points mostly to the right but slightly downward, so it's 26.6° south of east.</p>		
	<p>Sample Problem 4</p> <p>Two people pull a crate with forces of 50.0 N at 70.0° above the positive x-axis and 40.0 N at 20.0° below the positive x-axis; find the magnitude and direction of the resultant force.</p>		
	<p>Given:</p> <p>$F_1 = 50.0 \text{ N}$, 70.0° above the positive x-axis</p> <p>$F_2 = 40.0 \text{ N}$, 20.0° below positive x-axis</p>	<p>Direction:</p> <p>East = positive</p> <p>North = positive</p>	
	<p>Resolve F_1:</p> <p>$F_1 = 50.0 \text{ N}$</p> <p>$F_{1x} = F_1 \cos\theta$</p> <p>$F_{1x} = 50.0 \cos 70.0^\circ$</p> <p>$F_{1x} = 17.1 \text{ N East}$</p> <p>$F_{1y} = F_1 \sin\theta$</p> <p>$F_{1y} = 50.0 \sin 70.0^\circ$</p> <p>$F_{1y} = 46.9 \text{ N North}$</p>	<p>Resolve F_2:</p> <p>$F_2 = 40.0 \text{ N}$</p> <p>$F_{2x} = F_2 \cos\theta$</p> <p>$F_{2x} = 40.0 \cos 20.0^\circ$</p> <p>$F_{2x} = 37.6 \text{ N East}$</p> <p>$F_{2y} = F_2 \sin\theta$</p> <p>$F_{2y} = 40.0 \sin 20.0^\circ$</p> <p>$F_{2y} = 13.7 \text{ N South}$</p>	
	<p>Resultant – Horizontal Components</p> <p>$R_x = F_{1x} + F_{2x}$</p> <p>$R_x = 17.1 \text{ N} + 37.6 \text{ N}$</p> <p>$R_x = 54.7 \text{ N East}$</p>	<p>Resultant – Vertical Components</p> <p>$R_y = F_{1y} + F_{2y}$</p> <p>$R_y = 46.9 \text{ N} + (-13.7 \text{ N})$</p> <p>$R_y = 33.2 \text{ N North}$</p>	

Annotation:

In this activity, the teacher and learners explore the PhET Interactive Simulation on Vector Addition together. Since some learners may not yet be familiar with using simulations, the teacher should walk them through the features step by step, guiding them on how to manipulate vectors, turn on the graph and values, and observe the changes. Learners are directed to record their observations in their notebooks while responding to guide questions.

If there is limited access to individual gadgets in the locality, the simulation can be projected in class while the teacher navigates it. Learners will be guided to observe what happens on the screen, and the teacher will pause at key points to ask questions, solicit predictions, and confirm understanding. This ensures that all learners benefit from the interactive experience even without personal devices.

Relevance to IDF:

This activity promotes hands-on learning through technology integration. Learners directly interact with the PhET simulation by dragging and adjusting vectors to observe how magnitudes and directions combine. This manipulation builds deeper understanding, making abstract vector concepts more concrete and meaningful.

Resultant Vector

$$R = \sqrt{R_x^2 + R_y^2}$$
$$R = \sqrt{54.7^2 + 33.2^2}$$
$$R = 64.0 \text{ N}$$

Direction

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\tan \theta = \frac{33.2}{54.7}$$

$$\theta = 31.4 \text{ North of East}$$

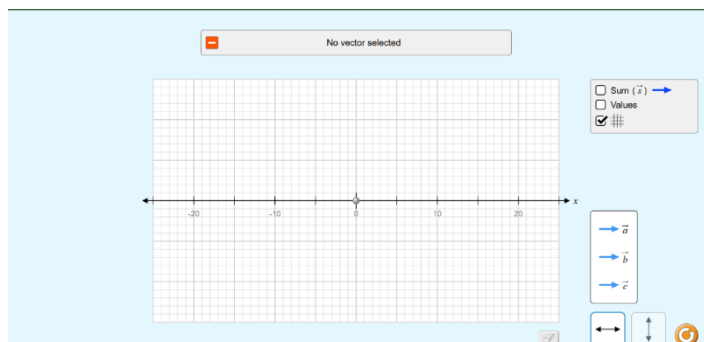
Final Answer:

The resultant force acting on the crate is 63.9 N at 31.3° North of East.

Note: The forces of the two men are combined into a single force equivalent to 64.0 N. Because the pull to the right is stronger than the downward part, the net force points mostly to the right but slightly upward, at an angle of about 31.4° above the positive x-axis or north of east.

Option 2: Interactives on Vector Addition

Go to https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_all.html and open the simulation on vector addition in one dimension



User interface of PhET Interactive Simulations on Vector Addition.

2. Developing Mastery

Problem Solving (Pair)

Learners will work in pairs and record complete solutions in their notebooks. Each solution should begin with a diagram of the vectors, drawn to scale with arrows showing magnitude and direction. They must then write the equations, show the step-by-step calculation, and present the final answer with

The simulation also enables learners to check their work, fostering independent learning.

Annotation:

To check learners' mastery of the lesson, provide relatable word problems that assess their problem-solving skills in calculating vectors in one or two dimensions.

For learners having difficulty, pair them with peers who demonstrate excellent performance in solving vectors.

Relevance to IDF:

This part creates meaningful and collaborative experiences that connect directly to learners' realities.

Guided inquiry is used when the stronger learner explains reasoning and models problem-solving strategies to the struggling learner

	<p>magnitude, unit, and direction. Negative results should be expressed as positive magnitudes with opposite direction, and same-direction vectors must be grouped before subtracting opposites. Selected pairs will present their work on the board following the same structure.</p> <ol style="list-style-type: none"> 1. Your classmate from Roxas City walks 600.0 m east from the town plaza toward the market, then realizes he forgot his wallet and walks 350.0 m back west toward the plaza. Taking east as positive and west as negative, find his total displacement from the town plaza. 2. A student from Sigma walks 400.0 m due north to reach the barangay health center, then walks 300.0 m due east to buy snacks at a nearby sari-sari store. Using the idea of perpendicular vectors, calculate the magnitude and direction of his total displacement from the starting point. 3. A student from Roxas City walks 80.0 m in a direction 30.0° north of east to reach the municipal library, then walks 60.0 m in a direction 50.0° south of east to go to a nearby internet café. Using the component method, find the resultant displacement of the student from the starting point at the town plaza. 	
C. Demonstrating Knowledge and Skills	<p>2. Finding Practical Application</p> <p>Option 1: Flood Route Planning</p> <p>Think of this: The place where your school is located is prone to flooding, and the designated evacuation area is the barangay.</p> <p>Learners will create a flood route map showing how a boat or rescue vehicle can move from the school to the barangay hall. They will draw the individual vectors first to represent the normal route through roads and pathways that are still passable when the area is not yet flooded. Then, they will show the resultant vector to represent the direct route that can be used once the area is flooded, since the boat can no longer follow the road layout and must move toward the safest and shortest reachable path.</p>	<p>Annotation:</p> <p>Begin by explaining the scenario to the students. Have students first track and map this route on a local map (physical or digital) before starting the main activity to build spatial awareness and context.</p> <p>For a more practical approach, let learners create a flood evacuation route from their own home to the nearest evacuation center, especially if their area is prone to flooding.</p> <p>For localities not experiencing flooding, learners may instead apply the same activity to other natural disasters. For example, in earthquake scenarios, they can map evacuation routes from classrooms to open grounds, showing individual vectors for hallways and exits, and a resultant vector for the direct path to safety. In volcanic</p>

	<p>Required Output:</p> <ol style="list-style-type: none">1. A hand-drawn map of a familiar flooded community or school area.2. At least three labeled individual vector arrows showing the route through roads or paths.3. One resultant vector arrow showing the direct route in flood conditions. <p>Scoring Rubric:</p> <table><tr><th>Criterion</th><th>4</th><th>3</th><th>2</th><th>1</th></tr><tr><td>Map Accuracy & Detail (5 pts)</td><td>Exceptionally detailed and precise depiction of familiar locale; meticulously rendered with scale.</td><td>Adequately detailed and largely accurate; includes scale.</td><td>Basic details with inaccuracies; moderately neat.</td><td>Vague and imprecise; poorly executed.</td></tr><tr><td>Individual Vectors (5 pts)</td><td>Minimum three precisely labeled vectors for standard route (. </td><td>Three vectors markedly accurate and labeled.</td><td>Three vectors with errors or incomplete labels.</td><td>Fewer than three; gravely erroneous or unlabeled.</td></tr><tr><td>Resultant Vector (5 pts)</td><td>Precisely synthesized (head-to-tail); clearly labeled optimal flood route.</td><td>Substantially accurate and labeled flood route.</td><td>Present yet imprecise or inadequately labeled.</td><td>Absent or entirely incorrect.</td></tr><tr><td>Creativity (5 pts)</td><td>Innovative secure route with supplemental elements</td><td>Competent route and application.</td><td>Elementary execution.</td><td>Minimal innovation</td></tr></table> <p>Option 2: Flood Evacuation Route Scenario: During a flood in your barangay, a family evacuates from their house to the barangay hall. To avoid deep water, they first walk 200.0 m east, then 150.0 m north, and finally 50.0</p>	Criterion	4	3	2	1	Map Accuracy & Detail (5 pts)	Exceptionally detailed and precise depiction of familiar locale; meticulously rendered with scale.	Adequately detailed and largely accurate; includes scale.	Basic details with inaccuracies; moderately neat.	Vague and imprecise; poorly executed.	Individual Vectors (5 pts)	Minimum three precisely labeled vectors for standard route (.	Three vectors markedly accurate and labeled.	Three vectors with errors or incomplete labels.	Fewer than three; gravely erroneous or unlabeled.	Resultant Vector (5 pts)	Precisely synthesized (head-to-tail); clearly labeled optimal flood route.	Substantially accurate and labeled flood route.	Present yet imprecise or inadequately labeled.	Absent or entirely incorrect.	Creativity (5 pts)	Innovative secure route with supplemental elements	Competent route and application.	Elementary execution.	Minimal innovation	<p>eruption contexts, learners can plot safe routes from communities to designated evacuation centers, again using individual vectors for possible paths and a resultant vector for the most efficient evacuation route.</p> <p>This activity helps learners connect vectors to real-life situations. By drawing evacuation routes and showing the resultant vector, students see how physics supports disaster response planning. It also links to navigation and transport, since displacement and direction are used in plotting safe paths for boats, vehicles, or rescue teams.</p> <p>Relevance to IDF: The principle of contextual learning is evident in the activity because the task connects vector concepts to a real-life situation of flood evacuation.</p> <p>Active engagement is also present since learners must draw maps, plot vectors, and determine the resultant vector which ensures hands-on learning</p> <p>The activity also promotes problem-based learning because it presents a realistic challenge requiring mathematical reasoning to solve.</p> <p>Annotation: In this activity, the students will read and analyze the scenario, then answer the guide questions centered on vectors. To ensure practicality and student engagement, revise the scenario to one that’s relatable. Use familiar settings from your area to make vector concepts more concrete and applicable.</p> <p>Relevance to IDF: IDF is applied by guiding students through a structured process. They will read a scenario, analyze it, and then answer questions that deepen their understanding of vectors.</p>
Criterion	4	3	2	1																							
Map Accuracy & Detail (5 pts)	Exceptionally detailed and precise depiction of familiar locale; meticulously rendered with scale.	Adequately detailed and largely accurate; includes scale.	Basic details with inaccuracies; moderately neat.	Vague and imprecise; poorly executed.																							
Individual Vectors (5 pts)	Minimum three precisely labeled vectors for standard route (.	Three vectors markedly accurate and labeled.	Three vectors with errors or incomplete labels.	Fewer than three; gravely erroneous or unlabeled.																							
Resultant Vector (5 pts)	Precisely synthesized (head-to-tail); clearly labeled optimal flood route.	Substantially accurate and labeled flood route.	Present yet imprecise or inadequately labeled.	Absent or entirely incorrect.																							
Creativity (5 pts)	Innovative secure route with supplemental elements	Competent route and application.	Elementary execution.	Minimal innovation																							

m west. Analyze their path using vectors to understand the straight-line distance and direction to safety.

Guide Questions:

1. What are the three displacement vectors in the family’s evacuation route?
2. Which movements are along one axis only, and like north-east combinations?
3. Calculate the resultant displacement:
4. Find the net east-west displacement.
5. Find the net north-south displacement.
6. Use the Pythagorean Theorem to determine the straight-line distance from start to end. What is the magnitude in meters?
7. Determine the final direction using trigonometry.
8. Apply to emergencies: Why is knowing the resultant displacement more useful than the total path distance during a flood? How might this guide safer evacuation planning?

2. Making Generalization
Concept Mapping Activity (Group Activity)

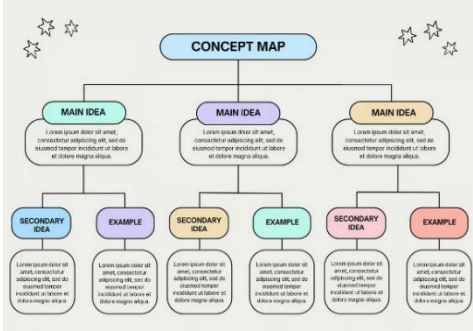
Students will organize and connect the ideas about vectors in one-dimension, perpendicular vectors, and the component method through a concept map. Students will do the following:

1. Write the main topic in the center of the paper.
2. Create three main branches for vectors in one dimension, vectors in two dimensions – perpendicular, and vectors in two dimensions – component method.
3. Add supporting details, formulas, steps, and examples under each branch.
4. Include at least one example problem under each category.
5. Present the work to the class in two minutes.

Contextual learning is also applied in this activity, as the scenario is crafted around something familiar to learners, making it more practical and engaging.

Annotation:

Discuss briefly to learners how to make a concept map. See sample below.



Link:<https://app.affine.pro/api/workspaces/qf73AF6vzWphbTJdN7KiX/blobs/LuaX9li0V5ifFm4HIG-29HB-MXinFs29eThpegX0Kq8=>

<p>V. ASSESSMENT (Assessing Learning)</p>	<p>I. MULTIPLE CHOICE. Write the letter of the BEST answer.</p> <ol style="list-style-type: none"> Which of the following is a vector quantity? <table border="0"> <tr> <td>a. Room temperature of 25.0°C</td> <td>c. A force of 50.0 N acting downward</td> </tr> <tr> <td>b. A box with a mass of 15.0 kg</td> <td>d. Speed of 80.0 km/h</td> </tr> </table> When two vectors of 10.0 N and 5.0 N are acting in the same direction, what is their resultant? <table border="0"> <tr> <td>a. 5.0 N</td> <td>c. 20.0 N</td> </tr> <tr> <td>b. 15.0 N</td> <td>d. 2.0 N</td> </tr> </table> Which method is most appropriate for adding two vectors that are perpendicular to each other? <table border="0"> <tr> <td>a. Algebraic Addition</td> <td>c. Component Method</td> </tr> <tr> <td>b. Pythagorean Theorem</td> <td>d. Simply subtracting the two</td> </tr> </table> In the component method, what do the final values of R_x and R_y represent? <table border="0"> <tr> <td>a. Magnitude of the individual vectors</td> <td>c. Total horizontal and vertical vectors</td> </tr> <tr> <td>b. Final angle of the resultant vector</td> <td>d. Hypotenuse of the resultant</td> </tr> </table> Why is it necessary to break down vectors into x and y components when adding vectors that are acting at an angle? <ol style="list-style-type: none"> Because components make the vectors collinear. Because it is impossible to draw vectors at an angle. Because it allows us to simplify complex angles into a single right-triangle pair that is easier to calculate. Because the resultant magnitude is always the sum of the components. <p>II. PROBLEM-SOLVING. Solve the problem below and provide what is being asked. Provide a complete solution.</p> <p>Problem 1: A rugby player is pushed forward by two teammates. One pushes with a force of 60.0 N forward, and the other pushes with 90.0 N forward. Calculate the resultant force.</p> <p>Problem 2: Two workers push a cart with forces of 75.0 N at 55.0° above the positive x-axis and 60.0 N at 35.0° below the positive x-axis. Find the magnitude and direction of the resultant force.</p> <p>Key to Assessment</p> <p>I. Multiple Choice</p> <ol style="list-style-type: none"> C B B C C 	a. Room temperature of 25.0°C	c. A force of 50.0 N acting downward	b. A box with a mass of 15.0 kg	d. Speed of 80.0 km/h	a. 5.0 N	c. 20.0 N	b. 15.0 N	d. 2.0 N	a. Algebraic Addition	c. Component Method	b. Pythagorean Theorem	d. Simply subtracting the two	a. Magnitude of the individual vectors	c. Total horizontal and vertical vectors	b. Final angle of the resultant vector	d. Hypotenuse of the resultant
a. Room temperature of 25.0°C	c. A force of 50.0 N acting downward																
b. A box with a mass of 15.0 kg	d. Speed of 80.0 km/h																
a. 5.0 N	c. 20.0 N																
b. 15.0 N	d. 2.0 N																
a. Algebraic Addition	c. Component Method																
b. Pythagorean Theorem	d. Simply subtracting the two																
a. Magnitude of the individual vectors	c. Total horizontal and vertical vectors																
b. Final angle of the resultant vector	d. Hypotenuse of the resultant																

II. Problem-Solving

Problem 1

Method: 1D Algebraic Addition.

Given: $F_1 = 60.0 \text{ N forward}$ $F_2 = 90.0 \text{ N forward}$	Direction Forward = positive Rightward = negative	Equation: $R = F_1 + F_2$
Solution: $R = F_1 + F_2$ $R = 60.0 \text{ N} + 90.0 \text{ N}$ $R = 150.0 \text{ N forward}$		

Problem 2

Method: 2D Component Method

Given: $F_1 = 75.0 \text{ N}, 55.0^\circ$ above the positive x-axis $F_2 = 60.0 \text{ N}, 35.0^\circ$ below positive x-axis	Direction: East = positive North = positive
Resolve F_1 : $F_1 = 75.0 \text{ N}$ $F_{1x} = F_1 \cos \theta$ $F_{1x} = 75.0 \cos 55.0^\circ$ $F_{1x} = 43.0 \text{ N East}$ $F_{1y} = F_1 \sin \theta$ $F_{1y} = 75.0 \sin 55.0^\circ$ $F_{1y} = 61.4 \text{ N North}$	Resolve F_2 : $F_2 = 60.0 \text{ N}$ $F_{2x} = F_2 \cos \theta$ $F_{2x} = 60.0 \cos 35.0^\circ$ $F_{2x} = 49.1 \text{ N East}$ $F_{2y} = F_2 \sin \theta$ $F_{2y} = 60.0 \sin 35.0^\circ$ $F_{2y} = 34.4 \text{ N South}$
Resultant – Horizontal Components $R_x = F_{1x} + F_{2x}$ $R_x = 43.0 \text{ N} + 49.1 \text{ N}$ $R_x = 92.1 \text{ N East}$	Resultant – Vertical Components $R_y = F_{1y} + F_{2y}$ $R_y = 61.4 \text{ N} + (-34.4 \text{ N})$ $R_y = 27.0 \text{ N North}$
Resultant Vector $R = \sqrt{R_x^2 + R_y^2}$ $R = \sqrt{92.2^2 + 27.0^2}$ $R = 96.1 \text{ N}$	Direction $\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$ $\tan \theta = \frac{27.0}{92.2}$ $\theta = 16.3 \text{ North of East}$

Final Answer:
The resultant force acting on the crate is 96.1 N at 16.3° North of East.

Scoring Rubric for Problem Solving

Criteria	Excellent (3 Points)	Satisfactory (2 Points)	Needs Improvement (1 Point)
Identification of Method	Correctly identifies and applies the appropriate method	Method identified but with minor inaccuracies or incomplete application.	Method not identified or incorrectly applied.
Given Information	All given values (forces, angles, directions) are correctly stated and organized.	Most given values are included but with minor omissions or errors.	Given information is incomplete, disorganized, or incorrect.
Equation Setup	Equations are correctly formulated ($R = F_1 + F_2$ for Problem 1; component equations for Problem 2) with clear notation.	Equations are present but contain minor errors or lack clarity.	Equations are missing, incorrect, or unclear.
Step-by-Step Solution	Complete and logical sequence of calculations:	Partial solution shown; some steps skipped or minor computational errors.	Solution is incomplete, disorganized, or contains major errors.
Final Answer	Final answer clearly stated with correct magnitude, unit (N), and direction	Final answer given but missing either unit, direction, or clarity.	Final answer missing, incorrect, or incomplete.
Presentation and Clarity	Work is neat, organized, and easy to follow; demonstrates strong understanding of the problem-solving process.	Work is somewhat organized but may be difficult to follow in certain parts.	Work is disorganized, unclear, or demonstrates limited understanding.

VI. REFLECTION

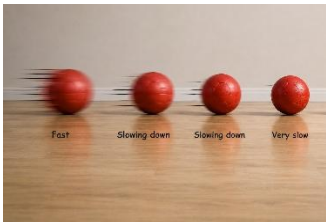
Reflection Questions for Teacher:

<i>(Feedback and Continuous Improvement)</i>	<ol style="list-style-type: none"> 1. Which activities (walking exercise, board work, PhET simulation, flood route planning) engaged students most effectively? 2. What common difficulties did learners encounter in solving vector problems, and how were these addressed? <p>Reflection Questions for Students:</p> <ol style="list-style-type: none"> 1. Which activity (walking, diagramming, problem solving, simulation, or mapping) helped you understand vectors best? Why? 2. What part of the lesson do you feel confident about, and what part do you need more practice with?
VII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot in enhancing the scoring rubrics, generating images, and correcting the grammar. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	12
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	The learners learned that the principles of force and motion can be understood by analyzing equilibrium and non-equilibrium conditions, representing forces through diagrams, and solving problems involving the relationships among force, mass, and acceleration.
B. Performance Standard	The learners demonstrate their ability to represent forces through accurate free-body diagrams and apply these representations to solve problems involving equilibrium and non-equilibrium conditions using the relationships among force, mass, and acceleration.
C. Learning Competencies	The students apply Newton's laws of motion in solving word problems involving equilibrium and non-equilibrium cases.
II. REFERENCES and MATERIALS (<i>Selecting Resources and Materials</i>)	<ul style="list-style-type: none"> • Cutnell, J. D., K. W. Johnson, D. Young, and S. Stadler. n.d. "4.12 Nonequilibrium Applications of Newton's Laws of Motion." WebAssign. Accessed May 7, 2026. https://www.webassign.net/ebooks/cj10demo/toc.html?page=4.12. • OpenStax. 2016. "6.1 Solving Problems with Newton's Laws." University Physics Volume 1. September 18, 2016. https://openstax.org/books/university-physics-volume-1/pages/6-1-solving-problems-with-newtons-laws. • Miss Martins Maths and Science. 2024. "Free Body Diagrams: Grade 11 and 12 Physics." YouTube video, February 6, 2024. https://www.youtube.com/watch?v=sudlgCWd9U. • Miss Martins Maths and Science. 2024. "Newton's First Law of Motion Grade 11 and 12 Physics." YouTube video, February 10, 2024. https://www.youtube.com/watch?v=laqTrb-r-j8. • Miss Martins Maths and Science. 2024. "Newton's Second Law of Motion Grade 11 and 12 Physics." YouTube video, February 12, 2024. https://youtu.be/ExvwFwQe1us.
III. CONTENT (<i>Sequencing Content</i>)	Application of Newton's Laws of Motion in Equilibrium and Non-equilibrium Cases
IV. OBJECTIVES (<i>Setting Clear Objectives and Analyzing the Tasks</i>)	<ol style="list-style-type: none"> 1. Distinguish between equilibrium and non-equilibrium conditions by analyzing the state of motion of an object. 2. Construct free-body diagrams to represent all individual forces acting on an object. 3. Calculate unknown forces, mass, or acceleration by applying the equilibrium condition to static or constant-velocity systems. 4. Calculate unknown quantities in non-equilibrium problems by applying the relationship between net force, mass, and acceleration.

IV. PROCEDURES	ANNOTATIONS
<p>A. Activating Prior Knowledge</p>	<p>1. Activating Prior Knowledge</p> <p>Option 1. Force Bank (Group Activity)</p> <ul style="list-style-type: none"> • Divide the class into small groups of 3–5 members. • Provide each group with a set of prepared small blank cards (meta cards). • Each group brainstorms and writes down as many forces as they can recall (gravity, friction, tension, normal, applied, air resistance, magnetic, electrostatic, etc.). • One force per card, written clearly with its name and symbol. • Instruct them to sort these into contact forces and non-contact forces using the organizer prepared on the board. • Require at least two real-world examples for each category. • Emphasize the connection: “Whenever we talk about forces, we’ll represent them as arrows, because arrows show both strength and direction, just like vectors.” <p>Option 2. Force Spotting Task</p> <ul style="list-style-type: none"> • Project or distribute the illustrations (box on floor, ball rolling, lamp hanging, child on swing, crate lifted by crane). • For each illustration, students must: <ul style="list-style-type: none"> ✓ Identify all forces acting on the main object. ✓ Label the direction of each force (upward, downward, forward, backward). ✓ Explain the effect of each force (e.g., friction opposes motion, tension supports weight). <p>Annotation: Begin the class by asking students to brainstorm and name as many types of forces as they can recall, such as gravity, friction, tension, normal, and applied forces. Guide them to group these into two categories:</p> <ul style="list-style-type: none"> • Contact forces, which require physical touch (e.g., friction, normal force). • Non-contact forces, which act at a distance (e.g., gravity). <p>Write their ideas on the board to create a class reference list, gently correcting misconceptions as needed. This builds collective knowledge and a shared understanding.</p> <p>Relevance to IDF: The activity applies IDF by activating prior knowledge through brainstorming, guiding learners to organize ideas, and encouraging collaborative discussion to build shared understanding. By requiring students to share real-world examples, the task contextualizes abstract concepts.</p> <p>Annotation: Project five illustrations on the screen one at a time. For each, instruct students to:</p> <ul style="list-style-type: none"> • Identify all forces acting on the main object. • Label the direction of each force. • Explain the effects of each force (e.g. friction opposes motion, slowing the object down). <p>To ensure students can accurately determine force directions, review key rules upfront (e.g. gravity always pulls downward toward Earth's center; tension pulls along the rope toward the anchor point; normal force is perpendicular to the surface).</p>

Illustration	Forces
<p>Box being pushed horizontally on a rough floor</p> 	<p>a. Applied force - forward b. Frictional force – backward c. Gravitational force – downward d. Normal force - upward</p>
<p>Ball rolling and slowing down</p> 	<p>a. Gravitational force - downward b. Normal force - upward c. Frictional force – opposite to motion</p>
<p>Lamp hanging motionless from a cord</p> 	<p>a. Gravitational force - downward b. Tension force – upward from the cord</p>
<p>A child sitting still on a swing</p> 	<p>a. Gravitational force - downward b. Tension force – upward from the two chains</p>

Relevance to IDF:

This activity emphasizes the analysis and application of students' previously learned knowledge about forces by having them examine forces depicted in each illustration.

Descriptions accompanying the illustrations accommodate diverse learning styles, while guided practice through the teacher's upfront review of key force concepts ensures students can effectively complete the task.

Annotation:

The students must master first the skill on identifying forces acting on an object before learning about equilibrium (balanced) and non-equilibrium (unbalanced) concepts.

Establish the concept of equilibrium through a scenario-based group activity where students analyze real-world examples to discover that balanced forces result in no acceleration, while unbalanced forces cause changes in motion.

To determine if forces on an object are balanced, have learners list all forces acting in four directions: east, west, north, and south.

Forces are balanced if:

- The magnitudes of forces in the east-west direction are equal.
- The magnitudes of forces in the north-south direction are equal.

Emphasize that when forces are balanced, the resultant force is zero, and the object is in equilibrium. This means there is no acceleration, and the object's state of motion does not change.

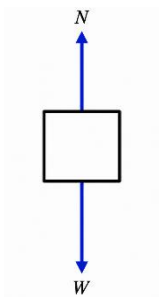
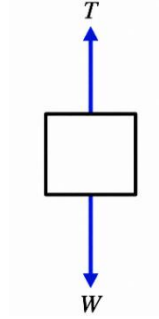
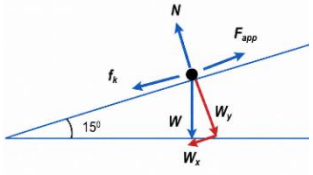
	<p>2. Establishing the Purpose of the Lesson</p> <p>Activity: Equilibrium Analysis (Group Activity)</p> <ul style="list-style-type: none"> • Divide the class into five groups. • Provide each group with an activity sheet containing the scenarios (book on desk, car on highway, ball down ramp, skateboarder on path). • Each group completes the analysis table with: <ul style="list-style-type: none"> ✓ State of motion (at rest, constant velocity, accelerating). ✓ Classification: Equilibrium or non-equilibrium. ✓ Reason for classification <p>Reiterate the Principle:</p> <ul style="list-style-type: none"> • Balanced forces = Equilibrium. The forces cancel, net force is zero, so the object stays at rest or moves at constant speed. • Unbalanced forces = Non-equilibrium. The forces don't cancel, net force is not zero, so the object's motion changes—it speeds up, slows down, or changes direction. <p>Scenarios</p> <ol style="list-style-type: none"> 1. Book on desk: A 2.0 kg physics textbook rests on a horizontal wooden desk. The desk surface is level and no external horizontal forces act on the book. The book remains at rest for 10 minutes while people walk nearby. 2. Car on highway: A family sedan travels at a constant speed of 90 km/h on a straight, level interstate. Engine thrust exactly balances rolling friction, air drag, and other resistive forces, so the car maintains this speed for 5.0 km. 3. Ball down ramp: A soccer ball is released from rest at the top of a concrete ramp. The ramp is 1.00 m long and inclined at 20.0° above horizontal. The ball rolls/slides (specify if needed) and reaches a speed of 3.00 m/s at the bottom after 2.0 s; gravity accelerates it while friction reduces its acceleration slightly. 	<p>Relevance to IDF:</p> <p>The activity guides learners to discover the principle of equilibrium through structured, scenario-based inquiry. The activity ensures purposeful alignment by connecting everyday situations to the physics concept of balanced and unbalanced forces, making abstract ideas concrete and meaningful.</p> <p>It promotes active engagement as students collaborate in groups, analyze scenarios, and complete the table, which scaffolds their reasoning from describing motion to identifying forces and determining equilibrium.</p> <p>The guide questions further anchor the concept by prompting learners to articulate the relationship between net force and motion, reinforcing that equilibrium occurs when the resultant force is zero, and the state of motion remains unchanged.</p>
--	--	--

	<p>4. Skateboarder on path: A 50 kg skateboarder travels at constant velocity 4.0 m/s along a flat paved path. A steady 5.0 N tailwind exactly balances 5.0 N of air resistance and rolling/frictional forces, so the skateboarder maintains speed and direction for 20 m.</p> <p>Analysis Table</p> <table><tr><th>Scenario</th><th>State of Motion</th><th>Equilibrium? Yes/No</th><th>Reason</th></tr><tr><td>1</td><td>At rest</td><td>Yes</td><td>Normal force counters gravitational force</td></tr><tr><td>2</td><td>Constant Velocity</td><td>Yes</td><td>Engine balances drag and friction</td></tr><tr><td>3</td><td>Accelerating</td><td>No</td><td>Gravitational force is greater</td></tr><tr><td>4</td><td>Constant Velocity</td><td>Yes</td><td>Wind from behind counters air resistance</td></tr></table> <p>Guide Questions:</p> <ol style="list-style-type: none">1. What defines the state of motion of an object?2. How do you determine if forces acting on an object are balanced or unbalanced?3. What is the relationship between net force and an object's motion?	Scenario	State of Motion	Equilibrium? Yes/No	Reason	1	At rest	Yes	Normal force counters gravitational force	2	Constant Velocity	Yes	Engine balances drag and friction	3	Accelerating	No	Gravitational force is greater	4	Constant Velocity	Yes	Wind from behind counters air resistance	
Scenario	State of Motion	Equilibrium? Yes/No	Reason																			
1	At rest	Yes	Normal force counters gravitational force																			
2	Constant Velocity	Yes	Engine balances drag and friction																			
3	Accelerating	No	Gravitational force is greater																			
4	Constant Velocity	Yes	Wind from behind counters air resistance																			
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>Learners will analyze the same set of scenarios and identify Newton's Laws of Motion.</p> <p>Task:</p> <ul style="list-style-type: none">• Read each scenario carefully (e.g., book at rest, car moving at constant speed, ball accelerating down a ramp).• For each scenario, decide which Newton’s Law of Motion applies:<ul style="list-style-type: none">✓ First Law → when the object remains at rest or moves at constant velocity.✓ Second Law → when the object accelerates due to a net force.	<p>Annotation:</p> <p>After learning how to identify objects or systems in equilibrium and non-equilibrium states, learners must be able to determine which Newton's law of motion applies to a given scenario.</p> <p>Instruct learners to analyze the provided scenarios and identify which of Newton's Laws of Motion applies. They should draw on their understanding of balanced forces (no change in motion) and unbalanced forces (change in motion) to complete this task successfully.</p> <p>Relevance to IDF:</p> <p>This part presents concrete, relatable scenarios that allow learners to connect abstract principles of Newton’s Laws to observable outcomes. By analyzing whether forces are</p>																				

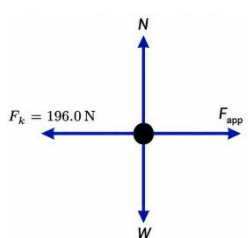
	<ul style="list-style-type: none"> For each scenario, state the law and give a short explanation in one sentence. <p>Guide Questions:</p> <ol style="list-style-type: none"> Is the object at rest, moving at constant speed, or accelerating? Which Newton's Law of Motion explains this situation? How does the motion of the object show the principle of the law you identified? <p>2. Discussing New Concept</p> <p>A. What is a Free-Body Diagram?</p> <ul style="list-style-type: none"> A Free-Body Diagram is a simplified representation of a single object (called the <i>system</i>) isolated from its surroundings, with all external forces acting on it shown as vectors. The size of the arrow in a free-body diagram is reflective of the magnitude of the force. The direction of the arrow reveals the direction in which the force acts. <p>Steps in Constructing a Free-Body Diagram</p> <ol style="list-style-type: none"> Decide which object or system you want to analyze. Represent the object as a simple shape (e.g. dot or a box) Identify all forces acting on the object. Draw each force as an arrow starting on the object and pointing in the direction of the force and label each force. If needed, establish a coordinate system (x – y axis) to resolve forces into components. If magnitudes of forces are known, write them beside the arrows with units. For unknown forces, use symbols and assume a direction; a negative result in calculations simply means the true direction is opposite. 	<p>balanced or unbalanced, students actively construct meaning rather than passively receiving definitions, which supports cognitive engagement and scaffolds their ability to generalize laws of motion across contexts.</p> <p>Annotation: Students must build on the activity used to activate prior knowledge as a foundation for constructing free-body diagrams. This helps them connect what they already know about forces to identifying, labeling, and drawing the forces acting on an object or system, which supports a clearer understanding of equilibrium and non-equilibrium.</p> <p>During the discussion of free-body diagrams, be clear and strict about arrow directions and labels for each identified force. Be consistent with the symbol of forces to avoid confusion among students.</p> <p>Relevance to IDF: This part explicitly teaches students how to construct and interpret free-body diagrams. Learners move from intuitive observations of forces to a structured symbolic representation that supports deeper analysis.</p> <p>The step-by-step process scaffolds their understanding, ensuring clarity and consistency in applying Newton's Laws, while the guided activity promotes active engagement and immediate practice. This alignment strengthens cognitive organization, bridges prior knowledge of balanced and unbalanced forces with formal visualization and prepares students for problem-solving tasks that demand precise reasoning.</p>
--	---	--

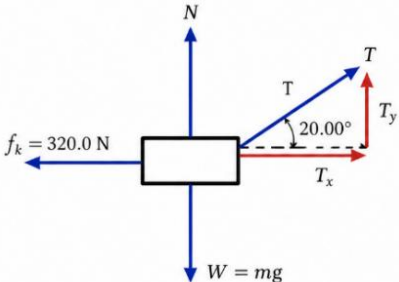
Activity: Free-Body Diagram Construction

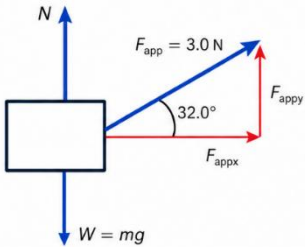
Instruct the class to analyze the given situations and draw a free-body diagram for each identified object/system.

Scenario	Forces	Free-Body Diagram
A backpack rests on top of a student's desk in the classroom.	Forces acting on the backpack: a) Normal Force (N) b) Gravitational Force (W)	
A crate of vegetables is suspended motionless in mid-air by a rope attached to a pulley system at the market.	Forces acting on the crate: a) Tension Force (T) b) Gravitational Force (W)	
A delivery person pushes a hand cart loaded with boxes up a sidewalk ramp leading to a store entrance. The ramp makes a 15° angle with the horizontal, and the cart moves at constant speed.	Forces acting on the box: a) Applied Force (F_{app}) b) Friction Force (f_k) c) Normal Force (N) d) Gravitational Force (W)	

	<p>Guide Questions:</p> <ol style="list-style-type: none"> 1. In your free-body diagram, which forces act upward, downward, and horizontally, and how did you decide on their directions? 2. Looking at your diagram, are the forces on the object balanced or unbalanced? Explain how you can tell. 3. Based on the balance or imbalance of forces, what should happen to the motion of the object (stay at rest, move at constant speed, or accelerate)? 4. How does your free-body diagram help you clearly connect the forces acting on the object to the motion described in the situation? <p>B. Equilibrium Applications of Newton's Laws of Motion</p> <ul style="list-style-type: none"> • An object is in equilibrium when it has zero acceleration. • Objects in equilibrium can either be static or dynamic. <ul style="list-style-type: none"> ✓ Static equilibrium occurs when an object is at rest with zero velocity. (e.g. a book on a table, where all acting forces cancel each other out) ✓ Dynamic equilibrium involves constant velocity motion with zero acceleration, so net force remains zero despite ongoing motion. (e.g. a plane flying at a steady velocity, meaning net force is still zero) • The equilibrium condition is expressed as: $\sum F = 0$ <p>Steps involved in solving equilibrium problems</p> <ol style="list-style-type: none"> 1. Draw a free-body diagram and draw all the forces acting on it. 2. Select x and y axis to simplify calculations (e.g., aligning them with the direction of applied force or an incline) 3. Choose your positive directions. (e.g. Right = positive, North = positive) 4. Break down forces acting at angle to horizontal (F_x) and vertical (F_y) components using trigonometry. <p>When the angle is measured from the horizontal (x-axis)</p> <ul style="list-style-type: none"> ✓ Horizontal (x) component = $F \cos \theta$ ✓ Vertical (y) component = $F \sin \theta$ 	<p>Annotation:</p> <p>To ensure a smooth discussion on solving equilibrium and non-equilibrium problems using Newton's laws of motion, learners must demonstrate mastery in constructing free-body diagrams to identify forces and resolve them into horizontal and vertical components.</p> <p>When teaching the equilibrium applications of Newton's laws of motion, remind students that these are situations where forces are balanced, so the object does not accelerate.</p> <p>For non-equilibrium problems, remind students that these are situations where forces are unbalanced, so the object accelerates.</p> <p>In discussing the steps, use a sample problem to demonstrate the step-by-step process. Encourage students to draw diagrams and do calculations on their notes during demonstration and guided practice.</p> <p>Relevance to IDF:</p> <p>IDF is applied in this part through strategies that make learning structured and effective. The lesson clarifies purpose by contrasting equilibrium and non-equilibrium, uses real-world examples to anchor abstract ideas, applies step-by-step scaffolding with diagrams and equations, ensures active engagement by having students work during demonstrations, and provides guided practice with feedback through sample problems.</p>
--	--	---

	<p>When the angle is measured from the vertical (y-axis)</p> <ul style="list-style-type: none"> ✓ Horizontal (x) component = $F\sin\theta$ ✓ Vertical (y) components = $F\cos\theta$ <p>5. Apply Newton's Laws (Equilibrium Equations). Write equations setting the sum of forces equal to zero:</p> $\sum F_x = 0$ $\sum F_y = 0$ <p>6. Solve for the unknown using the equation.</p> <p>C. Non-Equilibrium Applications of Newton's Laws of Motion</p> <ul style="list-style-type: none"> • An object is not in equilibrium when it has nonzero acceleration. • A non-equilibrium system has a net force not equal to zero. • The non-equilibrium condition is expressed as: $\sum F_x = ma_x$ $\sum F_y = ma_y$ • Note that acceleration in one direction (either horizontal or vertical component) may be zero. • The steps involved in solving non-equilibrium problems are the same as those for equilibrium problems; they differ only in the equation used. <p>Option 1: Exploring Newton's Law in Equilibrium and Non-Equilibrium Cases</p> <p>Sample Problem 1</p> <p>A body of mass 100.0 kg rests on a horizontal surface. If the frictional force is equal to 196.0 N, calculate the force required to slide the body at a constant velocity and normal force.</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 10px; width: 45%;"> <p>FBD:</p>  </div> <div style="border: 1px solid black; padding: 10px; width: 45%;"> <p>Directions: Up = Positive Right = Positive</p> </div> </div>	<p>Annotation:</p> <p>Use this activity to assess learners' understanding of application of Newton's law in equilibrium and non-equilibrium that progress from simple to complex word problems. Demonstrate first the steps using a sample problem and let students solve the problems in the activity.</p> <p>Instruct learners to show complete, organized solutions with proper units and labels, then carefully check their work and provide specific feedback, tips, and reminders on how to structure their solutions and avoid common errors in problem solving.</p> <p>For an advanced class, use more challenging word problems to challenge them and retain their focus on the class.</p> <p>Relevance to IDF:</p> <p>The IDF is relevant in this activity because it structures learning to move from simple equilibrium cases to more complex non-equilibrium scenarios, ensuring gradual skill development.</p> <p>By modeling the first solution, the teacher demonstrates expert reasoning before students practice independently, which reflects IDF's emphasis on guided learning.</p> <p>Learners actively engage by drawing free-body diagrams, organizing solutions, and applying Newton's laws, reinforcing both conceptual understanding and procedural fluency.</p> <p>The requirement for complete solutions with proper units, along with targeted feedback, aligns with IDF's focus on scaffolding and formative assessment, helping students avoid errors while building systematic problem-solving strategies.</p>
--	--	--

	<p>Horizontal Components (x-axis)</p> <p>Applied Force (F_{app}) = ?</p> <p>Friction Force (f_k) = 196.0 N</p>	<p>Vertical Components (y-axis)</p> <p>Normal Force (N) = ?</p> <p>Gravitational Force (W) = ma_g</p> <p>$W = (100.0\text{kg}) (9.8\text{m/s}^2)$</p> <p>$W = 980.0 \text{ N}$</p>
	<p>Solving for Applied Force</p> <p>$\sum F_x = 0$</p> <p>$F_{app} + f_k = 0$</p> <p>$F_{app} + (-196.0 \text{ N}) = 0$</p> <p>$F_{app} = 196.0 \text{ N, right}$</p>	<p>Solving for Normal Force</p> <p>$\sum F_y = 0$</p> <p>$N + W = 0$</p> <p>$N + (-980.0 \text{ N}) = 0$</p> <p>$N = 980.0 \text{ N, Up}$</p>
	<p>Note: Since the object slides at constant velocity, the equilibrium condition applies and the net force is zero. Horizontally, the applied force of 196.0 N to the right cancels the frictional force of 196.0 N to the left. Vertically, the normal force of 980.0 N upward balances the weight of 980.0 N downward.</p> <p>Sample Problem 2</p> <p>A car with a mass of 1500.0 kg is towed at a steady speed by a rope held 20.0° from the horizontal. A friction force of 320.0 N opposes the car's motion. What is the tension in the rope? What is the value of normal force?</p>	
	<p>FBD:</p> 	<p>Directions:</p> <p>Up = Positive</p> <p>Right = Positive</p>
	<p>Horizontal Components (x-axis)</p> <p>Friction Force (f_k) = 320.0 N</p> <p>Tension Force (T_x) = $T\cos\theta$</p>	<p>Vertical Components (y-axis)</p> <p>Normal Force (N) = ?</p> <p>Tension Force (T_y) = $T\sin\theta$</p> <p>Gravitational Force (W) = ma_g</p> <p>$W = (1500.0 \text{ kg}) (9.8\text{m/s}^2)$</p> <p>$W = 14\,700.0 \text{ N downward}$</p>

	<p>Solving for T_x</p> $\sum F_x = 0$ $T_x + f_k = 0$ $T \cos \theta + (-320.0 \text{ N}) = 0$ $T \cos \theta = 320.0 \text{ N}$ $T = 340.5 \text{ N right}$ <p>Note: The car is towed at steady speed, so the net force is zero. Horizontally, the tension's component of 320.0 N cancels the frictional force of 320.0 N, giving a rope tension of 340.5 N to the right. Vertically, the normal force of 14 583.5 N upward balances the weight of 14 700.0 N downward together with the upward tension component of 116.5 N. Thus, forces are equal and opposite, keeping the car in equilibrium.</p> <p>Sample Problem 3</p> <p>A 1.2 kg box is pulled with a force of 3.0 N at an angle of 32.0 degrees above the positive x-axis. What is the acceleration in horizontal and vertical component? What is the normal force on the box? No friction.</p>	<p>Solving for Normal Force</p> $\sum F_y = 0$ $N + T_y + W = 0$ $N + 340.5(\sin 20^\circ) + (-14\,700.0) = 0$ $N + 116.5 - 14\,700.0 = 0$ $N = 14\,583.5 \text{ N Up}$	<p>Annotation:</p> <p>In this activity, present and demonstrate the three scenarios to the class. Instruct students to observe carefully, focusing on the object's motion to determine if it is accelerating. Use these observations as the basis for concluding whether the object (or system) is in equilibrium.</p> <p>Relevance to IDF:</p> <p>This activity puts emphasis on observation, data analysis, and conclusion-making. Learners watch the book at rest, the car moving steadily, and the ball accelerating, then use these observations as evidence to predict forces and judge whether they are balanced or unbalanced.</p> <p>This process highlights active engagement and data-driven reasoning, where conclusions about equilibrium or non-equilibrium motion are derived from what learners see rather than simply being told. Guided questions and teacher feedback provide scaffolding, ensuring that students connect observed motion patterns to the concept of net force and strengthen their conceptual understanding of Newton's laws.</p>
	<p>FBD:</p> 	<p>Directions: Up = Positive Right = Positive</p>	
	<p>Horizontal Components (x-axis)</p> <p>Applied Force($F_{\text{app}x}$) = $F_{\text{app}} \cos 32^\circ$</p> $F_{\text{app}x} = 3.0 \text{ N} (\cos 32.0^\circ)$ $F_{\text{app}x} = 2.5 \text{ N right}$	<p>Vertical Components (y-axis)</p> <p>Normal Force (N) = ?</p> <p>Applied Force($F_{\text{app}y}$) = $F_{\text{app}} \sin 32.0^\circ$</p> $F_{\text{app}y} = F_{\text{app}} \sin 32.0^\circ$ $F_{\text{app}y} = 3 \text{ N} (\sin 32.0^\circ)$ $F_{\text{app}y} = 1.6 \text{ N upward}$ <p>Gravitational Force (W) = $m a_g$</p> $W = (1.2 \text{ kg}) (9.8 \text{ m/s}^2)$ $W = 11.8 \text{ N downward}$	

	<p>Solving for Acceleration- horizontal component</p> $\sum F_x = ma_x$ $F_{app,x} = ma_x$ $a_x = \frac{F_{app,x}}{m}$ $a_x = \frac{2.5 \text{ N}}{1.2 \text{ kg}}$ $a_x = 2.1 \text{ m/s}$	<p>Solving for Acceleration – vertical component</p> <p><i>The vertical acceleration of the box is zero because it remains in contact with the horizontal surface and does not move up or down.</i></p> <p>Solving for Normal Force</p> $\sum F_y = ma_y$ $N + F_{app,y} + W = ma_y$ $N + F_{app,y} + W = \cancel{ma_y}$ $N = -F_{app,y} - W$ $N = -1.6 \text{ N} - (-11.8 \text{ N})$ $N = 10.2 \text{ N upward}$	<p>Annotation:</p> <p>To check learners’ mastery of the lesson, provide relatable scenarios in the form of cases and let students analyze them to provide what is being asked in the activity.</p> <p>Use the data gathered from analyzing the scenario to perform calculations for the unknown quantities.</p> <p>Relevance to IDF:</p> <p>This activity requires learners to analyze evidence, apply reasoning, and confirm conclusions through calculations. By examining scenarios and classifying them as static equilibrium, dynamic equilibrium, or non-equilibrium, students engage in higher-order thinking rather than rote memorization.</p> <p>The guide questions direct learners to identify specific observational evidence, justify the inclusion of forces in diagrams, and connect mathematical results to conceptual classifications, which aligns with IDF’s emphasis on data-driven reasoning and conceptual understanding.</p>
--	---	--	--

Note: The box is pulled with a force of 3.0 N at an angle of 32.0°, giving components of 2.5 N right and 1.6 N up. The horizontal acceleration is 2.1 m/s², while the vertical acceleration is zero since the box stays on the surface. With a weight of 11.8 N down, the normal force is reduced by the upward pull of 1.6 N, resulting in 10.2 N up. Thus, the box accelerates at 2.1 m/s² horizontally, has no vertical acceleration, and experiences a normal force of 10.2 N upward.

Option 2: Anchoring Newton’s Laws of Motion

Learners will observe three simple demonstrations;

- Toy car moving at constant speed.
- Ball accelerating down a ramp.

It will be used to explore equilibrium and non-equilibrium motion. Learners will predict the forces acting in each case, decide if they are balanced or unbalanced based on the motion, and answer the guide questions.

Part A: Book at rest. Students observed that the book remained stationary because gravity was balanced by the desk’s normal force, illustrating static equilibrium.

Part B: Toy Car moving at constant velocity. Students rolled the toy car across a flat surface with markers at 50 cm intervals, recording times with a stopwatch. Equal time

intervals showed constant velocity, meaning forces were balanced and the car was in dynamic equilibrium.

Part C: Ball accelerating down a ramp. Students released the ball from the top of a 300 cm ramp and recorded times at marked sections. They observed increasing speed from top to bottom, showing that unbalanced forces caused acceleration, representing non-equilibrium.

Refer to the provided link for the copy of activity sheet:
<https://bit.ly/4nHjOYD>

3. Developing Mastery

Activity: Physics CSI: Motion Investigation

Learners will analyze scenarios to classify systems as static equilibrium, dynamic equilibrium, or non-equilibrium, construct free-body diagrams, and solve for unknown quantities. Use evidence from the scenario and your calculations to justify your classification.

Materials to be Used

- Activity sheets with case scenarios
- Graphing paper or plain bond paper for diagrams
- Rulers and pencils for accurate arrow representation
- Calculators for solving numerical problems

Scenarios:

Scenario 1: Construction Engineering

At a construction site, a 600.0 kg steel beam is suspended by two vertical cables. The beam hangs steadily in place, supported by the cables, while workers prepare to secure it. Calculate the tension in each cable if they share the load equally.

	<p>Scenario 2: Aviation</p> <p>A cargo plane with a mass of 20,000.0 kg flies at a constant velocity of 250.0 m/s at cruising altitude. The engines provide thrust forward, while air resistance pushes backward, and the lift force generated by the wings interacts with the plane's weight. Calculate the magnitudes of lift and weight.</p> <p>Scenario 3: Sports Science</p> <p>A cyclist with a mass of 70.0 kg pushes forward on the pedals, exerting a force of 280.0 N. Friction and air resistance together exert 70.0 N in the opposite direction. The cyclist begins to change speed as these forces interact. Calculate the net force and resulting acceleration</p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What evidence from the scenario allowed you to classify the system? 2. Why is it necessary to represent vertical forces even in horizontal motion? 3. How do your calculations confirm your classification? 	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Option 1: Forces in the Workplace</p> <p>Learners will observe everyday work situations and explain how Newton's laws of motion apply, focusing on equilibrium and non-equilibrium without solving numerical problems.</p> <p>Learners will:</p> <ul style="list-style-type: none"> • Watch short video clips, images, or recall real-life examples such as: <ul style="list-style-type: none"> ✓ A nurse pushing a wheelchair ✓ A construction worker lifting materials with a pulley ✓ A delivery worker moving a cart ✓ An athlete sprinting 	<p>Annotation:</p> <p>Begin by introducing the activity with a relatable hook: ask your high school students to recall how their heavy school bags feel when they stand still versus when they start walking, noting how the bag sways or swings.</p> <p>Prompt guiding questions like "Why does it swing?" or "What forces change?" to spark lively class discussion and activate prior knowledge.</p> <p>Relevance to IDF:</p> <p>The application of IDF is evident in how the task transforms a familiar, everyday experience into a structured learning opportunity that builds conceptual understanding of forces and equilibrium.</p>

- List the forces acting on the main object or person and indicate the direction of each force.
- Decide if the situation shows equilibrium non-equilibrium and write one sentence to explain the reasoning.
- Write a short paragraph (5–6 sentences) explaining how knowledge of forces helps professionals perform their jobs safely and effectively.

Rubric

Part	3	2	1
Observation of Forces	All major forces are correctly identified and directions are clearly stated.	Most forces are identified but one or two are missing or directions are incomplete.	Only one force is identified or descriptions are vague/incorrect.
Classification of Motion	All scenarios are correctly classified as equilibrium or non-equilibrium with clear explanations.	Most scenarios are correctly classified but explanations show minor inaccuracies.	Scenarios are misclassified or explanations are unclear/incorrect.
Reflection	Reflection is thoughtful, at least five sentences, and clearly connects Newton's laws to workplace safety, efficiency, or performance.	Reflection is 3–4 sentences, shows some career connection but lacks detail or depth.	Reflection is 1–2 sentences, vague, or shows little connection to careers.

Option 2: Carrying a Heavy Bag

Think of this: Learners often carry a heavy school bag. When standing still, the upward force from their arms balances the downward weight of the bag. When they start walking, the forces become unbalanced, and the bag swings. Learners will sketch themselves holding a bag and identify the forces acting on it.

By starting with a relatable hook, the activity situates learning in the students' own context, ensuring engagement and accessibility. The required outputs scaffold the learning process from concrete representation through sketches, to symbolic representation with labeled vectors, and finally to abstract reasoning in the explanation of equilibrium versus non-equilibrium.

Annotation:

Begin the activity with a brief demonstration of transporting a chair upstairs.

Systematically present the guide questions and provide clues to help students come up with correct answers.

Relevance to IDF:

The activity systematically guides learners from concrete experience to conceptual understanding.

Beginning with a brief demonstration provides an anchoring strategy, allowing students to visualize the forces at play in a familiar, everyday situation. The structured guide questions serve as scaffolding, prompting learners to identify the downward pull of gravity, the upward force exerted by the student, and the changes in balance when pausing versus climbing. This progression ensures that learners move step by step from observation to analysis, aligning with IDF's principle of sequenced learning tasks.

	<p>Required Output:</p> <ol style="list-style-type: none">1. A hand-drawn sketch of a person carrying a bag.2. Labeled force vectors: weight, support force from arms, and swing force when walking.3. A short explanation of equilibrium when standing still vs. non-equilibrium when walking. <p>Rubric</p> <table><tr><th>Part</th><th>3</th><th>2</th><th>1</th></tr><tr><td>Sketch</td><td>Clear drawing of person holding a bag</td><td>Basic drawing, mostly clear</td><td>Messy or incomplete</td></tr><tr><td>Force Labels</td><td>All forces are correct</td><td>Two forces are correct</td><td>Only one is correct</td></tr><tr><td>Explanation</td><td>Concise and accurate</td><td>Clear explanation with minor inaccuracies</td><td>Partially correct</td></tr></table> <p>2. Making Generalization (Think-Pair-Share)</p> <p>Ask students the following questions:</p> <ol style="list-style-type: none">1. What pattern can you state about the motion of an object whenever the net force on it is zero, and how does this differ when the net force is not zero?2. What general rule can you write for how to represent all forces acting on any object, no matter what situation it is in?3. What do all equilibrium problems (whether the object is at rest or moving at constant velocity) have in common in how you set up the equations for the forces?4. How does the relationship $F = ma$ help you predict or explain how changes in net force or mass will affect an object’s acceleration in any non-equilibrium situation?	Part	3	2	1	Sketch	Clear drawing of person holding a bag	Basic drawing, mostly clear	Messy or incomplete	Force Labels	All forces are correct	Two forces are correct	Only one is correct	Explanation	Concise and accurate	Clear explanation with minor inaccuracies	Partially correct	<p>Annotation:</p> <p>Guide students in a 5-minute think-pair-share to synthesize Newton's first and second laws by posing the questions sequentially on the board.</p> <p>Relevance to IDF:</p> <p>This part moves learners from concrete examples to abstract principles through structured questioning and collaborative reasoning. By asking students to identify patterns in motion when net force is zero versus when it is not, to write general rules for representing forces, this part embodies IDF’s emphasis on progression, scaffolding, and active engagement.</p>
Part	3	2	1															
Sketch	Clear drawing of person holding a bag	Basic drawing, mostly clear	Messy or incomplete															
Force Labels	All forces are correct	Two forces are correct	Only one is correct															
Explanation	Concise and accurate	Clear explanation with minor inaccuracies	Partially correct															
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>I. MULTIPLE CHOICE. Write the letter of the CORRECT answer.</p> <ol style="list-style-type: none">1. Which situation shows equilibrium?<ol style="list-style-type: none">a. A car speeding up on a straight roadb. A ball falling freelyc. A book resting on a tabled. A cyclist turning a corner2. Which situation shows non-equilibrium?<ol style="list-style-type: none">a. A parked carb. A box moving at constant velocityc. A dropped stone accelerating downwardd. A hanging lamp at rest																	

3. A box is pushed across a floor at constant velocity. Which statement is correct?

- a. The net force on the box is zero
- b. The box is accelerating
- c. The applied force is zero
- d. The friction force is zero

4. What condition must be met for an object to be in static equilibrium?

- a. Velocity is constant but not zero
- b. The object is accelerating
- c. Net force is equal to mass times acceleration
- d. The object is at rest, and the net force is zero

5. According to Newton's Second Law, what is the relationship among net force, mass, and acceleration?

- a. $F = ma$
- b. $F = \frac{m}{a}$
- c. $F = \frac{a}{m}$
- d. $F = m + a$

II. PROBLEM-SOLVING. Solve the problem below and provide what is being asked. Draw a free-body diagram and provide a complete solution.

Problem 1

A 50.0-kg crate sits on a flat surface. You push the crate horizontally, resulting to constant velocity. If the force of friction is 80.0 N, what is the magnitude of your applied force? What is the value of normal force?

Problem 2

A 10.0-kg box is pulled across a frictionless horizontal surface with a constant horizontal force of 40.0 N. Calculate the horizontal acceleration of the box and the normal force.

Scoring Rubric

Criteria	4	3	2	1
Problem Setup	Correct identification of knowns, unknowns, and proper FBD.	Correct setup with minor missing details in FBD.	Incorrect identification of forces.	No logical setup provided.
Conceptual Application	Correctly chooses and applies the appropriate law ($\Sigma F = 0$ or $F = ma$).	Correct choice of law with minor application errors.	Confusion between equilibrium and non-equilibrium laws.	Fails to apply relevant physical laws.
Mathematical Accuracy	Flawless calculation and units.	Minor calculation or unit errors.	Major calculation errors.	No mathematical solution.

Key to Assessment

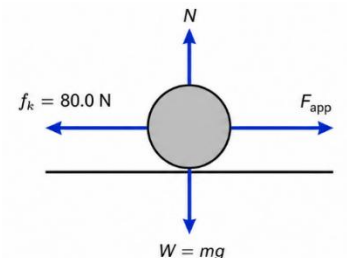
Part I. Multiple Choice

1. C

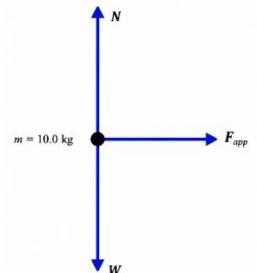
2. C
3. A
4. D
5. A

Part II. Problem Solving

Problem 1

<p>FBD:</p> 	<p>Directions: Up = Positive Right = Positive</p>
<p>Horizontal Components (x-axis) Applied Force (F_{app}) = ? Friction Force (f_k) = 80.0 N</p>	<p>Vertical Components (y-axis) Normal Force (N) = ? Gravitational Force (W) = ma_g $W = (50.0\text{kg})(9.8\text{m/s}^2)$ $W = 490.0\text{ N}$</p>
<p>Solving for Applied Force $\Sigma F_x = 0$ $F_{app} + f_k = 0$ $F_{app} + (-80.0\text{ N}) = 0$ $F_{app} = 80.0\text{ N, right}$</p>	<p>Solving for Normal Force $\Sigma F_y = 0$ $N + W = 0$ $N + (-490.0\text{ N}) = 0$ $N = 490.0\text{ N, Up}$</p>

Problem 2

<p>FBD:</p> 	<p>Directions: Up = Positive Right = Positive</p>
---	---

	Horizontal Components (x-axis) Applied Force(F_{app}) = 40.0 N	Vertical Components (y-axis) Normal Force (N) = ? Gravitational Force (W) = ma_g W = (10.0 kg) (9.8m/s ²) W = 98 N downward	
	Solving for Acceleration-horizontal component $\sum F_x = ma_x$ $F_{app} = ma_x$ $a_x = \frac{F_{app}}{m}$ $a_x = \frac{40.0\text{ N}}{10.0\text{ kg}}$ $a_x = 4\text{ m/s}$	Solving for Acceleration – vertical component <i>The vertical acceleration of the box is zero because it remains in contact with the horizontal surface and does not move up or down.</i> Solving for Normal Force $\sum F_y = 0$ $N + W = 0$ $N + (-98.0\text{ N}) = 0$ $N = 98.0\text{ N, Up}$	
	Reflection Questions for Teacher: 1. Which activity most effectively engaged learners in understanding equilibrium and non-equilibrium conditions? 2. Did the guide questions and sample problems provide sufficient evidence of learners’ mastery of Newton’s Laws? 3. What common errors or misconceptions about forces and motion emerged, and how were they addressed during the lesson? 4. How did linking physics concepts to workplace or everyday scenarios enhance learner motivation and relevance? Reflection Questions for Students: 1. In which scenario did you clearly see the difference between balanced and unbalanced forces? Explain why. 2. Which of Newton’s Laws was easiest for you to apply, and which was most challenging? Why? 3. When solving equilibrium or non-equilibrium problems, which step (diagramming, resolving components, applying equations) helped you most? 4. How can knowledge of forces and motion help you in real-world situations, such as sports, transportation, or workplace safety?		
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot to enhance the scoring rubrics for activities, assess learners’ answers in problem-solving tasks, generate free-body diagrams and illustrations, and improve the grammar. The author(s) reviewed and finalized the content, and they take full responsibility for it.		

Learning Area	PHYSICS 1	Lesson Exemplar	13
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>Newton's Laws of Motion, work, energy, power, and the conservation of energy are essential for understanding the behavior of objects and systems;</i>
B. Performance Standard	<i>By the end of the quarter, learners describe and explain rotational motion in terms of torque, moment of inertia, angular acceleration, and angular momentum. They apply these concepts to explain translational dynamics and rotational mechanics in simple everyday situations and in large scale real-world scenarios. They qualitatively and quantitatively apply Newton's Law of Universal Gravitation to describe and predict the motion of celestial bodies and near-Earth objects, including satellites and planets.</i>
C. Learning Competencies	<i>Calculate work done by an applied force and the power generated in practical situations such as engineering and sports science;</i>
II. REFERENCES and MATERIALS (Selecting Resources and Materials)	<p>BYJUS. 2022. "Dot Product of Two Vectors." September 22, 2022. https://byjus.com/maths/dot-product-of-two-vectors/.</p> <p>Díez, Á. 2026a. "Work Calculator." Omni Calculator. April 15, 2026. https://www.omnicalculator.com/physics/work.</p> <p>Díez, Á. 2026b. "Work Calculator." Omni Calculator. April 15, 2026. https://www.omnicalculator.com/physics/work.</p> <p>Khan Academy. "Client Challenge." Accessed May 13, 2026. https://www.khanacademy.org/science/ap-college-physics-1/xf557a762645cccc5:work-energy-and-power.</p> <p>Math Insight. "The Formula for the Dot Product in Terms of Vector Components." Accessed May 13, 2026. https://mathinsight.org/dot_product_formula_components.</p> <p>Physics Classroom. "Work Launch." Accessed May 13, 2026. https://www.physicsclassroom.com/concept-builder/work-and-energy/work/launch.</p> <p>Science Facts. 2020. "Applied Force." December 15, 2020. https://www.sciencefacts.net/applied-force.html.</p> <p>Tenor. 2024. "Hits the Ball Major League Baseball GIF." September 27, 2024. https://tenor.com/view/hits-the-ball-major-league-baseball-batting-justin-turner-seattle-mariners-gif-1524781298760373605.</p>

III. CONTENT <i>(Sequencing Content)</i>	1. Work 2. Power
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	1. Explain work and power; 2. Express work and power in equation form; 3. Discuss situations, such as engineering and sports science, in which work is done and power is generated; and 4. Calculate work done by an applied force and the power generated in practical situations such as engineering and sports science.
V. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i> This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension. (Each part shall have 2–3 varied activities)	<p style="text-align: center;">ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>
A. Activating Prior Knowledge	<p>OPTION 1. DOT PRODUCT RECALL</p> <p>1. Prepare cards with:</p> <ul style="list-style-type: none"> • Vector Pairs (e.g., $A = (2,3)$, $B = (4,11)$) • Possible dot product answers • Short concept prompts (e.g., What does a negative dot product mean) <p>Example:</p> <p>(a) Vector Pairs: $\vec{A} = (4, 1)$, $\vec{B} = (4,1)$ Dot Product Answer $\vec{A} \cdot \vec{B} = (4)(4) + (1)(1) = 16 + 1 = 17$ Concept Prompt: positive dot product $\rightarrow$ same direction, angle $< 90^\circ$</p> <p>(b) Vector Pairs: $\vec{P} = (-1, 5)$, $\vec{Q} = (2,3)$ Dot Product Answer $\vec{P} \cdot \vec{Q} = (-1)(2) + (5)(3) = -2 + 15 = 13$</p> <p>Note for Teachers:</p> <ul style="list-style-type: none"> • Prepare class cards in advance containing: <ul style="list-style-type: none"> *Vector pairs *Possible dot product answers *Short concept prompts • Revisit the Unit Vectors Dot product Rules: $\hat{i} \cdot \hat{i} = \hat{j} \cdot \hat{j} = \hat{k} \cdot \hat{k} = 1$ $\hat{i} \cdot \hat{j} = \hat{j} \cdot \hat{i} = 0$ $\hat{i} \cdot \hat{k} = \hat{k} \cdot \hat{i} = 0$ $\hat{j} \cdot \hat{k} = \hat{k} \cdot \hat{j} = 0$

	<p>Concept Prompt: Why can vectors with negative components still have a positive dot product? <i>dot product depends on the sum of products of components, not on whether components are individually positive or negative.</i></p> <p>(c) Vector Pairs: $\vec{M} = (6, -2)$, $\vec{N} = (1, 3)$ Dot Product Answer: $\vec{M} \cdot \vec{N} = (6)(1) + \{(-2)(3)\} = 6 + (-6) = 0$ Concept Prompt: dot product = 0, perpendicular vectors, angle = 90°</p> <ol style="list-style-type: none"> Students work in pairs or small groups. They match: <ul style="list-style-type: none"> Vector pair $\rightarrow$ correct dot product value Concept question $\rightarrow$ correct explanation After matching, students briefly justify one of their answers and share it with the class <p>OPTION 2: FIND THE HIDDEN CONNECTION</p> <p>TASK 1</p> <ol style="list-style-type: none"> Divide the class into five groups. Mission: Solve vector challenges to uncover clues. Each correct dot product reveals a clue or correct dot products reveal clues that leads to the final answer. Solve and Reveal <ul style="list-style-type: none"> Clue 1: $\vec{a} = (2, -1)$, $\vec{b} = (3, 4)$ Clue 2: $\vec{c} = (-2, 5)$, $\vec{d} = (5, 2)$ ☒ If the dot product is 0, write PERP ☒ If positive, write ACUTE ☒ If negative, write OBTUSE For each vector pair below, decide without full computation, whether the angle between them is acute, obtuse, or right. Explain briefly. <ol style="list-style-type: none"> (1,2) and (2,4) (3,-1) and (1,4) Be sure to take note of your answer in number 4. 	<p>Materials Needed:</p> <ul style="list-style-type: none"> Class cards White Board & Markers or 1/8 Illustration Board & Chalk <p>IDF Relevance: The activity connects prior knowledge to new concepts, promotes conceptual readiness, encourages collaborative learning, and prepares learners' conceptual foundation so they can meaningfully understand work and power as applications of the dot product.</p> <p>Note for the Teachers:</p> <ul style="list-style-type: none"> The teacher will carefully facilitate the flow of the activity to ensure that no key details are missed. <p>Task 1</p> <p>Answer (# 6)</p> <p>The dot product of two vectors equals zero when the vectors are perpendicular (orthogonal) to each other. This indicates that the angle between them is 90°, meaning they have no directional alignment.</p> <p>Task 2</p> <ol style="list-style-type: none"> 1.1 No, the book is not moving. 1.2 Yes. The book still experiences forces even if it is not moving. 2.1 Gravity or gravitational force pulls the book downward. 2.2 The table exerts an upward normal force that supports the book. 4. Expected FBD:
--	---	---

6. Answer the question: When does the dot product of two vectors equal zero, and what does it tell us about their direction?
7. Ask a representative from each group to share their takeaways from the activity.

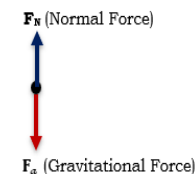
TASK 2

1. Place a book on the table.
Ask:
 - 1.1 Is the book moving?
 - 1.2 Does the book experience forces even if it is not moving? (Allow brief responses.)
2. Guide learners in identifying the forces acting on the book.
Ask:
 - 2.1 What force pulls the book downward?
 - 2.2 What prevents the book from falling through the table?
3. Ask learners to identify all the forces acting on the object.
4. Draw the simple FBD on the board. Ask volunteers to draw all the forces acting on the object. Emphasize balanced forces.
5. Gently push the book across the table.
 - 5.1 What happened to the book?
 - 5.2 What caused the book to move?
 - 5.3 What are the different forces involved? Show the free-body diagram.
6. From reviewing how forces are represented in a free-body diagram and how they act in different directions—along with the idea of the dot product that connects force and displacement—we can now see that not all force contributes to motion in the same way. This leads us to our lesson focus: defining work done in physics and understanding how force and displacement are related.

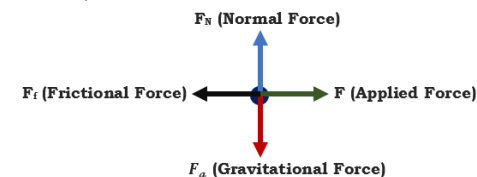
2. Establishing the Purpose of the Lesson

OPTION 1: FORCE in ACTION

1. Show simple situations using drawings, GIFs, or video clips of the following:



- 5.1 The book moved across the table.
- 5.2 The applied force (push).
- 5.3 Applied force (push), Frictional Force (opposes motion), gravitational force (downward), Normal Force (upward)
FBD:



Materials Needed:

- Marker & white board or 1/8 illustration board and chalk
- Book
- Spring Balance
- Meterstick

IDF Relevance: The activity is designed to help learners connect procedural computation of dot product with its geometric meaning in a meaningful, engaging, and student-centered way before formal discussion of applications.

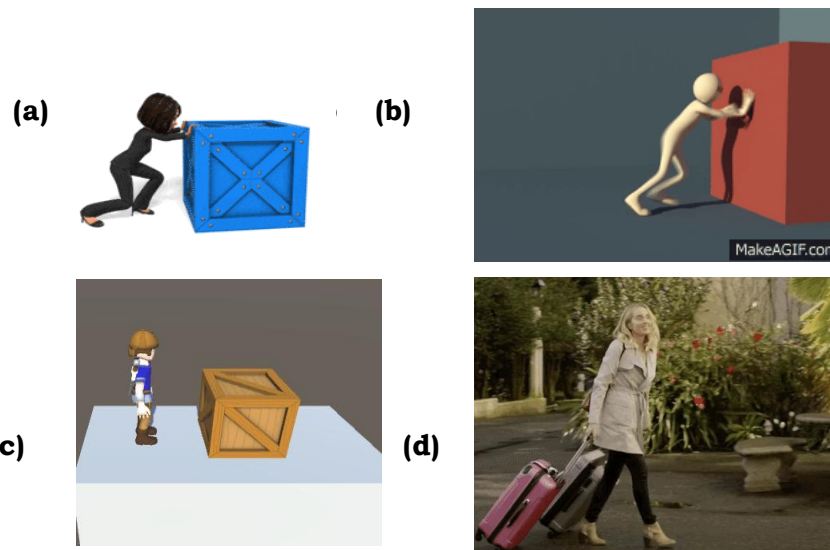
Note for Teachers:

- Prepare the materials ahead of time.
- Write the learners' key responses on the board.

Expected Answer:

- 2.1 The object starts moving or resists

- Pushing a box forward
- Carrying luggage



2. Ask the following questions:

- 2.1 What causes the object to start moving or resist movement in this situation?
- 2.2 What effect does an applied force have on an object?
- 2.3 What do we call the change in position of an object caused by an applied force?
- 2.4 What physical quantity is produced when an applied force causes an object to be displaced?

3. Since force can cause an object to move through a displacement, let us now explore how this interaction is described in physics through the concept of work.

OPTION 2: FORCE IN ACTION: Will It Move or NOT?

1. Divide the class into 5 groups.
2. Each group will assign one member to act out the chosen real-life scenario.
3. The actor will pick one scenario written on a strip of paper. They will be given 30 seconds to think and

movement because of the forces acting on it.

2.2 When a force is applied to an object, it can change its state of motion. It may cause the object to start moving, stop moving, speed up, slow down, or change direction.

2.3 Displacement

2.4 Work

Materials Needed:

- GIF, or video clip of the ff:
 - * Pushing a box
 - * Carrying a suitcase
 - * Climbing a tree by means of a rope

IDF Relevance:

Learners first recall the concept of force and its effects on objects, then analyze how force can cause displacement. By organizing the questions from simple observation to conceptual reasoning, the activity helps learners logically derive the concept of work. This scaffolding process establishes the purpose of the lesson and prepares learners for meaningful understanding of work in physics.

Note for Teachers:

- Prepare to write the ff. real-life situations on strips of paper:
 - * Pushing a wall
 - * Pulling a book from the bookshelf
 - * Lifting a stack of books
 - * Lifting a barbell to a certain height
 - * Throwing a bowling ball to hit the

	<p>prepare for the performance. Remember: One Line, One Scene.</p> <p>4. While the actor performs, the class will observe the actions and identify two important physical quantities being described.</p> <p>Guide Questions:</p> <p>(a) Is force applied with motion or without motion? <i>*The group will respond by raising an “IT WILL NOT MOVE” or “IT WILL MOVE” card.</i></p> <p>(b) What happens to the object when force is applied?</p> <p>(c) Does the applied force cause a change in the object’s motion or state?</p> <p>(d) What change do you observe in the object due to the applied force?</p> <p>5. So far, we observed force and distance in action. Now, let us give this interaction a name—what do we call it when force produces motion over a distance?</p> <p>6. With force and displacement in mind, we will now explore actual situations that illustrate how work is defined in physics.</p>	<p>Pins</p> <p>Materials Needed:</p> <ul style="list-style-type: none">• white board or 1/8 illustration board.• Marker, chalk• Paper strips containing the following: <p>IDF Relevance:</p> <p>The activity develops students’ conceptual understanding of force through real-life classification, while actively engaging them in decision-making and observation.</p>																				
<p>B. *Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>OPTION 1: SPORTS SCIENCE SPOTLIGHT</p> <p>(A Teacher-Led Discussion)</p> <div><div><p>(a)</p></div><div><p>(b)</p></div></div>	<p>Note for Teachers:</p> <ul style="list-style-type: none">• You may either prepare the GIFs or video clips of the sports such as: * Weightlifting * Bowling * Baseball * Basketball <p><i>Sample Answer</i></p> <table><tr><th>Conditions</th><td>A Weightlifter lifting weights</td><td>A Bat Hitting a Baseball</td><td>A Bowling Ball Hitting the Pins</td><td>A Basketball Player Preparing for a Lay-up</td></tr><tr><th>Presence of Force</th><td>☑</td><td>☑</td><td>☑</td><td>☑</td></tr><tr><th>Type of Force Applied</th><td>Applied Force, Gravitational Force, Normal Force, Frictional Force</td><td>Applied Force, Gravitational Force, Reaction Force, Air Friction</td><td>Applied Force, Gravitational Force, Frictional Force, Reaction Force, Contact Force</td><td>Gravitational Force, Applied Force, Normal Force, Frictional Force</td></tr><tr><th>Displacement of the Object</th><td>☑</td><td>☑</td><td>☑</td><td>☑</td></tr></table> <p>Materials Needed:</p> <ul style="list-style-type: none">• GIFs or video clips of the sports Mentioned	Conditions	A Weightlifter lifting weights	A Bat Hitting a Baseball	A Bowling Ball Hitting the Pins	A Basketball Player Preparing for a Lay-up	Presence of Force	☑	☑	☑	☑	Type of Force Applied	Applied Force, Gravitational Force, Normal Force, Frictional Force	Applied Force, Gravitational Force, Reaction Force, Air Friction	Applied Force, Gravitational Force, Frictional Force, Reaction Force, Contact Force	Gravitational Force, Applied Force, Normal Force, Frictional Force	Displacement of the Object	☑	☑	☑	☑
Conditions	A Weightlifter lifting weights	A Bat Hitting a Baseball	A Bowling Ball Hitting the Pins	A Basketball Player Preparing for a Lay-up																		
Presence of Force	☑	☑	☑	☑																		
Type of Force Applied	Applied Force, Gravitational Force, Normal Force, Frictional Force	Applied Force, Gravitational Force, Reaction Force, Air Friction	Applied Force, Gravitational Force, Frictional Force, Reaction Force, Contact Force	Gravitational Force, Applied Force, Normal Force, Frictional Force																		
Displacement of the Object	☑	☑	☑	☑																		

(c)



(d)



1. Look at the different GIF of different sports as projected on the TV.
2. Let us explore real-life movements in sports where force is applied to make the body or object move.
3. Observe each sport carefully. Focus on what the athlete is doing and how movement happens.
Guide Questions:
 - Do the different sports situations involve the presence of Force?
* *Allow students to respond briefly.*
 - If there is force, what force/s is/are being applied in each situation?
 - Is there movement or displacement of the object due to these forces?
* Call a representative to write their answers on the board
* Yes, across all four sports situations:
* An applied force is present, and there is a resulting displacement.
- 4) Let's investigate further by answering the following questions:
 - * Who exerted the force on the baseball?
The player using the bat.
 - * Who exerted the force on the basketball?
The player holding the ball.
 - * Who exerted the force on the barbell?
The weightlifter.
 - * Who exerted the force on the bowling pins?
The bowling ball.

- white board or 1/8 illustration board.
- Marker, chalk

IDF Relevance:

The activity helps students analyze concrete examples—such as the bat exerting force on the baseball, the dancer's feet applying force against the floor, the lifter applying an upward force on the barbell, and the bowling ball exerting force on the pins—and recognize that in each case, the applied force results in displacement. It supports developmental learning by using familiar sports contexts that make abstract concepts easier to understand and visualize. Finally, it serves a formative purpose by allowing the teacher to assess whether students can correctly identify applied forces and resulting displacement as essential conditions for work before formally introducing equations and problem-solving.

5) After identifying who exerted the force in each situation, let us now determine whether these applied forces caused the objects to undergo displacement.

* Let's take a look at the direction of the force applied.

Do the forces applied to those objects enable them to undergo displacement? Not always (player holding the ball)

* Is the direction of the force and displacement parallel with each other? *Not always (player holding the ball)*

6) With this in mind, let us now explore how the direction of force and displacement is used to define work.

- When the force applied is the same direction with the displacement, the force does work on the object.

2. Discussing New Concept

OPTION 1: FORMULA HUNT

Recall: *When the force applied is the same direction with the displacement, the force does work on the object.*

1. Let us now translate this situation into a mathematical expression.
2. This teacher-led discussion will be accompanied by a Pair-Think-Share activity.
3. Let's recall the Baseball, the Barbell, the Bowling Pins and the Basketball.

Object	Who Applied Force?	Displaces the object?	Force and Displacement Parallel	Work Done?
Baseball	Player	Yes	Yes	Yes
Basket ball	Floor	Yes	No	No
Barbell	Weightlifter	Yes	Yes	Yes
Bowling Pins	Ball	Yes	Yes	Yes

Note for Teachers:

- Ensure that each pair of students has a calculator, a pencil or ballpen, and a notebook.

Sample Answer:

$H=1.00\text{ m}$ $m_{\text{barbell}} = 10.0\text{ kg}$	Student A	Student B
Work done	98.0J	98.0 J
Time	2.00 seconds	5.00 seconds
Power	49.0 W	19.6 W

* Based on the table, work is done when a force causes displacement.

Mathematically,

(a) $W = Fd$

If the applied force is not parallel to the displacement, an angle is formed between the force and the displacement of the object. Work done is given by:

(a) $W = Fd\cos\theta$

4. Let's again use the barbell. Draw the barbell on your paper. Draw a red arrow to represent the force applied on the Barbell. Draw another arrow(blue) to represent the displacement of the barbell.



5. Earlier, we learned that the dot product depends on the magnitudes of vectors and the angle between them. Force and displacement are also vectors—so we use the dot product to describe work.

Recall: $\vec{A} \cdot \vec{B} = AB \cos\theta$

Using: $W = \vec{F} \cdot \vec{d}$

Replace the vectors: $W = \vec{F} \cdot \vec{d} = Fd\cos\theta$

Explain gradually:

$F \rightarrow$ magnitude of the applied force

$d \rightarrow$ magnitude of displacement

$\theta \rightarrow$ angle between force and displacement

Same height	Student A	Student B
Work done	500.0 J	200.0 J
Time	10.0 seconds	10.0 seconds
Power	50.0 W	20.0 W

Materials Needed:

- Calculator
- Pencil
- Notebook
- Different colors of Ballpen

IDF Relevance:

The Formula Hunt activity promotes active discovery of formulas for work and power, strengthens conceptual understanding, and develops learners' ability to connect time, work, and power in solving real-life problems.

	<p>• <i>When force and displacement are parallel</i> $\theta = 0^\circ, \cos 0 = 1 \rightarrow \text{maximum work}$</p> <p>• <i>When force and displacement are perpendicular</i> $\theta = 90^\circ, \cos 90 = 0 \rightarrow \text{no work}$</p> <p>• <i>When force is opposite displacement, Work is negative</i></p> <p>6. We have learned that work is done when a force causes displacement, and we can calculate it using $W = Fd \cos \theta$.</p> <p><i>Can different people do the same amount of work? YES</i></p> <p><i>Imagine two students lifting the same barbell to the same height.</i> <i>Student A lifts the barbell slowly</i> <i>Student B lifts the barbell quickly</i> <i>Ask:</i></p> <ul style="list-style-type: none"> • <i>Did both students apply force?</i> • <i>Did the barbell move the same distance?</i> • <i>Did they do the same amount of work?</i> <p>☒ <i>Expected realization: Yes, same work.</i></p> <p><i>Now ask the key question:</i> <i>If they did the same amount of work, what is different between the two situations?</i> <i>Guide students to answer: Time taken to do the work.</i></p> <p>Highlight: One finished faster, the other took longer.</p> <p><i>In physics, we are not only interested in how much work is done, but also how fast the work is done.</i></p> <p><i>Write on the board: Power is how fast work is done.</i> <i>Derive the Formula of Power.</i></p> <ul style="list-style-type: none"> • <i>Power depends on:</i> <ul style="list-style-type: none"> * <i>Amount of work done</i> 	
--	---	--

* Amount of time taken

• Write: $\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$

• Introduce symbols: (a) $P = \frac{W}{t}$

Use: $\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$

$$P = \frac{F.d}{t}$$

• now connect displacement and time

So: (b) $P = F.v$

($P=Fv$ applies when force and velocity are parallel. In general,
 $P=Fv=Fv\cos\theta$.)

7. Let us now relate work, time, and power by completing the table below:

Situation 1: Lifting a barbell (same work and height)

Given: Height = 1.00m $m_{\text{barbell}} = 10.0 \text{ kg}$	Student A	Student B
Work done	98.0 J	98.0 J
Time	2.00 seconds	5.00 seconds
Power		

Insight:

Even though work is the same, Student A has greater power because they used less time.

Situation 2: Different Work, Same Time Challenge

Running Upstairs (Different Work, Same Time)

Same height	Student A	Student B
Work done	500.0 J	200.0 J
Time	10.00 seconds	10.00 seconds
Power	50.00 W	20.00 W

CONCEPT:

- Work tells how much energy is transferred by a force.
- Time tells how long it takes
- Power tells how fast energy is transferred or how fast work is done.

3. Developing Mastery

OPTION 1: WORK POWER MASTERY

1. Require students to look for a pair then do the Rotational Learning Activity.

LEARNING STATION 1;

A block of mass 2.50 kg is pushed 2.20 m along a frictionless horizontal table by a constant 16.0-N force directed 25.0° below the horizontal.

- a) Draw the Free Body Diagram
- b) What is the work done on the block by the applied force, normal force, and gravitational force?
- c) Determine the total work done on the block.

LEARNING STATION 2:

A crane lifts a steel beam using a force of 500 N to a height of 8 m in 4 seconds.

- a) How much work is done?
- b) What is the power generated by the crane?

LEARNING STATION 3:

Note for Teachers:

- Prepare the materials needed for the Rotation Learning Activity.
- Group the learners into pairs before conducting the activity.

Materials Needed:

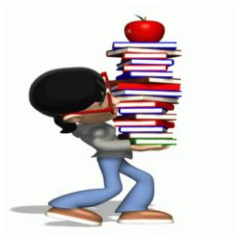
- Prepare a laminated copy of the different parts of the Rotational Learning Activity
- Calculator
- Worksheets

IDF Relevance:

The activity guides learners from conceptual understanding to mastery through structured problem-solving. Learners apply the concepts and equations of work and power to real-life situations in engineering and sports science, promoting higher-order

	<p>A basketball player applies an average force of 150 N to jump upward while taking a shot. The player’s center of mass rises by 0.6 m in 0.5 seconds.</p> <p>a) How much work is done by the player during the jump?</p> <p>b) What is the power output during the takeoff?</p> <p>c) Based on your answer, what does this tell you about the power required for explosive movements in sport?</p>	<p>thinking skills such as analyzing, computing, and interpreting results. This enables them to connect physics concepts to practical contexts, thereby strengthening mastery through authentic application of knowledge.</p>												
<p>C. Demonstrating Knowledge and Skills</p>	<p>OPTION 1: Crane Work and Power Challenge</p> <p>1. Divide learners into small groups.</p> <p>2. Present the scenario:</p> <p>A crane lifts a 200 kg steel beam to a height of 5 meters in 10 seconds.</p> <p>Tasks:</p> <p>a) Compute the work done.</p> <p>b) How much is the power generated by the crane?</p> <p>3. Share your answers with the class.</p> <p>OPTION 2: SPRINT, POWER, AND WORK in ACTION</p> <p>1. A coach is analyzing two sprinters during a training session.</p> <p>2. See table below for the data gathered.</p> <table><tr><th>Sprinter</th><th>Applied Force (N)</th><th>Distance Covered (m)</th><th>Time (s)</th></tr><tr><td>A</td><td>160</td><td>4</td><td>1.2</td></tr><tr><td>B</td><td>140</td><td>5</td><td>1.0</td></tr></table> <p>3. Guide Questions:</p> <p>a) Compute the work done by each sprinter.</p> <p>b) Compute the power output of each sprinter.</p>	Sprinter	Applied Force (N)	Distance Covered (m)	Time (s)	A	160	4	1.2	B	140	5	1.0	<p>Note for Teachers:</p> <ul style="list-style-type: none">● Provide varied problem-solving tasks involving the computation of work and power. <p>Materials Needed:</p> <ul style="list-style-type: none">● Calculator <p>IDF Relevance:</p> <p>Through analyzing how a crane lifts a load, learners develop deeper conceptual understanding by computing work and power, interpreting results, and connecting physics principles to real-world efficiency. This structured application fosters higher-order thinking skills, conceptual mastery, and meaningful learning transfer.</p> <p>Note for Teachers:</p> <ul style="list-style-type: none">● Require the learners to show the complete details of how the given problems were being solved.● Set clear criteria for scoring● Encourage complete and organized solutions <p>Materials Needed:</p> <ul style="list-style-type: none">● Calculator● Individual copy of the Worksheet <p>IDF Relevance: The activity reflects authentic and application-based</p>
Sprinter	Applied Force (N)	Distance Covered (m)	Time (s)											
A	160	4	1.2											
B	140	5	1.0											

	<p>c) Which sprinter shows better explosive performance, and why?</p> <p>d) If both athletes are preparing for a 100 m sprint, which one generates greater power?</p> <p>2. Making Generalization</p> <p>OPTION 1: COMPLETE the CONCEPT</p> <ol style="list-style-type: none"> 1. Ask learners to complete the following statements based on the concepts they learned about work and power. 2. Encourage them to explain their answers briefly. 3. Discuss the answers as a class to summarize the lesson. <p>Statements:</p> <p>Work is done when _____.</p> <p>Power refers to _____.</p> <p>The equation for work is _____.</p> <p>The equation for power is _____.</p> <p>In sports and engineering, work and power are important because _____.</p> <p>Using one sentence, state the general rule about work and power: _____</p>	<p>learning by allowing learners to apply the concepts and equations of work and power in a real-world sports science context. Through analyzing sprint performance, learners compute work and power, interpret results, and relate physics concepts to athletic performance.</p> <p>Note for Teachers:</p> <p>You may revise the activity for conducting the summary of the concept by using alternative activities like Concept Relay, Gallery Walk, Agree, Disagree, Explain, and Real-Life Connector.</p> <p>Expected answers:</p> <ul style="list-style-type: none"> • Work is done when a force causes an object to move in the direction of the force. • Power refers to how fast energy is transferred or how fast work is done. • The equation for Work is $W = Fd\cos\theta$. • The equation for power is $P = W/t$. • In sports and engineering, work and power are important because they help us understand how much energy is needed and how quickly tasks can be done at the fastest rate possible. • General rule: Work tells how much energy is transferred by a force, while power tells how fast energy is transferred or how fast work is done.
--	--	--

		Materials Needed: <ul style="list-style-type: none"> ● Marker ● Paper Strips IDF Relevance: This activity supports Intellectual development by helping students understand and connect the concepts of force, displacement, work, and power and addresses developmental needs by engaging learners through interactive and real-life activities.
VI. ASSESSMENT <i>(Assessing Learnings)</i>	<p>I. Work or No Work? Prove It! For each GIF, identify the object, the force applied, the displacement, and whether the force has a component along the displacement. Then write W if work is done and NW if no work is done.</p> <div style="display: flex; flex-wrap: wrap; justify-content: space-around;"> <div style="text-align: center;"> <p>1)</p>  </div> <div style="text-align: center;"> <p>2.</p>  </div> <div style="text-align: center;"> <p>3)</p>  </div> <div style="text-align: center;"> <p>4)</p>  </div> <div style="text-align: center;"> <p>5)</p>  </div> </div>	

SITUATIONS	OBJECT	FORCE APPLIED	DISPLACEMENT	IS THERE A COMPONENT OF FORCE ALONG THE DISPLACEMENT?	Work (W) or No Work (NW)
1. A person climbs by means of a rope	Person	Upward pull of the rope on the person	Upward (along the rope)	Yes- the force and displacement are in the same direction	Work is Done (W)
2. A man lifting a book from the ground	Book	Upward force exerted by the person's hand on the book	Upward (from the ground to a higher position)	Yes	Work is Done
3. A man typing on a keyboard	Keyboard keys	Downward force exerted by the person's fingers on the keys	Downward (keys move slightly when pressed)	Yes	Work is Done
4. A man carrying a baby	Baby	Upward force exerted by the person's arms on the baby	Horizontal (forward as the person walks)	No — the force is upward while the displacement is horizontal (they are perpendicular)	No Work is Done
5. A girl carrying a stack of books	Stack of books	Upward force exerted by the person's arms on the books	Horizontal (forward motion while walking)	No — the force is vertical (upward) while the displacement is horizontal, so they are perpendicular	No Work is Done

II. Open the URL below.

OPTION 1: <https://www.physicsclassroom.com/concept-builder/work-and-energy/work>

1. Launch the concept builder.
2. Click Start to begin.
3. Capture a screenshot of the launch activity progress.
4. Complete the sentence by specifying the intended endpoint.

Work
Version 2.2

Objective: To identify whether positive, negative, or zero work is being done, to identify the force that is doing the work, and to describe the energy transformation associated with such work.

You are **NOT** using this Concept Builder as a Logged-in student. You may log in and return to this page. Or you can do this Concept Builder as a Guest. If you continue as a Guest, a record of completing it will NOT be stored in the database.

Guest

Start

Consider this situation:
A **baseball** is brought to a stop upon hitting the catcher's mitt.

In this situation, work is done on the **baseball** by the _____.

☐ The force of the pitcher into the baseball
☐ The force of the catcher's mitt pushing against the baseball
☐ The force of the baseball pushing the mitt forward
☐ The force of gravity on the baseball

As a result, the mechanical energy of the **baseball** _____.

Tap on the **To Main Menu** button to end your session.
 ... or you will automatically be returned to the Main Menu when you have demonstrated a mastery of these questions.

Tap for Question Specific Help

OPTION 2: Read each item carefully and identify what concept of work and power is being asked. Use the correct formula or definition to complete each blank.

1. Work is calculated by multiplying force and displacement.
2. Power is the rate of doing work over time.
3. A worker applies a force of 40 N to move a box 5 m. The work done is 200 J.
4. In engineering and sports science, a machine or athlete with greater power can perform work faster.
5. Two athletes perform the same amount of work, but one finishes in less time. The athlete who finishes faster produces greater power.

III. PROBLEM SOLVING: Show the complete solution.

A construction worker uses a crane to lift a steel beam with a weight of 600 N to a height of 5 meters in 10 seconds.

(a) How much work is done in lifting the beam?

$$(Ans.: W = Fd = (600N)(5m) = 3000 J)$$

(b) How much power is generated by the crane?

$$(c) (Ans.: P = \frac{W}{t} = \frac{3000 J}{10 s} = 300 W)$$

Rubric: 10 Points

Criteria	Points	Description
1) Correct formula used for Work and Power	2 pts	Correct identification and use of formulas
2) Correct substitution of values	3 pts	Properly substitutes given values into equations
3) Correct computation of Work	2 pts	Accurate calculation of work
4) Correct computation of Power	2 pts	Accurate calculation of power
5) Final answer with correct unit and clarity	1 pt	Answers include correct units (J, W) and are clearly written

Total: 10 points

VII. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;">  Learner's Reflection <ol style="list-style-type: none"> 1. In your own words, how would you explain work and power to a classmate using one example from sports or daily life? 2. What real-life situation (sports, machines, or daily tasks) helped you best understand work and power? Explain how. 3. Can you think of another situation outside the classroom where power is important? </div> <div style="width: 48%;">  Teacher's Reflection <ol style="list-style-type: none"> 1. Were learners able to clearly explain the concepts of work and power using their own examples? 2. Did learners successfully connect the lesson to real-life situations? 3. What teaching strategies worked well in helping learners understand the relationship between work, time, and power? </div> </div>
VIII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft 365 Copilot, ChatGPT, and Gemini AI to generate some of the variations in style and format, and to support the presentation of concepts related to work and power, including the development of explanations, sample activities, and solutions for selected word problems. These AI-assisted tools were utilized as supplementary tools to enhance the organization, clarity, and accessibility of the instructional material. The author(s) carefully reviewed, validated, revised, and finalized all content to ensure its accuracy, relevance, and alignment with the intended learning competencies, and take full responsibility for the integrity of this Lesson Exemplar.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	14
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>Newton's Laws of Motion, work, energy, power, and the conservation of energy are essential for understanding the behavior of objects and systems;</i>
B. Performance Standard	<i>By the end of the quarter, learners describe and explain rotational motion in terms of torque, moment of inertia, angular acceleration, and angular momentum. They apply these concepts to explain translational dynamics and rotational mechanics in simple everyday situations and in large scale real-world scenarios. They qualitatively and quantitatively apply Newton's Law of Universal Gravitation to describe and predict the motion of celestial bodies and near-Earth objects, including satellites and planets.</i>
C. Learning Competencies	<i>Explain how energy is conserved in various real-life scenarios</i>
II. REFERENCES and MATERIALS <i>(Selecting Resources and Materials)</i>	<p>BBC Bitesize. 2024, July 16. "How Does a Roller Coaster Work?" https://www.bbc.co.uk/bitesize/articles/zm4cqp3#:~:text=The%20roller%20coaster%20is%20pulled,creates%20due%20to%20its%20motion.%20Roller%20coaster%20ride</p> <p>Energy Conservation Launch. n.d. https://www.physicsclassroom.com/concept-builder/work-and-energy/energy-analysis-1/launch</p> <p>Homemade Science with Bruce Yeany. 2014, October 26. "Potential Kinetic Energy Investigation // Homemade Science with Bruce Yeany" [Video]. YouTube. https://www.youtube.com/watch?v=Hqfg7eDzXt8</p> <p>Icccc. 2021, May 15. "11 GIF - 11 - Discover & Share GIFs." Tenor. https://tenor.com/view/11-gif-21572647</p> <p>Knowing Factory. 2024, March 9. "How Does a Syringe Work? 3D Animation" [Video]. YouTube. https://www.youtube.com/watch?v=edcnC2XkL1o</p> <p>Redirecting. n.d. https://m365.cloud.microsoft/chat/conversation/2d64812d-e8ea-4b8e-a519-4ef36b506c06?fromCode=cmcv2&redirectId=2077DEE7FEA84C4489E63C6DB9C9F85B&login_hint=maryann.lavilles%40depd.gov.ph&internalredirect=CCM&client-request-id=20dbefc8-c4b0-433f-9c3a-d0181c886e2a&origindomain=CCM</p> <p>The Physics Classroom website. n.d. https://www.physicsclassroom.com/troubleshooting</p> <p>Wisconsin Valley Improvement Company. n.d. "How Hydropower Works." https://www.wvic.com/Content/How_Hydropower_Works.cfm</p>

III. CONTENT (Sequencing Content) (Sequencing Content)	<i>Energy</i>	
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	At the end of the lesson, learners should be able to: 1. explain the law of conservation of energy using real-life situations; 2. illustrate energy transformations in real-life scenarios using diagrams, tables, or equations; and 3. use the concept of energy conservation to solve real-life problems involving changes in kinetic and potential energy in systems such as falling objects, pendulum motion, and a cyclist moving up and down a hill.	
V. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i> This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.		<p style="text-align: center;">ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>
<p style="text-align: center;">(Each part shall have 2-3 varied activities)</p>		
A. Activating Prior Knowledge	1. Activating Prior Knowledge OPTION 1: Track the Energy Trail 1. The teacher will show GIF images or show GIF animations of the following situations: 1.1 A falling ball https://tenor.com/view/trefl-trefl-gdansk-trefl-gda%C5%84sk-siatk%C3%B3wka-volleyball-gif-7228401508365322022 1.2 Swing in a playground https://tenor.com/view/swing-play-ground-smile-having-fun-adult-swing-gif-17430638 1.3 Roller coaster on a track	<p>Note for Teachers: You may use the provided link to access GIFs or search for video clips showing a falling ball, a playground swing, and a roller coaster on a track.</p> <p>Materials Needed:</p> <ul style="list-style-type: none"> • GIF image/video clip of a falling ball, swing in a playground, and a roller coaster.

<https://tenor.com/view/rollercoaster-alton-towers-theme-park-the-smiler-smile-gif-24960150>

2. Instruct learners to work in pairs, observe each GIF, and complete the quick response chart below

Situation	What do you observe in motion?	What forms of energy might be involved?
1. Falling Ball		
2. Swing		
3. Roller Coaster		

OPTION 2: The Energy Swing Challenge

1. The teacher will divide the class into 10 groups.
2. The teacher will present a simulation of a simple pendulum on the slide. Click the URL below to access the simulation.
<https://www.mypysicslab.com/pendulum/pendulum-en.html>
3. The teacher will manipulate the simulation by performing the following actions:
 - 3.1 Pull the pendulum to one side and hold it.

Ask: What kind of energy does the pendulum possess at this position?
 - 3.2 Release the pendulum and let it swing. Pause at the lowest point.

Sample Answers

Situation	What do you observe in motion?	What forms of energy might be involved?
1. Falling Ball	The ball speeds up as it falls downward	PE-KE
2. Swing	The swing moves back and forth; fastest at the bottom	PE - KE
3. Roller Coaster	Moves fast going down, slows down when going up	PE - KE

IDF Relevance: The learners analyze the GIFs of Falling Ball, Swing, and Roller Coaster to identify and recall the forms of mechanical energy, the Kinetic and Potential Energy.

Note for Teachers:

1. Show the simple pendulum on the TV screen using the link.
2. Require the students to observe and record their observations.

Expected Answers:

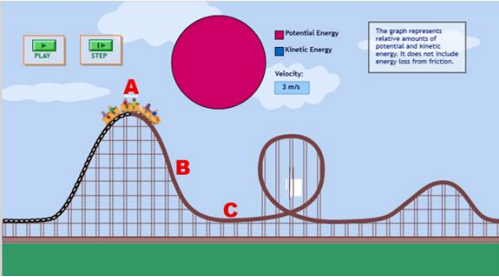
- 3.1 Gravitational Potential Energy
- 3.2. Kinetic Energy
- 3.3 Gravitational Potential Energy
- 3.4 The pendulum's energy continuously changes between gravitational potential energy and kinetic energy.

Materials Needed

- markers and pens

IDF Relevance: The activity provides learners with the opportunity to observe the forms of mechanical

	<p>Ask again: What kind of energy does the pendulum possess at this position?</p> <p>3.3 Pull the pendulum to the other side and hold it.</p> <p>Ask: What kind of energy does it possess at this position?</p> <p>3.4 Let the pendulum swing back and forth.</p> <p>Ask: How does the pendulum's energy change between kinetic energy and potential energy as it swings?</p> <p>3.5 Ask one representative from each group to share their observations and answers.</p> <p>3.6 Write the key points shared by each group on the board.</p> <p>2. Establishing the Purpose of the Lesson</p> <p>OPTION 1: "Ride the Energy" Brainstorm</p> <ol style="list-style-type: none"> 1) The teacher will show a short clip of a roller coaster ride. https://www.pbslearningmedia.org/resource/hew06.sci.phys.maf.rollercoaster/energy-in-a-roller-coaster-ride/ 2) Ask learners: Where does the energy go as the coaster climbs and descends? 3) Have them brainstorm in pairs and list everyday examples of energy transformations. 4) Ask at least 3 volunteers to share answers with the class. <p>OPTION 2: "Energy Hunt" Quick Game</p> <ol style="list-style-type: none"> 1. The teacher will divide the class into 5 groups. 2. Give students 2 minutes to look around the classroom and identify objects or actions that involve kinetic or potential energy. 	<p>energy possessed by the pendulum at different positions and recognize that during its motion, potential energy transforms into kinetic energy and vice versa.</p> <p>Note for Teachers:</p> <ol style="list-style-type: none"> 1. Prepare the materials ahead of time. 2. Connect learners' insights to the objectives <p>Materials Needed:</p> <ul style="list-style-type: none"> • Video Clip/GIF of a roller coaster ride • Markers or sticky notes <p>IDF Relevance: This activity helps learners recall and connect their everyday experiences with motion (such as rides or movement activities) to the concept of energy, preparing them for deeper understanding of energy transformation and conservation.</p>
--	--	---

	<ol style="list-style-type: none"> 3. Set a challenge tone: <i>"You are energy detectives. Find the most creative and accurate examples of energy in action"</i> 4. Each group shares one example, connecting it to the law of conservation of energy. 5. Wrap-up reinforcement: <i>Highlight that all examples show the law of conservation of energy.</i> 	<p>Note for Teachers:</p> <ul style="list-style-type: none"> • Ensure the classroom is safe for movement and observation. • Explain the task clearly. <p>Materials Needed:</p> <ul style="list-style-type: none"> • Marker • Strips of paper <p>IDF Relevance: This activity promotes active engagement instead of passive listening, develops critical thinking and classification skills, and connects abstract energy concepts to real-life situations</p>
<p>B. Instituting New Knowledge</p>	<p>B.1 Presenting Examples</p> <p>OPTION 1: Track the Energy</p> <ol style="list-style-type: none"> 1. Divide the learners into small groups. 2. •The teacher will show the roller coaster ride using the simulation. https://www.pbslearningmedia.org/resource/hew06.sci.phys.maf.rollercoaster/energy-in-a-roller-coaster-ride/ <ul style="list-style-type: none"> • Instead of a simulation, the teacher demonstrates a simple marble roller coaster model. 3. Give each group a roller coaster illustration with labeled points. See figure below. 	<p>Note for Teachers:</p> <ul style="list-style-type: none"> • Make sure you have access to the roller coaster simulation in advance using the link provided. • Show the movement of a roller coaster along the track to identify the forms of mechanical energy at different points. • If a simulation is not accessible, construct a simple roller coaster track using cardboard or a tube, then let a marble roll from a raised height. Guide learners as you demonstrate the marble's movement from the top, middle, and bottom of the track. <p>Materials Needed:</p> <ul style="list-style-type: none"> • Short video clip of a roller coaster • Marker and Manila Paper • Worksheet • Cardboard or illustration board • Flexible tubing (bendable tube made of plastic or rubber), or folded cardboard strips (for tracks)

4. The teacher plays the simulation to let the whole class observe the different positions of the roller coaster in the track.

5. Let the learners accomplish the table below by describing the relative magnitudes of Potential Energy (PE) and Kinetic Energy (KE) at each position of the roller coaster.

Position of the Roller Coaster on the Track	Potential Energy	Kinetic Energy
Top of the Hill		
Middle		
Bottom		

6. The teacher facilitates the discussion with the following guide questions:

- In a roller coaster system, what component performs work against gravity to raise the cars to the highest starting point?
- What is the key factor that drives the motion of the roller coaster after it reaches the top of the first hill?
- At the highest point of the roller coaster, what type of energy is greatest? What evidence supports your answer?
- As the roller coaster moves down the track, how does potential energy change into kinetic energy?
- At what point in the ride is kinetic energy at its maximum? Why do you think this happens?

OPTION 2: The Rolling Cart Energy Quest

- Divide the class into 10 groups.
- The group leader will access and open the simulation using the URL provided below.
https://javalab.org/en/mechanical_energy_en/
- Instruct each group to run the simulation and thoroughly explore all of its features.

Expected Answers:

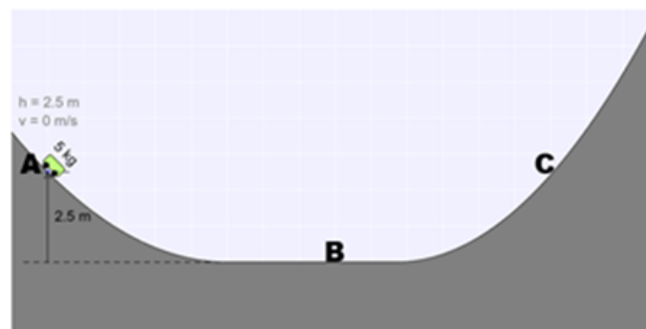
Position of the Roller Coaster on the Track	Potential Energy	Kinetic Energy
Top of the Hill	Highest	Lowest (almost zero)
Middle	Moderate	Moderate
Bottom	Lowest	Highest

- A motor or chain lift system pulls the roller coaster cars upward against gravity.
- Gravity is the key factor that drives the motion after the coaster reaches the top.
- Gravitational potential energy is greatest at the highest point, because the coaster has the maximum height and minimum speed (often momentarily at rest).
- As the coaster goes down, potential energy decreases and is converted into kinetic energy, increasing the coaster's speed.
- Kinetic energy is maximum at the lowest point of the ride because the coaster has the greatest speed there due to the full conversion of potential energy into motion.

IDF Relevance: This activity functions as a guided inquiry-based exploration task that helps learners move from observation → interpretation → conceptual understanding of energy transformation in a system.

4. Each member should carefully observe the cart's height and speed throughout its entire motion as it travels downhill and uphill along the track, especially at the labeled locations on the track. See the figure below as a guide.

Conservation of Mechanical Energy



5. Repeat if necessary to explore further and answer the following questions:
- (a) What do you think will happen when the cart is released?
 - (b) Why does the cart move faster as it goes downhill?
 - (c) At which point will the cart move fastest?
 - (d) At what point is kinetic energy greatest? Explain your answer.
 - (e) At which point will the cart have the greatest stored energy?
 - (f) What happens to the cart's potential energy as its kinetic energy increases?

Note for Teachers:

Make sure you have access to the rolling cart simulation using the link provided. Instruct the group leader to download the simulation in advance.

Expected Answers:

- (a) When the cart is released, it will start moving down the track due to gravity. It will accelerate as it goes downhill and slow down as it goes uphill, repeating this motion along the track.
- (b) The cart moves faster downhill because gravitational potential energy is being converted into kinetic energy. As it descends, gravity pulls it downward, increasing its speed.
- (c) The cart moves fastest at the lowest point of the track (the bottom of the hill), where it has the least height and therefore the least potential energy.
- (d) Kinetic energy is greatest at the lowest point of the track because kinetic energy depends on speed, and the cart is moving fastest there.
- (e) The cart has the greatest stored energy (potential energy) at the highest point of the track, because it is farthest from the ground and has the most gravitational potential energy.
- (f) As the cart's kinetic energy increases, its potential energy decreases. This is because potential energy is being converted into kinetic energy as the cart moves downward, showing the law of conservation of energy.

IDF Relevance: This hands-on experience bridges the gap between theory and real-world experience, allowing learners to meaningfully connect abstract concepts with observable phenomena. It transforms the complex concept of the conservation of mechanical energy into an engaging, observable, interactive, and student-centered learning experience.

B.2 Discussing New Concept

OPTION 1: Conservation Law Unlocked

Phase 1: Mission Briefing

1. Present the Question: Why does a roller coaster move fast at the bottom but slow down at the top?
2. Let learners share initial ideas. Call one representative from each group.
3. Introduce the challenge: **“Today, you will become Energy Detectives and unlock how energy is conserved in a roller coaster ride.”**

Phase 2: Simulation Exploration

1. Open the roller coaster simulation by clicking the link below:
<https://www.pbslearningmedia.org/resource/hew06.sci.phys.maf.rollercoaster/energy-in-a-roller-coaster-ride/>
2. Run the simulation several times. Observe the motion of the roller coaster. Focus on:
 - Height of the roller coaster
 - Speed
 - The amount of PE and KE at different points on the track.
3. Complete the table below based on observations from the simulation using descriptive words only.

Position	Height	Speed	Potential Energy (PE)	Kinetic Energy (KE)
1				
2				
3				
4				
5				
6				

Note for Teachers:

- Emphasize the importance of the PIE Chart.
- Instruct learners to focus their observations on the different points of the roller coaster track by clicking the Step Button.
- (Phase 4) You will present how the equations for potential energy and kinetic energy are derived and how these are combined to obtain the equation for total mechanical energy.

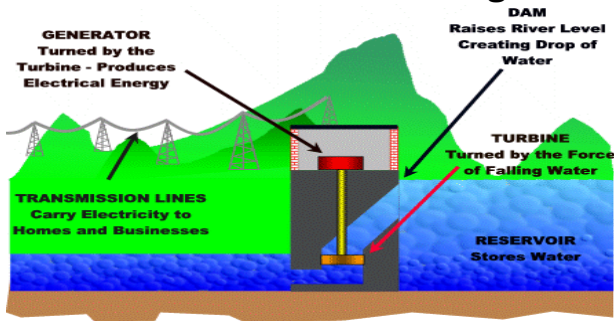
Expected Answers:

Position	Height	Speed	Potential Energy (PE)	Kinetic Energy (KE)
1	Very High	Minimum	Maximum	Minimum
2	Very low	Maximum	Minimum	Maximum
3	Near the bottom	High	Low	High
4	Medium High	High	High	Low
5	Very low	High	Minimum	Maximum
6	Medium	Low	Medium	Low

- (a) The roller coaster's potential energy is converted into kinetic energy, causing its speed to increase and become greatest at the lowest point.
- (b) The potential energy decreases because height decreases.
- (c) As the coaster gains height, it slows down because kinetic energy is converted into gravitational potential energy. As it climbs, more of its kinetic energy is transformed into potential energy, resulting in a decrease in speed.
- (d) When the coaster is at a higher height, it has more potential energy and less kinetic energy, so its speed is lower. When it moves to a lower height, potential energy is converted into kinetic energy, so its speed increases.

	<p>4. Elicit further observations by asking the following questions:</p> <ol style="list-style-type: none"> Why does the roller coaster move fastest at the lowest point of the track? What happens to the roller coaster's potential energy as it moves downward? Why does the coaster slow down as it climbs upward? How are height and speed related in the roller coaster ride? What evidence from the simulation supports that energy is not lost but transformed? What law explains this transformation? How does the simulation demonstrate the law of conservation of energy? <p>Phase 3: Concept Construction</p> <ol style="list-style-type: none"> Draw the energy transformations of the roller coaster at the following points and intervals: <ol style="list-style-type: none"> Point 1 Points 1 - 2 Point 2 Points 2-4 Point 4 Point 2 4-5 Point 5 Point 5 to point 6 Questions: <ol style="list-style-type: none"> How does the diagram show energy transformation? Why does the total mechanical energy remain constant? 	<p>(e)The roller coaster car successfully completes the entire track—from Point 1, through the loop, and up to Point 6—showing that energy is continuously transformed between gravitational potential energy and kinetic energy rather than being lost, as shown in the PIE chart.</p> <p>(f) Law of conservation of Mechanical Energy</p> <p>(g)The simulation demonstrates the law of conservation of energy by showing that the roller coaster's potential energy and kinetic energy are continuously transformed into each other while the total energy of the system remains constant throughout its motion.</p> <p>(a)The diagram shows energy transformation by illustrating how potential energy decreases while kinetic energy increases during the descent, and how kinetic energy converts back into potential energy during ascent, usually shown through changing bar graphs, arrows, or labeled energy levels.</p> <p>(b) The total mechanical energy remains constant because, based on the diagram, as one form of energy (PE or KE) decreases, the other increases by the same amount, showing that energy is only transformed and not lost.</p> <p>Materials Needed:</p> <ul style="list-style-type: none"> • Laptop/Cellphone/Tablet • Internet Connection • Roller Coaster Simulation • Activity Sheet <p>IDF Relevance:</p> <p>This activity follows a constructivist, inquiry-based instructional design, progressing from: Engagement → Exploration → Explanation → Elaboration, ensuring learners build understanding from experience to abstraction.</p>
--	---	--

	<p>Phase 4: Equation Connection</p> <p>B.3 Developing Mastery</p> <p>OPTION 1: Energy Station Rotation</p> <p>1. Set up stations with different tasks:</p> <ul style="list-style-type: none">• Station 1: Simulation Exploration <p>https://javalab.org/en/mechanical_energy_en/</p> <ul style="list-style-type: none">• Station 2: Cyclist’s Energy Journey• Station 3: Problem Solving-The Ultimate Skate Ramp Challenge <p>2. Divide the class into 5 groups and distribute the activity sheets. Groups rotate every 5 minutes from one station to another.</p> <p>3. After completing all stations, learners compare and discuss their answers with their group mates.</p> <p>4. Conduct group reporting to share findings and insights</p> <p>OPTION 2: Energy Conversion Exploration</p> <p>1. Ask learners to open the simulation.</p> <p>https://javalab.org/en/mechanical_energy_en/</p> <p>2. Set the cart at the highest point on the track.</p> <p>3. Instruct learners to observe:</p> <ul style="list-style-type: none">• Height of the cart• Speed of the cart• PE and the KE values shown in the simulation <p>4. Let learners run the simulation slowly.</p> <p>5. Learners pause the simulation at selected points along the track.</p> <p>6. At each point, learners record:</p> <ul style="list-style-type: none">• Height (m)• Speed (m/s)• Potential Energy (J)	<p>Note for Teachers:</p> <ul style="list-style-type: none">• Make sure to prepare the simulation ahead of time• Give the Activity: The Cyclist Energy Transformation Graph <p>Materials Needed:</p> <ul style="list-style-type: none">• Laptop/Tablet• White Board and Marker/Illustration Board and Chalk• Activity Sheet <p>IDF Relevance: This approach turns problem-solving into a collaborative, tiered challenge where students move from conceptual sketches to complex mathematical calculations.</p> <p>Note for Teachers:</p> <ul style="list-style-type: none">• Ensure all learners have access to the simulation through gadgets or group stations. <table><tr><th>L o c a t i o n</th><th>H e i g h t (m)</th><th>S p e d (m/s)</th><th>P E (J)</th><th>K E (J)</th><th>T o t a l M E</th></tr><tr><td>A</td><td>4</td><td>0</td><td>196</td><td>0</td><td>196</td></tr><tr><td>B</td><td>0</td><td>6.7</td><td>0</td><td>196</td><td>196</td></tr><tr><td>C</td><td>4</td><td>0</td><td>196</td><td>0</td><td>196</td></tr></table> <p>(a) The graph shows energy transformation by illustrating how gravitational potential energy decreases while kinetic energy increases, and vice versa, as the object moves. When one form</p>	L o c a t i o n	H e i g h t (m)	S p e d (m/s)	P E (J)	K E (J)	T o t a l M E	A	4	0	196	0	196	B	0	6.7	0	196	196	C	4	0	196	0	196
L o c a t i o n	H e i g h t (m)	S p e d (m/s)	P E (J)	K E (J)	T o t a l M E																					
A	4	0	196	0	196																					
B	0	6.7	0	196	196																					
C	4	0	196	0	196																					

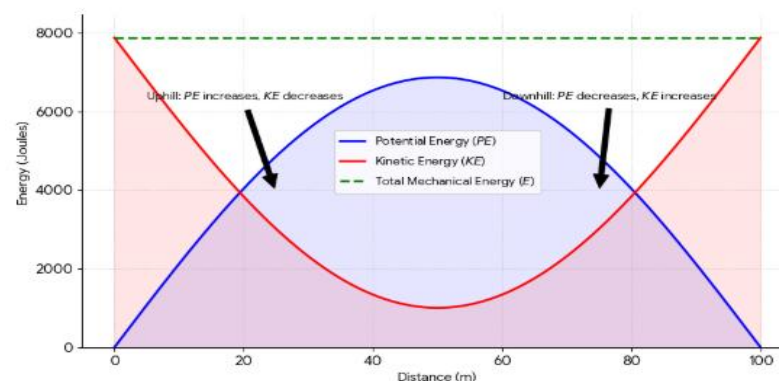
	<ul style="list-style-type: none">• Kinetic Energy (J) <p>7. Learners complete the table below:</p> <table><tr><th>Location</th><th>Height (m)</th><th>Speed (m/s)</th><th>PE (J)</th><th>KE (J)</th><th>Total ME</th></tr><tr><td>A</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>B</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>C</td><td></td><td></td><td></td><td></td><td></td></tr></table> <p>8. Convert the data into graph form. Create a graph of</p> <ul style="list-style-type: none">• Height vs. Potential Energy• Speed vs. Kinetic Energy <p>9. Answer the following questions:</p> <p>(a) How does the graph show energy transformation?</p> <p>(b) What evidence proves that energy is conserved?</p> <p>(c) Why does total mechanical energy remain nearly constant?</p>	Location	Height (m)	Speed (m/s)	PE (J)	KE (J)	Total ME	A						B						C						<p>of energy goes up, the other goes down, showing that energy is being converted between potential and kinetic forms.</p> <p>(b) The evidence is that the total mechanical energy line (or total energy value) remains constant throughout the motion. Even though kinetic and potential energy change individually, their sum stays the same.</p> <p>(c) Total mechanical energy remains nearly constant because of the law of conservation of energy, which states that energy cannot be created or destroyed—only transformed. In real situations, there may be a slight decrease due to friction or air resistance, but overall, the energy is conserved within the system.</p> <p>Materials Needed:</p> <ul style="list-style-type: none">• Activity Sheets• Calculator• Graphing Paper• Pencil and Ruler <p>IDF Relevance:</p> <p>The activity follows an instructional design framework by guiding learners from exploration (simulation) to development (data collection and graphing), and finally to mastery (explaining energy transformation and conservation).</p>
Location	Height (m)	Speed (m/s)	PE (J)	KE (J)	Total ME																					
A																										
B																										
C																										
<p>C. Demonstrating Knowledge and Skills</p>	<p>C.1 Finding practical application</p> <p>OPTION 1: How a Hydroelectric Dam Works: Energy Transformation Challenge</p> 	<p>Note for Teachers:</p> <ul style="list-style-type: none">• Be sure to have a copy of the Hydroelectric Dam diagram.• The teacher prepares three energy stations, each focusing on a different stage of the dam. <p>Materials Needed:</p> <ul style="list-style-type: none">• Activity Sheet <p>IDF Relevance:</p> <p>Through the mini dam model or simulation, learners discover how gravitational potential energy</p>																								

	<ol style="list-style-type: none"> 1. The teacher briefly presents the diagram, GIF, or video clip of a hydroelectric dam. 2. Divide the class into five groups. 3. Distribute Activity Sheet. 4. Trace how energy transforms as water moves through a dam using the following stations: <ul style="list-style-type: none"> • Station 1: Reservoir • Station 2: Flowing Water • Station 3: Turbine and Generator 5. Answer all the questions found in the activity sheets. 6. The group finalizes their findings and insights. 7. Group reporting. <p>OPTION 2: Solving Real-World Challenges</p> <p>Main Activity: Applied Energy Stations</p> <p>Students work in teams and rotate through three stations</p> <p>Station A: Falling Objects</p> <p>A 1.8 kg medical drone falls from 75 m.</p> <ol style="list-style-type: none"> (a) Explain how gravitational potential energy changes into kinetic energy as the drone falls. (b) At what point is the potential energy maximum and kinetic energy minimum? (c) Calculate the kinetic energy just before impact and compare it to the initial potential energy. (d) Based on your results, what can you conclude about the Total Mechanical Energy (TME) of the system? <p>Station B: Pendulum Motion</p> <p>A patient's lower leg (4.2 kg) swings with a maximum height of 0.28 m.</p> <ol style="list-style-type: none"> (a) Describe the energy transformation as the leg swings from the highest point to the lowest point. 	<p>transforms into kinetic energy as water flows downward. The activity develops conceptual understanding, critical thinking, and problem-solving skills while helping learners apply energy conservation in authentic situations such as hydroelectric power generation. It also reinforces mastery of the competency: explaining how energy is conserved in real-life scenarios.</p> <p>Note for Teachers:</p> <ul style="list-style-type: none"> • Prepare the different stations. • Be sure that the instructions for conducting the rotational activities are clear to the learners. <p><i>Expected Answers:</i></p> <p>Station A:</p> <ol style="list-style-type: none"> (a) As the drone falls, its gravitational potential energy (GPE) decreases because its height decreases. At the same time, its kinetic energy (KE) increases because its speed increases. (b) The potential energy is maximum, and the kinetic energy is minimum at the highest point, before the drone starts falling. (c) Initial Potential Energy = 1323 J Final Kinetic Energy $\approx$ 1323 J (d) The Total Mechanical Energy (TME) of the system remains nearly constant because energy is conserved. As the drone falls, potential energy changes into kinetic energy, but the total amount of mechanical energy stays the same (ignoring air resistance and friction). <p>Station B:</p> <ol style="list-style-type: none"> (a) As the leg swings downward from the highest point, its gravitational potential energy decreases while its kinetic energy
--	--	---

- (b) Where is kinetic energy greatest in motion? Where is potential energy greatest?
- (c) Show that the potential energy at the highest point is equal to the kinetic energy at the lowest point (ideal case).
- (d) What does this tell you about the Total Mechanical Energy (TME) of the pendulum system?

Station C: Cyclist on Hill

Cyclist Energy Transformation Graph



A 50kg cyclist is at the top of a hill with 8000 J of Total Mechanical Energy. (Assume $g = 9.8 \frac{m}{s^2}$)

- (a) Calculate the potential energy (PE), kinetic energy (KE), and total mechanical energy (TME) at different positions as depicted in the cyclist's energy transformation graph.
- Bottom (start)
 - Midway Up
 - Top of the hill

increases. The stored energy due to height is transformed into energy of motion as the leg speeds up.

- (b) •Kinetic energy is greatest at the lowest point of the swing because the leg moves fastest there.
•Potential energy is greatest at the highest point because the leg is at its maximum height.
- (c) PE at highest point = 11.52J
KE at lowest point = 11.52J
- (c) This shows that the Total Mechanical Energy (TME) of the pendulum system remains constant. Energy changes form between potential and kinetic energy, but the total amount of mechanical energy is conserved in the system (ideal case).

Position on Hill	PE (Joules)	KE (Joules)	Total ME (Joules)
Bottom (start)	0	8000	8000
Midway Up	4000	4000	8000
Top of Hill	8000	0	8000

- (d) The values of potential energy (PE) and kinetic energy (KE) are approximately equal. As potential energy decreases, kinetic energy increases by the same amount. This shows that energy is conserved because energy is not lost but only transformed from one form to another.
- (e) The Total Mechanical Energy (TME) of the system remains nearly constant. The sum of potential energy and kinetic energy stays the same throughout the motion, showing the law of conservation of energy.

Materials Needed:

- Activity Sheet
- Calculator

	<p>(b) Complete the table below:</p> <table><tr><th>Position on Hill</th><th>PE (Joules)</th><th>KE (Joules)</th><th>Total ME (Joules)</th></tr><tr><td>Bottom (start)</td><td></td><td></td><td></td></tr><tr><td>Midway Up</td><td></td><td></td><td></td></tr><tr><td>Top of Hill</td><td></td><td></td><td></td></tr></table> <p>(c) Compare PE and KE values and explain whether energy is conserved.</p> <p>(d) What can you conclude about the Total Mechanical Energy (TME) of the system in this situation?</p> <p>C.2. Making Generalization</p> <p>OPTION 1: Making Generalization: The "Energy Equation Mural"</p> <ol style="list-style-type: none">The Setup: Give each group a large piece of Manila paper or a digital canvas. At the center, they write the core principle: The Law of Conservation of Mechanical Energy.The Task: Three-Branch Concept Map. Groups must create three branches stemming from the center that summarizes the entire lesson.<ul style="list-style-type: none">• Branch 1: The Relationship (The Math)• Branch 2: The Condition (The “When”)• Branch 3: The Real-World Connection (The “Where”)The Reflective "Exit Ticket" (Individual Summary).Gallery Walk: Each group leaves one Reporter behind to explain their mural to other groups.	Position on Hill	PE (Joules)	KE (Joules)	Total ME (Joules)	Bottom (start)				Midway Up				Top of Hill				<p>IDF Relevance: This activity supports conceptual mastery through exploration, application, repetition of ideas across stations, and structured learner output, ensuring students can confidently explain and analyze energy transformation in real-world systems.</p> <p>Note for Teachers:</p> <ul style="list-style-type: none">• Announce the required materials in advance• Once the murals are completed, conduct a Gallery Walk <p>Materials Needed:</p> <ul style="list-style-type: none">• Manila Paper• Marker• Coloring Materials• Laptop or tablet <p>IDF Relevance: The activity strengthens understanding by turning abstract concepts into a clear, visual, and meaningful summary of learning.</p>
Position on Hill	PE (Joules)	KE (Joules)	Total ME (Joules)															
Bottom (start)																		
Midway Up																		
Top of Hill																		
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>I. Energy in My Daily Life</p> <p>Choose One Real-life situation from your daily experiences and explain how the Law of Conservation of Energy applies to it.</p> <p>You may choose from:</p> <ul style="list-style-type: none">• Riding a bicycle up and down a hill• Swinging on a playground• Dropping a ball																	

Rubric: 10 points

CRITERIA	4 Points	3 Points	2 Points	1 Point
Understanding of Energy	Correct explanation of energy conservation	Mostly correct explanation with minor errors or omitted details.	Some correct ideas	Incorrect or unclear
Real-life Example	Clear and correct example with explanation	Relevant example with adequate but unclear explanation.	Example is given but explanation is weak	No clear example or wrong example
Clarity of Answer	Easy to understand and well explained	Generally clear with minor unclear parts.	Some unclear parts	Hard to understand

II. Open this URL: <https://www.physicsclassroom.com/concept-builder/work-and-energy/energy-analysis-1/launch> and launch the concept builder.

1) Start from Energy Analysis 1.

The **Energy Analysis 1 Concept Builder** challenges learners to conduct an energy analysis of a motion involving the conservation of mechanical energy. There are three difficulty levels, with each level involving a different motion story and an additional set of PE and KE blanks. The analysis includes determining the PE and KE values at specific points along the motion path. A built-in number pad makes numerical entry very easy on mobile devices. Feedback is immediate and communicated by means of a color code system. Learners can repeat a difficulty level in an effort to improve their health percentage.

2) Launch the Concept Builder and begin. Since you are not logged in, your progress will not be tracked. You take a screenshot of all your progress as proof.

3) Start as a Guest and follow the instructions.

4) Choose the Apprentice Level, then begin answering.

5) Continue answering the questions until you reach the **Wizard Level**.

Rubric: 15 Points

CRITERIA	5 Points	3 Points	1 Point
Correct Use of Formula (PE, KE, TME)	Correct formulas used in all solutions	Some correct formulas used	Incorrect or missing formulas
Accuracy of Computation	All answers are correct	Few minor errors in computation	Many errors or no correct answers
Solution Process	Complete and clear step-by-step solution	Steps are shown but unclear or incomplete	No clear solution steps

III. PROBLEM SOLVING: The Falling Package Challenge

A 3.0 kg package is released from rest at the top of a frictionless inclined conveyor system used in an automated warehouse. The package starts at a height of 6.0 m, slides down a smooth track, and then enters a horizontal conveyor belt that slows it down before it stops.

- (a) Calculate the gravitational potential energy at the top.
- (b) Determine the velocity at the bottom of the incline.
- (c) Explain the energy transformation throughout the motion.
- (d) Calculate the average braking force of the conveyor belt.
- (e) Explain why energy losses must be considered in real engineering systems.

Rubric: 15 points

CRITERIA	4 Points	3 Points	2 Points	1 Point
Concept Understanding	Clear and correct explanation of energy conservation and transformation	Mostly correct explanation with minor errors	Partially correct explanation with minor errors	Incorrect or unclear explanation
Problem Solving Accuracy	Correct formulas, steps, and final answers	Minor errors in computation or steps	Minor errors in computation or steps	Major errors or no correct solution
Engineering Reasoning (HOTS)	Clear explanation of real-life engineering application	Basic connection to real-life situation	Basic connection to real-life situation	No clear engineering connection

<p>VI. REFLECTION (Feedback and Continuous Improvement)</p>	<div> <div>  Learners' Energy Exit Pass <p>⚡ My Biggest Energy Discovery Today, I discovered that _____.</p> <p>🌀 Energy in Real Life One real-life example of conservation of energy is _____.</p> <p>😊 My favorite Part The activity or demonstration I enjoyed the most was _____ because _____.</p> <p>? Still Wondering... One question I still have is _____.</p> <p>🚀 My Energy Challenge I will apply what I learned about conservation of energy by _____.</p> </div> <div>  Teacher's Energy Exit Pass <p>1) What evidence showed that learners understood the conservation of energy?</p> <p>2) Which activity created the highest learner participation and interest?</p> <p>3) What strategies helped learners better understand the concepts?</p> <p>4) What can I improve in future lessons to make learning more meaningful and interactive?</p> </div> </div>
<p>VIII. USE OF GENERATIVE AI</p>	<p>In preparing this Learning Exemplar (LE), the author(s) used Microsoft 365 Copilot, ChatGPT, and Gemini AI to generate variations of styles and formats and to support easier access to concepts of Conservation of Energy (Potential Energy and Kinetic Energy), as well as to develop explanations and solutions for selected word problems. The author(s) carefully reviewed and finalized the content and take full responsibility for its accuracy and integrity.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	15
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>Learners learned that... Newton's Laws of Motion, work, energy, power, and the conservation of energy are essential for understanding the behavior of objects and systems; momentum, impulse, and the laws of conservation are essential in evaluating the efficiency and safety of physical systems.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Develop a table to summarize how the principles of impulse and conservation of linear momentum apply in various real-life contexts, such as sports performance, vehicle safety systems, industrial processes, and space exploration.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<p><i>"Momentum Science for Kids." YouTube video. https://www.youtube.com/watch?v=j0ABgeP4aK8.</i></p> <p><i>"Momentum Definition in Physics for Kids What is Momentum?" Twinkl USA. YouTube video. https://www.youtube.com/watch?v=rMdjoCuY_3M.</i></p> <p><i>"What is Momentum?" YouTube video. https://www.youtube.com/watch?v=EzNfvwPCFs0</i></p> <p><i>Department of Education. Strengthened Senior High School Curriculum Guide in Physics 1. n.d.</i></p> <p><i>OpenStax. "8.1 Linear Momentum, Force, and Impulse." In Physics. https://openstax.org/books/physics/pages/8-1-linear-momentum-force-and-impulse.</i></p> <p><i>PhET Interactive Simulations. Collision Lab: Conservation of Energy and Collisions. University of Colorado Boulder. https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_all.html.</i></p> <p><i>The Physics Classroom. "Momentum and Impulse Connection." https://www.physicsclassroom.com/class/momentum/Lesson-1/Momentum-and-Impulse-Connection.</i></p>
III. CONTENT (Sequencing Content)	<i>Impulse and Momentum</i>

<div>IV. OBJECTIVES</div> <div>(Setting Clear Objectives and Analyzing the Tasks)</div>	<div>By the end of this lesson, the learners should be able to:</div> <div><div>1. Apply impulse and conservation of linear momentum to real-life situations, particularly in sports performance, vehicle safety systems, industrial processes, and space exploration.</div><div>2. Calculate the initial momentum, final momentum, impulse, and force applied.</div><div>3. Develop a table summarizing how impulse and conservation of linear momentum apply in sports, vehicle safety, industrial processes, and space exploration.</div></div>
<div>IV. PROCEDURES</div> <div>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</div> <div>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</div> <div>(Each part shall have 2-3 varied activities)</div>	<div>ANNOTATIONS</div> <div><div>*Instruction to the teacher on how to facilitate the activities.</div><div>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</div></div>
<div>A. Activating Prior Knowledge</div>	<div><div>1. Activating Prior Knowledge</div><div>Option 1: Decode the Hidden Word</div><div>Decode and define the scrambled hidden word using the code table.</div><div><div><div>1.</div><div><div>19</div><div>1</div><div>19</div><div>13</div></div></div><div><div>2.</div><div><div>5</div><div>13</div><div>20</div><div>9</div></div></div></div><div><div>3.</div><div><div>5</div><div>15</div><div>18</div><div>6</div><div>3</div></div></div></div> <div><div>4.</div><div><div>15</div><div>22</div><div>12</div><div>9</div><div>3</div><div>25</div><div>20</div><div>5</div></div></div> <div><div>Guide Question:</div><div><div>• Define force, time, mass and velocity operationally.</div></div></div> <div><div>Refer to this QR code for the code table.</div><div><div><div><div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><</div></div></div></div></div>

Refer to this QR code for the code table.



Scan Me!

NOTE TO TEACHER

1. Let learners define the terms to connect prior knowledge of the previous lesson.

IDF RELEVANCE

Letting learners define key terms at the start of a lesson helps connect new concepts to prior knowledge, which is a core principle of effective instructional design. This strategy activates what students already know,

Option 2: Word Search

Find and circle the hidden physics terms in the puzzle. The words may appear horizontally, vertically, or diagonally.

Q	W	E	R	T	Y	U	I	O	P	L	K
A	Z	X	C	V	B	N	M	Q	W	E	R
C	V	E	L	O	C	I	T	Y	T	Y	U
C	B	N	M	L	K	J	H	G	F	D	S
E	R	T	Y	U	I	O	P	A	S	D	F
L	K	J	H	G	F	D	S	A	Q	W	E
E	M	I	T	Z	X	C	V	B	N	M	Q
R	T	Y	U	I	O	P	A	S	D	F	G
A	S	D	F	G	H	J	K	L	Z	X	C
T	R	E	W	Q	P	O	I	U	Y	T	R
I	U	Y	T	R	E	W	Q	A	S	D	F
O	P	L	K	J	H	G	F	D	S	A	Z
N	M	B	V	C	X	Z	L	K	J	H	G
E	C	R	O	F	Q	W	E	R	T	Y	U
P	O	I	U	Y	T	R	E	W	Q	A	S

Clue:

1. A push or pull that can change the motion of an object. (FORCE)
2. The measured duration between events or actions. (TIME)
3. The amount of matter contained in an object. (MASS)
4. The speed of an object in a specific direction. (VELOCITY)

Guide Question:

- What is common on these terms?

Processing Questions:

1. How are mass and velocity related to momentum?
2. How are force and time related to impulse?

allowing teachers to identify misconceptions and adjust instruction accordingly.

Answer Key

- VELOCITY → Row 3 (forward)
- TIME → Row 7 (backward)
- FORCE → Row 14 (backward)
- ACCELERATION → Column 1 (downward)

Possible Answer:

1. Momentum is directly related to both mass and velocity. An object with greater mass or greater velocity will have greater momentum. This means momentum increases when either mass or velocity increases.
2. Impulse is the product of force and the time during which the force acts. A greater force or a longer contact time produces a greater impulse, resulting in a larger change in momentum.

	<div>2. Establishing the Purpose of the Lesson</div> <div>Option 1: Picture Analysis</div> <table><tr><td><div>Picture A</div><div></div><div>https://media.istockphoto.com/id/1199749886/photo/re-d-truck-on-interstate-reworked.jpg?s=612x612&w=0&k=20&c=2W5LKk0VgC3reg2IV5p5jx9FybeCh_KgEoJhuM3yx40=</div></td><td><div>Picture B</div><div></div><div>https://assets.newatlas.com/dims4/default/905d80e/2147483647/strip/true/crop/5472x3648+0+0/resize/1200x800/quality/90/?uri=http%2F%2Fnewatlas-brightspot.s3.amazonaws.com%2Farchive%2F2020-land-rover-discovery-sport-10.jpg</div></td></tr></table> <div>If both vehicles move at the same speed, which has greater momentum and which would require greater impulse or force to stop? Explain.</div>	<div>Picture A</div> <div></div> <div>https://media.istockphoto.com/id/1199749886/photo/re-d-truck-on-interstate-reworked.jpg?s=612x612&w=0&k=20&c=2W5LKk0VgC3reg2IV5p5jx9FybeCh_KgEoJhuM3yx40=</div>	<div>Picture B</div> <div></div> <div>https://assets.newatlas.com/dims4/default/905d80e/2147483647/strip/true/crop/5472x3648+0+0/resize/1200x800/quality/90/?uri=http%2F%2Fnewatlas-brightspot.s3.amazonaws.com%2Farchive%2F2020-land-rover-discovery-sport-10.jpg</div>	<div>NOTE TO TEACHER</div> <ul style="list-style-type: none">Encourage learners to explain their reasoning in terms of real-life situations, such as breaking distance and road safety.Use follow-up questions to correct misconceptions (e.g., “Does the heavier object always move faster?”) and reinforce that greater mass leads to greater momentum, requiring more force or time to stop. <div>Through video analysis, learners discover that impulse affects the change in momentum of an object. They also recognize the importance of impulse and momentum in improving sports performance and ensuring athlete safety.</div>
<div>Picture A</div> <div></div> <div>https://media.istockphoto.com/id/1199749886/photo/re-d-truck-on-interstate-reworked.jpg?s=612x612&w=0&k=20&c=2W5LKk0VgC3reg2IV5p5jx9FybeCh_KgEoJhuM3yx40=</div>	<div>Picture B</div> <div></div> <div>https://assets.newatlas.com/dims4/default/905d80e/2147483647/strip/true/crop/5472x3648+0+0/resize/1200x800/quality/90/?uri=http%2F%2Fnewatlas-brightspot.s3.amazonaws.com%2Farchive%2F2020-land-rover-discovery-sport-10.jpg</div>			
	<div>Option 2: Video Analysis</div> <div>The teacher presents sports video clips showing athletes applying force during motion such as basketball shooting, boxing punches, volleyball spikes, soccer kicks, or baseball batting. Learners observe how force and time affect the motion of the ball or athlete during impact.</div> <div>Links for sample videos.</div> <ul style="list-style-type: none">Basketball Shooting Mechanics - https://www.youtube.com/shorts/PETFOpfkA0A?feature=shareSoccer Kick in Slow Motion - https://www.youtube.com/shorts/7eLiDoTaXHw?feature=shareBoxing Punch Slow Motion - https://www.youtube.com/shorts/rcIgmc2Ek-U?feature=shareVolleyball Spike Analysis - https://www.youtube.com/shorts/HkYsfGkpYjA?feature=share	<div>IDF RELEVANCE</div> <div>Encouraging learners to explain their reasoning through real-life situations helps connect new concepts to meaningful contexts, making learning more relevant and easier to understand. It supports instructional design by promoting active learning and deeper conceptual understanding.</div>		

	<p>Guide Questions</p> <ol style="list-style-type: none"> 1. Which athlete applied for the greatest force? 2. How did force affect the motion of the ball or object? 3. Why is follow-through important in sports? 4. How does safety equipment reduce injuries during collisions? 5. Where can impulse and momentum be observed in the videos? 	
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples Option 1: Think - Pair-Share about Momentum Ask students to answer the following questions in their notebooks. When they're done, tell them to share their answers with a partner, preferably their seatmates.</p> <ol style="list-style-type: none"> 1. Which vehicle has greater momentum if both move at the same speed? How does momentum affect the impact during collision? 2. What if two cars have the same mass, but one car is moving faster than the other; which vehicle will require greater impulse to stop? 3. Which vehicle has greater potential impact if stopping time is short? 4. What safety measures can reduce the impact during a collision between a truck and a car? <p>Option 2: "Momentum or Not?" Explain to the students that an object has a momentum if it has mass and the object is moving. The teacher will present a list of scenarios:</p> <ol style="list-style-type: none"> a. A rolling bowling ball b. A parked bicycle c. A falling mango d. A sleeping cat e. A speeding motorcycle <ul style="list-style-type: none"> • Students classify each as having momentum or not having momentum. • Write one reason using the sentence stem: "It has/does not have momentum because ..." 	<p>Presenting examples through the Think-Pair-Share Activity. Discuss students' answers and guide them to identify the factors affecting momentum.</p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> • Ensure learners understand key terms (momentum, impulse) before answering. • Pair learners strategically encourage balanced participation. • Guide discussions and correct misconceptions. • Ensure equal sharing within pairs. • Address common errors and reinforce correct concepts during discussion. • Concludes the class with a brief sharing and consolidates the students' understanding of their lesson.

		<p>NOTE TO TEACHER <i>During the discussion, carefully guide students to recognize that momentum depends on mass and velocity. Ask probing questions to deepen understanding and correct misconceptions, such as confusing speed with momentum or assuming only fast objects have momentum.</i></p>
	<p>2. Discussing New Concept Class Discussion Video Presentation: Momentum Science for Kids - YouTube Guide questions:</p> <ol style="list-style-type: none"> 1. How do mass and velocity affect the momentum of an object? 2. If two objects with different masses are moving at the same speed, which one has greater momentum and why? 3. What are the real – life situations where impulse and momentum are applied? <p><i>Momentum</i> is the quantity of motion of an object. Things we need to consider:</p> <ul style="list-style-type: none"> • The object has a mass. • The object is moving <p>Mathematically, it is expressed as:</p> $p = m * v$ <p>Where:</p> $p = \text{momentum } \left(\frac{\text{kg.m}}{\text{s}} \right) \text{ or Ns}$ $m = \text{mass (kg)}$ $v = \text{velocity } \left(\frac{\text{m}}{\text{s}} \right)$ <p>When the object slows down or moves faster, its velocity decreases or increases. If there is a change in velocity or the mass of an object, there is also a change in momentum. And that change is called <i>Impulse</i>.</p>	<p>Before discussing the momentum concepts, show the YouTube video about momentum. You can use the link below to access the video on YouTube: Momentum Science for Kids - YouTube</p> <p>NOTE TO TEACHER <i>Reinforce students' understanding of momentum and impulse by solving problems. Guide them using the formula.</i> <i>Solve the three sample problems on the board with the students following the problem-solving steps. Remind them that problem solving is an essential scientific skill, and they need to pay attention to details and correct steps. Emphasize that we also need to use the correct units for the quantities involved.</i></p>

Impulse = change in momentum

$$I = \Delta p$$

$$p = m(v_f - v_i)$$

Force is needed to change the momentum of the body.

The force (F) multiplied by the time of contact (t) is known as Impulse (I).

$$I = F\Delta t = m(v_f - v_i)$$

The SI unit for momentum and impulse is Newton-second (Ns) or kilogram – meter per second (kg. m/s).

According to the **Impulse-Momentum Theorem**:

$$F\Delta t = \Delta p = mv_f - mv_i$$

This shows that impulse causes a change in momentum.

The **Law of Conservation of Momentum** states that in a closed or isolated system (no external forces), the total momentum before and after a collision is constant:

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

Thus, impulse explains how momentum changes during interactions, while conservation of momentum explains that the total momentum of a system remains unchanged.

THINK OF THIS!

Scenario: A heavy truck and a car are traveling on a highway at the same speed. Consider what happens when these vehicles need to stop suddenly.

Guide questions:

1. Which has greater momentum: the truck or the car? Why?
2. If both vehicles stop in the same amount of time, which one requires more force to stop? Explain.

Review the System International (SI) units of quantities involved in the computations.

Quantity	Symbol	SI Unit
Mass	m	kg
Velocity	v	m/s
Time	t	s
Force	F	N
Momentum	p	kg. m/s or Ns
Impulse	I	kg. m/s or Ns

IDF RELEVANCE

Reinforcing momentum and impulse through guided problem solving supports instructional design by helping students apply concepts in a structured and meaningful way. A step-by-step solution of sample problems provides scaffolding that builds understanding and confidence in using formulas correctly.

Possible Answer in Guide Questions:

1. *The truck has greater momentum because momentum depends on both mass and velocity $p = mv$. Since both are traveling at the same speed, the truck's much larger mass gives it a greater momentum.*
2. *The truck requires more force to stop. Because it*

	<p>Steps to solve word problems:</p> <ol style="list-style-type: none"> 1. Read and understand the problem. 2. Identify what is known (given values) and unknown (what is required). 3. Determine the formula to use in computing the unknown. 4. Substitute the given values in the formula. 5. Write the final answer using the correct unit of measure. <p>Note: Round off answers based on precision of given data (significant figures)</p> <p>Exploring Momentum and Impulse Through Problem Solving</p> <ul style="list-style-type: none"> • Sample Problem 1: If a 4.5 kg bowling ball is rolled down the bowling lane with a velocity of 6.00 m/s, what is its momentum? <p>Given: $m = 4.5 \text{ kg}$ $v = 6.00 \text{ m/s}$</p> <p>Required: $\rho = ?$</p> <p>Formula: $\rho = m * v$</p> <p>Solution: $\rho = 4.5 \text{ kg} (6.00 \text{ m/s})$ $\rho = 27 \text{ kg.m/s or } 27 \text{ Ns}$</p> <p>Answer: The momentum of the bowling ball is $27 \text{ kg} \frac{\text{m}}{\text{s}}$ or 27 Ns.</p> <ul style="list-style-type: none"> • Sample Problem 2: A 1,200-kg car traveling at 20 m/s suddenly stops after hitting the brakes. The car comes to a complete stop in 4 seconds. What average force is applied to stop the car? <p>Given: $m = 1,200 \text{ kg}$ $v_i = 20 \text{ m/s}$ $t = 4 \text{ s}$</p> <p>Required: $F = ?$</p> <p>Formula: $F = \Delta \rho / t \quad \rho = m (v_f - v_i)$</p> <p>Solution: $\Delta \rho = \frac{(1,200 \text{ kg})(0 - 20 \text{ m/s})}{4 \text{ s}} = -6,000 \text{ kg.m or } -6,000 \text{ N}$</p> <p>Answer: The average force needed to apply is 6,000 N. (The negative sign means the force acts opposite the direction of motion.)</p> <ul style="list-style-type: none"> • Sample Problem 3: A football player kicks a ball with a force of 50N. Find the impulse on the ball if his body stays in contact with the football for 0.01s. 	<p><i>has greater momentum, it also has a larger change in momentum when it stops. If the stopping time is the same, a larger change in momentum means a greater force is needed (based on $F = \frac{\Delta p}{\Delta t}$).</i></p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> • Begin by reviewing key concepts (momentum, impulse, and conservation of momentum) before problem solving. • Model the first step-by-step solution with the class to demonstrate proper format (Given–Required–Formula–Solution–Answer). • Emphasize correct unit handling and consistency in SI units throughout all problems. • Guide students in identifying which formula applies before solving each item. • Circulate and check learner work, giving hints for incorrect setup rather than direct answers.
--	---	--

	<p>Given: $F = 50\text{ N}$ $t = 0.01\text{ s}$</p> <p>Required: $I = ?$</p> <p>Formula: $I = Ft$</p> <p>Solution: $I = 50\text{ N} (0.01\text{ s})$ $I = 0.5\text{ Ns}$</p> <p>Answer: The impulse of the football player is 0.5 Ns.</p> <ul style="list-style-type: none"> Sample Problem 4: Two ice skaters, one with a mass of 80kg and another with a mass of 40kg are initially at rest on a frictionless surface. They push against each other, causing the skater a mass of 80kg to move to the left with a velocity of -4 m/s. What is the velocity of a skater with a mass of 40 kg? <p>Given: $m_1 = 80\text{ kg}$ $m_2 = 40\text{ kg}$ $v_1 = 4\text{ m/s}$</p> <p>Required: $v_2 = ?$</p> <p>Formula: $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$</p> <p>Solution: Since both skaters are initially at rest, the total initial momentum is zero. $p_{\text{initial}} = 0$</p> <p>Using the law of conservation of momentum: $m_1v_1 + m_2v_2 = 0$</p> <p>Substitute the given values: $(80\text{ kg})(-4\text{ m/s}) + (40\text{ kg})v_2 = 0 - 320 + 40v_2 = 0$</p> <p>Solve for v_2: $40v_2 = 320$ $v_2 = 8\text{ m/s}$</p> <p>Answer: The 40 kg skater moves 8 m/s to the right (positive direction).</p>	<ul style="list-style-type: none"> Highlight common mistakes (e.g., sign errors in velocity, incorrect formula selection). Encourage learners to explain each step to strengthen conceptual understanding, not just computation. Reinforce the link between real-life situations and momentum/impulse concepts. Allow peer comparison of solutions to promote collaborative checking and correction. Conclude a brief synthesis of how momentum is conserved and how impulse relates to force and time.
	<p>3. Developing Mastery (30 mins)</p> <p>Option1: Investigating Momentum</p> <p>Students stay within their groupmates and perform the given activity.</p> <p>Objective: At the end of the activity, the students should be able to identify the different factors affecting momentum.</p>	<p>NOTE TO TEACHER <i>Select only one activity suitable for the availability of materials.</i></p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> For offline setup, ensure safety when using inclined planes and moving objects.

Materials Needed: Board or plank (at least 1.0 m long), books, block of wood, masking tape, protractor, ruler/ meter stick, toy cars (one at least twice as heavy as the other)

Instructions:

1. Place several books on top of the table and position the plane board at an angle of about 15 degrees from the horizontal.
2. Using the masking tape and marker, label distances of every 20 cm starting from the lower portion of the inclined plane up to the other edge of the inclined plane.
3. Place the block of wood about 10 cm from the foot of the inclined plane. Label this as the block's initial position.
4. Measure how far the block moved. Record this as the stopping distance.
5. Repeat steps 3 and 4 while varying only the initial position / distance for 40 cm, 60 cm, and 80 cm.
6. Do steps 3 to 5, using the heavy toy car. Record your data in the table given below.

Initial Distance (cm)	Stopping Distance (cm) of Light Toy Car	Stopping Distance (cm) of Heavy Toy Car
20		
40		
60		
80		

Guide Questions:

1. How will you compare their stopping distances?
2. Did the two toy cars immediately stop as they hit the block or the wood? Describe the stopping distances of the two toy cars as their point of release increases.

- Ask probing questions to deepen thinking (e.g., "What changed and what stayed the same?").
- Address misconceptions immediately, especially confusion between mass, speed, and momentum.
- Ensure all group members actively participate in setup, observation, recording, and discussion.
- Conclude with a class synthesis connecting findings to the relationship between momentum, mass, and velocity, and the idea of impulse and conservation of momentum.

Possible Answer to Guide Questions:

1. The stopping distances can be compared by measuring how far each toy car traveled after hitting the block or wood before completely stopping. The toy car that traveled farther had a longer stopping distance.
2. No, the two toy cars did not immediately stop when they hit the block or wood. They still moved a certain distance before stopping completely. As the point of

3. If momentum is a measure of how difficult it is to stop a moving object, which of the two cars had greater momentum for the same point of release?

Option 2: Phet Simulation

Part A: Same Mass, Vary Speed

Instructions:

1. Open the PhET simulation: Collision Lab (or equivalent momentum simulation).
2. Select two objects (e.g., carts) with the same mass.
3. Set both objects in motion one at a time.
4. First trial: Set a low speed for the cart and observe what happens during motion/collision.
5. Second trial: Increase the speed of the same cart and repeat the observation.
6. Record your observations in a table:

Trial	Mass	Speed	Observation	Momentum Effect
1				
2				

Guide Questions:

- What happens to momentum when speed increases, but mass stays the same?
- Which has greater momentum: slow or fast motion? Why?

Part B: Same Speed, Vary Mass

Instructions:

1. Reset the simulation.
2. Set two objects to move at the **same speed**.
3. First trial: Use a **small mass** object.
4. Second trial: Increase the mass while keeping speed constant.
5. Observe the motion and collision effects in both cases.
6. Record results in the same table format.

release increased, the stopping distances of the toy cars also increased because the cars moved faster and had greater momentum.

3. For the same point of release, the heavier toy car had greater momentum because momentum depends on mass and velocity. Since both cars moved at nearly the same speed, the car with greater mass was more difficult to stop.

NOTE TO TEACHER

If materials are limited, the teacher may demonstrate using:

- rolling a light vs. heavy object
- pushing an empty cart vs. a loaded cart
- sliding a small vs. large ball

Possible Answers:

Part A: Same Mass, Vary Speed

Trial	Mass	Speed	Observation	Momentum Effect
1	Same	Low	Moves slowly, less distance, weaker impact on objects	Low momentum

Record Your Answers

Trial	Mass	Speed	Observation	Momentum Effect
1	Same	Low		
2	Same	High		

Guide Questions

- What happens to momentum when speed increases?
- Which trial shows greater momentum? Why?

Part B: Same Speed, Vary Mass**Instructions**

1. Reset the setup.
2. Keep the speed the same by pushing each object with equal force from the same starting point.
3. Trial 1: Use the lighter object (toy car or small ball).
4. Trial 2: Use the heavier object (loaded car or larger ball).
5. Observe differences in motion and stopping behavior.
6. Record your observations.

Record Your Answers

Trial	Mass	Speed	Observation	Momentum Effect
1	Small	Same		
2	Large	Same		

Guide Questions

- What happens to momentum when mass increases?
- Which object is harder to stop? Why?

Generalization Questions**Answer in complete sentences:**

1. How does mass affect momentum when speed is constant?
2. How does speed affect momentum when mass is constant?
3. Based on your results, what variables increase momentum?
4. Using a summary table relating impulse, initial momentum, final momentum, and applied force, what relationship can you observe between force applied and change in momentum? How does this support the law of conservation of momentum?

Generalization Answers

1. Mass effect: Increasing mass increases momentum when speed is constant.
2. Speed effect: Increasing speed increases momentum when mass is constant.
3. Conclusion: Momentum depends directly on both mass and velocity; increasing either increases momentum.
4. The applied force over a time interval (impulse) is equal to the change in momentum ($Ft = \Delta p$). The table shows that when force is applied, momentum changes from initial to final value, but in an isolated system, the total momentum before and after interaction remains constant. This supports the law of conservation of momentum, which states that total momentum is conserved when no external force acts on the system.

<p>C. Demonstrating Knowledge and Skills</p>	<p>1. Finding Practical Application (20 mins) Option 1: Group Activity Distribute the following scenarios in each group. Let them discuss in their groups and present their outputs.</p> <p>A. Scenario # 1 If your group oversaw designing the surface of a new children's playground, what kind of material would you use and why? Explain your answer by using physics terms we talked about, such as momentum, impulse, velocity, mass, time, and force</p> <p>B. Scenario # 2 Using the concepts of momentum and impulse in physics and using what we have discussed, describe some attributes of a car that will help decrease the incidence of injury in collisions. Also explain how they work using the terms of momentum, impulse, velocity, mass, time, and force.</p> <p>C. Scenario # 3 If your group was in a water balloon throwing competition where you had to throw full water balloons between your group members at increasing distances while trying to not break them, how would you use physics to help you win? Explain your answer by using terms we talked about in class such as momentum, impulse, velocity, mass, time, and force.</p> <p>D. Scenario # 4 If your group was assigned to move heavy boxes on a fast-moving conveyor belt in a factory, how would you use physics to safely stop the boxes without damaging them? Explain your answer using terms such as momentum, impulse, velocity, mass, time, and force.</p> <p>E. Scenario # 5 If your team were assigned to launch a rocket into space, how would you use physics to increase the rocket's momentum and help it escape Earth's gravity? Explain your answer using terms such as momentum, impulse, velocity, mass, time, and force.</p>	<p>NOTE TO TEACHER</p> <ul style="list-style-type: none"> • Each group will be given a scenario about momentum, and they will explain it within the group and to the class. • Facilitate the answers of the students to give additional information based on their output. <p>IDF RELEVANCE Group explanation of momentum scenarios promotes collaborative and active learning, allowing students to construct understanding through discussion. Facilitating and extending student responses supports scaffolding, helping clarify ideas, correct misconceptions, and deepen understanding of momentum.</p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> • Ensure balanced participation by assigning speaking or writing roles per member. • Keep groups focused on one scenario at a time to manage cognitive load. • Highlight strong answers while sharing model quality responses aligned with the rubric.
---	---	--

The output will be graded based on the given rubric below:				
Criteria	4 – Excellent	3 – Proficient	2 – Developing	1 – Beginning
Accuracy of Impulse/Momentum Explanation	Explanation is complete and scientifically accurate; clearly shows correct relationship between impulse and momentum	Explanation is mostly accurate with minor errors	Explanation shows partial understanding but with noticeable errors	Explanation is incorrect or shows misunderstanding of impulse and momentum
Correct Use of Terms and Formulas	Consistently and correctly uses terms (momentum, impulse, force, velocity, mass, time) and applies formulas appropriately	Mostly correct use of terms and formulas with few mistakes	Limited or inconsistent use of correct terms/formulas	Incorrect or missing use of scientific terms and formulas
Completeness of Application Table	All sections of the table are fully completed with detailed and accurate entries	Most sections of the table are completed with generally correct information	Some sections are incomplete or lack detail	Table is mostly incomplete or not attempted
Real-Life Relevance	Responses clearly connect physics concepts to real-life situations with strong, meaningful examples	Responses show clear real-life connections with minor gaps	Limited or weak connection to real-life situations	No clear connection to real-life situations
Clarity of Presentation	Work is very well-organized, easy to read, and logically presented	Work is organized and generally easy to understand	Presentation is somewhat unclear or disorganized	Presentation is unclear and difficult to understand
Option 2: Group Performance Task Requirement: Summary Table Each group is required to submit a summary table showing how impulse and momentum concepts apply to real-life situations. The table must clearly connect physics principles to everyday contexts.				

	Field/Applicat ion	Situation or Example	How Impulse is Applied	How Conservation of Momentum is Applied	Importance/Ben efit
	Sports	Example: Catching a ball	Increasing catching time reduces force	Momentum transfers from ball to player	Prevents injury
	Vehicle Safety				
	Industrial Processes				
	Space Exploration				
	Instructions <ol style="list-style-type: none">1. Divide the class into four groups.2. Assign one topic per group:<ul style="list-style-type: none">• Group 1 – Sports• Group 2 – Vehicle Safety• Group 3 – Industrial Processes• Group 4 – Space Exploration3. Each group will discuss how impulse and conservation of linear momentum are applied in their assigned field.4. Learners will complete the summary table below.5. Each group presents their answers to the class. Guide Questions <ol style="list-style-type: none">1. How does increasing collision time reduce force?2. Why is conservation of momentum important during collisions?3. How do these applications help improve safety and efficiency?4. Which application do you think is most important in everyday life? Why?				

Expected Answer:	
Field	Key Idea
Sports	Players increase stopping time to reduce force during impact.
Vehicle Safety	Airbags and seatbelts reduce force by increasing stopping time.
Industrial Processes	Conveyor systems and machine collisions follow momentum principles.
Space Exploration	Rockets move forward because gases move backward, conserving momentum.

Expected Answer on Guide Questions:	
1.	Increasing the collision time reduces the force because the change in momentum happens more slowly. According to the impulse-momentum relationship, a longer stopping time results in a smaller force.
2.	Conservation of momentum is important because it explains how momentum is transferred between objects during collisions. The total momentum before collision is equal to the total momentum after collision

	<p>Rubric:</p> <table><tr><th>Criteria</th><th>4</th><th>3</th><th>2</th><th>1</th></tr><tr><td>Accuracy of Concepts</td><td>All ideas are correct and complete</td><td>Minor errors</td><td>Some incorrect ideas</td><td>Mostly incorrect</td></tr><tr><td>Completeness of Table</td><td>All parts completed</td><td>One part missing</td><td>Several missing parts</td><td>Mostly incomplete</td></tr><tr><td>Participation</td><td>Actively participated</td><td>Participated sometimes</td><td>Limited participation</td><td>Did not participate</td></tr><tr><td>Presentation</td><td>Clear and organized</td><td>Mostly clear</td><td>Somewhat unclear</td><td>Difficult to understand</td></tr></table>	Criteria	4	3	2	1	Accuracy of Concepts	All ideas are correct and complete	Minor errors	Some incorrect ideas	Mostly incorrect	Completeness of Table	All parts completed	One part missing	Several missing parts	Mostly incomplete	Participation	Actively participated	Participated sometimes	Limited participation	Did not participate	Presentation	Clear and organized	Mostly clear	Somewhat unclear	Difficult to understand	<p>when no external force acts on the system.</p> <p>3. These applications help improve safety by reducing the force experienced during impacts, such as airbags and helmets. They improve efficiency by allowing machines, vehicles, and rockets to move and operate effectively using momentum principles.</p> <p>4. Possible answer: Vehicle safety is very important because seatbelts and airbags protect people from serious injuries during accidents by reducing the impact of force.</p> <p><i>(Answers may vary depending on the learner's explanation.)</i></p>
Criteria	4	3	2	1																							
Accuracy of Concepts	All ideas are correct and complete	Minor errors	Some incorrect ideas	Mostly incorrect																							
Completeness of Table	All parts completed	One part missing	Several missing parts	Mostly incomplete																							
Participation	Actively participated	Participated sometimes	Limited participation	Did not participate																							
Presentation	Clear and organized	Mostly clear	Somewhat unclear	Difficult to understand																							
	<p>2. Making Generalization (2 mins)</p> <p>To sum up the lesson, identify the following.</p> <ul style="list-style-type: none">• 3 concepts you learned in the lesson• 2 factors affecting momentum and impulse• 1 question I still have• 1 sentence to explain momentum and impulse <p>Learners share their responses with a partner or small group. The teacher synthesizes learners' responses and highlights the major concepts of the lesson.</p> <p>3. Additional Activities</p> <p>The following activity is optional. This may be done if there is an extra time beyond the teacher's allocated budget for this unit or lesson. This will serve as an enrichment activity.</p>	<p>Teachers should review responses and use them to plan short remediation or enrichment.</p> <p>Key answer on Additional Activities:</p> <p>Given:</p> $m_1 = 1200\text{ kg}$ $v_1 = +18\text{ m/s}$ $m_2 = 1500\text{ kg}$ $v_2 = -12\text{ m/s}$																									

	<p>Problem: A 1200-kg car traveling east at 18 m/s collides with a 1500-kg SUV traveling west at 12 m/s. After a collision, the vehicles stick together.</p> <p>Guide Questions:</p> <ol style="list-style-type: none">1. What is the total momentum before collision?2. What is the final velocity of the combined vehicles?3. In what direction do the vehicles move after collision?4. Explain why momentum is conserved.	<p>Solution: Using conservation of momentum:</p> $\begin{aligned} m_1v_1 + m_2v_2 &= (m_1 + m_2)v_f \\ (1200\text{kg})(18\text{m/s}) + (1500\text{kg})(-12\text{m/s}) &= (2700\text{kg})v_f \\ &= (2700\text{kg})v_f \\ &= (2700\text{kg})v_f \\ &= 2700\text{kg}(v_f) \\ &= 1.33\text{ m/s} \end{aligned}$ <p>Answers:</p> <ol style="list-style-type: none">1. Total momentum before collision = 3600 kg.m/s east2. Final velocity = 1.33 m/s east3. Direction after collision = east4. Momentum is conserved because total momentum before and after collision is equal.
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>I. Modified True or False. Write TRUE if the statement is correct. If it is False, change the underlined word to make the statement correct.</p> <ol style="list-style-type: none">1. A fired bullet has a <u>large</u> momentum despite its small mass because it is moving very fast. TRUE2. A sleeping carabao has a <u>large</u> momentum. (zero)3. An object can have a <u>small</u> momentum if it has a large mass and moves at a fast speed. (large)4. <u>Mass and velocity</u> are the factors that affect momentum. (True)5. Momentum is a <u>scalar</u> quantity. (vector) <p>II. Answer the given scenario.</p> <p>Roy has large mass and high velocity, giving him large momentum; stopping him immediately requires a large impulse / force over a short period of time. Explain your answer.</p> <p><i>Possible Answer: Roy has a large mass and high velocity, so he has high momentum. To stop him immediately, his momentum must change to zero in a very short time. Since impulse equals change in momentum, a short stopping time requires a large force. Therefore, a large impulse (large force applied quickly) is needed to stop him suddenly.</i></p>	

III. Solve the given problem and complete the entries in the table below.

- During the earthquake a 55 kg rescuer from San Fabian MDRRM ran with the speed of 30 m/s just to save the people inside the school campus. What is the momentum of the rescuer?

Given:

$$m = 55 \text{ kg}$$

$$v = 30 \text{ m/s}$$

Required:

$$\rho = ?$$

Formula:

$$\rho = m * v$$

Solution:

$$\rho = 55 \text{ kg} (30 \text{ m/s}) = 1650 \text{ kg.m/s or } 1650 \text{ Ns}$$

Answer: The momentum of the bowling ball is $1650 \text{ kg} \frac{\text{m}}{\text{s}}$ or 1650 Ns.

- A 2,000-kg truck is moving at 15 m/s. The driver applies the brakes, and the truck slows down to a stop in 5 seconds.

Questions:

- What is the initial momentum of the truck?
- What is the final momentum of the truck?
- What is the impulse acting on the truck?
- What is the average force applied to stop the truck?

Given:

$$m = 2,000 \text{ kg}$$

$$v_i = 15 \text{ m/s}$$

$$t = 5 \text{ s}$$

Required:

$$\rho_i = ? \quad \rho_f = ? \quad I = ? \quad F = ?$$

$$v_f = 0 \text{ m/s}$$

Formula:

$$\rho_i = mv_i \quad I = \Delta\rho = \rho_f - \rho_i$$

$$\rho_f = mv_f \quad F = \frac{\Delta\rho}{t}$$

Solution:

$$\rho_i = mv_i$$

$$\rho_i = (2,000 \text{ kg}) \left(\frac{15 \text{ m}}{\text{s}} \right)$$

$$\rho_i = 30,000 \text{ kg} \cdot \frac{\text{m}}{\text{s}} \text{ or } 30,000 \text{ Ns}$$

$$\rho_f = mv_f$$

$$\rho_f = (2,000 \text{ kg}) \left(0 \frac{\text{m}}{\text{s}} \right)$$

$$\rho_f = 0 \text{ kg} \cdot \frac{\text{m}}{\text{s}} \text{ or } 0 \text{ Ns}$$

$$I = \Delta\rho = \rho_f - \rho_i$$

$$I = \Delta\rho = 0 \text{ Ns} - 30,000 \text{ Ns}$$

$$I = -30,000 \text{ Ns}$$

$$F = \frac{\Delta\rho}{t}$$

$$F = \frac{-30,000 \text{ Ns}}{5 \text{ s}}$$

$$F = -6,000 \text{ N}$$

(The negative sign shows the force is opposite the direction of motion.)

Answer: The initial momentum is 30,000 Ns, the final momentum is 0 Ns, the impulse is -30,000 Ns and the force applied is -6,000 N. The negative sign shows the opposite direction.

Rubric:

Excellent (4)	Correct given values, unknown, and formula are identified; Correct and complete solution is shown; Correct final answer is given; Complete entry values in table. (5 points)
Proficient (3)	Given values, unknowns, and formulas to use are identified, but one of these is incorrect. Correct and complete solutions are shown; Correct final answer is given; One missing value in the table. (4 points)
Satisfactory (2)	Incomplete given values, unknown, and formula to use are identified; Correct solution is shown; Correct final answer is given; Some units are lacking or incorrect; Two – three missing values in table. (3 points)
Developing (1)	Incomplete given values, unknown, and formula to use are identified; an incorrect solution is shown; an incorrect final answer is given; Some units are lacking or incorrect; No entry values in the table. (2 points)
Beginning (0)	No attempt to answer (0 points)

Performance Task: Complete the table below by explaining how impulse and conservation of linear momentum are applied in each situation. Describe how force, time, mass, and velocity affect the motion involved.

Situation/Field	Example Scenario	Application of Impulse	Application of Conservation of Linear Momentum
Sports			
Vehicle Safety			
Industrial Processes			
Space Exploration			

	Possible Answer:			
	Situation/Field	Example Scenario	Application of Impulse	Application of Conservation of Linear Momentum
	Sports	<i>Catching a baseball or kicking a soccer ball</i>	<i>Players increase the time of contact when catching the ball to reduce force. Kicking the ball applies force over time to change its momentum.</i>	<i>The momentum of the player and ball changes during interaction, but the total momentum before and after contact is conserved.</i>
	Vehicle Safety	<i>Airbags and seatbelts during collisions</i>	<i>Airbags and seatbelts increase stopping time, reducing the force on passengers during impact.</i>	<i>During a collision, momentum is transferred between the vehicle and passengers while total momentum remains conserved.</i>
	Industrial Processes	<i>Conveyor belts, hydraulic presses, or robotic arms in factories</i>	<i>Machines apply force over a certain time to stop, move, or shape materials safely and efficiently.</i>	<i>Momentum is transferred between machines and objects during stopping, lifting, or pressing operations.</i>
	Space Exploration	<i>Rocket launches, spacecraft docking, or rover landings</i>	<i>Rockets apply large force over time to increase momentum. Landing systems increase stopping time to reduce impact force.</i>	<i>Rockets move forward as gases move backward, conserving momentum. Docking spacecraft also conserves total momentum during contact.</i>
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<ul style="list-style-type: none"> • <i>What misconceptions appeared?</i> • <i>Which activity helped most?</i> • <i>Which learners need remediation?</i> • <i>What enrichment tasks will be given to advanced learners?</i> • <i>What will be adjusted next time?</i> 			
VII. USE OF GENERATIVE AI	In preparing this Lesson Exemplar (LE), the author(s) used ChatGPT in order to generate ideas for activities and efficiently look for articles, videos, and other online sources used herein. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.			

Learning Area	PHYSICS 1	Lesson Exemplar	16
----------------------	-----------	------------------------	----

I. OBJECTIVES	
A. Content Standard	<i>Learners learned that... Newton's Laws of Motion, work, energy, power, and the conservation of energy are essential for understanding the behavior of objects and systems; momentum, impulse, and the laws of conservation are essential in evaluating the efficiency and safety of physical systems.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Describe rotational motion in terms of angular displacement, angular velocity, angular acceleration, and angular frequency;</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<p><i>“Rotational Motion: Definition, Examples, and Equations.” n.d.</i></p> <p><i>Department of Education. Lesson Exemplar in General Science. n.d.</i></p> <p><i>Department of Education. Strengthened Senior High School Curriculum Guide in Physics 1. n.d.</i></p> <p><i>Engineering LibreTexts. “1.5 Orientation, Angular Displacement, Angular Velocity, and Angular Acceleration.”</i> https://eng.libretexts.org.</p> <p><i>OpenStax. “6.3 Rotational Motion.” In Physics. https://openstax.org/books/physics/pages/6-3-rotational-motion.</i></p> <p><i>Physics Catalyst. “Translational Motion: Definition, Types, and Examples.”</i> https://physicscatalyst.com/article/translational-motion/.</p>
III. CONTENT (Sequencing Content)	Rotational Motion
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	<ol style="list-style-type: none"> <i>1. Compare and contrast translational motion and rotational motion.</i> <i>2. Define angular displacement, angular velocity, angular acceleration, and angular frequency;</i> <i>3. Distinguish angular displacement, angular velocity, angular acceleration, and angular frequency using real – life scenarios;</i> <i>4. Apply these quantities to describe or predict rotational motion (e.g., angular displacement, angular velocity, angular acceleration, and angular frequency).</i>

IV. PROCEDURES		ANNOTATIONS									
<p><i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i></p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p style="text-align: center;">(Each part shall have 2-3 varied activities)</p>		<p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>									
A. Activating Prior Knowledge	1. Activating Prior Knowledge	<p>NOTE TO TEACHER <i>Facilitate the activities by encouraging all learners to actively participate in sharing their knowledge about translational motion.</i></p> <p>IDF Relevance <i>The purpose of grouping learners into triads promotes cooperative learning and shared accountability. It also allows them to exchange diverse ideas and insights that others may not have considered, thereby enhancing recall and encouraging richer idea generation.</i></p> <p><i>Guide question for Option 2(after the activity): Based on the statements, what do you know so far about motion?</i> <i>Answers:</i> 1. Bluff 2. Fact 3. Fact 4. Bluff 5. Fact 6. Fact 7. Bluff</p>									
	Option 1: K-W-L Chart Completion on Translational Motion										
	<p>The learners will work in triad. The teacher will instruct them to complete the K-W-L Chart on the topic of translational motion. The learners will recall the concepts that they previously learned and place them in the K column. Similarly, they will work together to complete W and L columns.</p>										
	<table><tr><td>K</td><td>W</td><td>L</td></tr><tr><td>What do we know about translational motion?</td><td>What have we learned about translational motion?</td><td>What do we want to know about translational motion?</td></tr><tr><td></td><td></td><td></td></tr></table>		K	W	L	What do we know about translational motion?	What have we learned about translational motion?	What do we want to know about translational motion?			
	K		W	L							
What do we know about translational motion?	What have we learned about translational motion?	What do we want to know about translational motion?									
<p>Ask the learners who want to present their outputs in front of the class. The teacher facilitates the flow by asking other learners if they have the same notes or have different notes not stated by the presenters.</p> <p>The teacher connects the prior knowledge of learners as to how they define displacement, velocity, and acceleration. They should have concrete information before proceeding to a new lesson.</p>											

	<p>Option 2: FACT or BLUFF!</p> <p>Divide the learners into five groups. Each group will be given flashcards; FACT or BLUFF. The scope of the game is statements about motion. Each group will decide and raise the flashcard for 10 seconds after reading the statements. Ask the learners to give their explanation and supporting ideas on whether the statement is FACT or BLUFF. Each correct answer is equivalent to 2 points, and the highest number of points earned will be the winner.</p> <p>The teacher shows statements regarding motion. Learners will identify if the statements involve motion or not.</p> <p>Statements:</p> <ol style="list-style-type: none"> 1. Displacement refers to the total path traveled by an object. 2. Velocity includes both speed and direction. 3. An object moving at constant velocity has zero acceleration. 4. Acceleration happens only when an object speeds up. 5. A car moving north at 60 km/h has a velocity. 6. Displacement can be zero even if an object has traveled a long distance. 7. Speed and velocity always mean the same thing. 8. An object accelerating can either speed up, slow down, or change direction. 9. If an object returns to its starting point, its displacement is zero. 10. A stationary object can have acceleration. <p>Processing Question:</p> <ul style="list-style-type: none"> • How would displacement, velocity, and acceleration change if the object moves around a fixed axis instead of a straight path? <p>2. Establishing the Purpose of the Lesson</p> <p>The teacher asks the learners, “Why is it important to study motion, and in what ways can we apply it in real life?”</p>	<ol style="list-style-type: none"> 8. Fact 9. Fact 10. Bluff <p><i>Possible Answer in Processing Question:</i> <i>When an object moves around a fixed axis, displacement, velocity, and acceleration change from linear to rotational forms. Displacement becomes angular displacement (rotation angle), velocity becomes angular velocity (rate of rotation), and acceleration becomes angular acceleration (rate of change of rotational speed).</i></p> <p><i>The teacher should highlight the importance of making learners aware of the lesson objectives, as this fosters intentional and self-aware learning, which is key to metacognitive development.</i></p>
--	---	---

	<p>The learners are encouraged to share their ideas and experiences related to motion. After the discussion, the teacher presents the unit objectives for the learners to read and understand.</p> <p>Also, the learners will compare linear and angular quantities and use these to describe rotating objects such as fans, wheels, doors, and amusement rides.</p>									
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>The teacher introduces the concepts of linear displacement, linear velocity, and linear acceleration, along with their definitions, and asks the learners to read them. The teacher explains that these concepts will be used in the succeeding activities. Learners are then given time to process the terms and clarify any difficult words they encounter in the definitions.</p> <p>Option 1: Motion Sort Challenge</p> <p>Objective</p> <p>Differentiate translational motion from rotational motion through real-life examples.</p> <p>Materials</p> <ul style="list-style-type: none">• Scenario cards or pictures• Manila paper/chart paper <p>Instructions</p> <ol style="list-style-type: none">1. Work with your group.2. Read each scenario card carefully.3. Classify whether the motion is:<ul style="list-style-type: none">○ Translational Motion○ Rotational Motion○ Both4. Place the cards in the correct category.5. Explain your answer briefly. <p>Sample Scenarios</p> <ul style="list-style-type: none">• Rolling wheel of a bicycle• Elevator moving upward• Ceiling fan spinning• Train moving on tracks• Ferris wheel rotating	<p><i>Students are encouraged to explain unfamiliar terms on their own or seek help from their classmates. The teacher only provides the correct definitions when learners are unable to give accurate explanations. This approach promotes active participation, peer learning, and gradual understanding of the concepts.</i></p> <p><i>Suggested definitions of the physical quantities:</i></p> <ol style="list-style-type: none">1. <i>Linear displacement is the straight-line change in position of an object from its starting point to its ending point, with direction.</i>2. <i>Linear velocity is the rate of change of displacement over time, including direction.</i>3. <i>Linear acceleration is the rate of change of velocity over time.</i> <p><i>Key Answer in Option 1:</i></p> <table><tr><th>Scenario</th><th>Correct Answer</th></tr><tr><td>Rolling wheel of a bicycle</td><td>Both</td></tr><tr><td>Elevator moving upward</td><td>Translational Motion</td></tr><tr><td>Ceiling fan spinning</td><td>Rotational Motion</td></tr></table>	Scenario	Correct Answer	Rolling wheel of a bicycle	Both	Elevator moving upward	Translational Motion	Ceiling fan spinning	Rotational Motion
Scenario	Correct Answer									
Rolling wheel of a bicycle	Both									
Elevator moving upward	Translational Motion									
Ceiling fan spinning	Rotational Motion									

- Soccer ball rolling on the ground

Guide Questions

1. How did your group decide whether the motion was translational, rotational, or both?
2. What clues in the situation helped you identify the type of motion?
3. Which scenario was most difficult to classify? Why?
4. How did discussing with your group improve your understanding of motion?
5. How can understanding motion help explain movements in everyday life?

Option 2: “Motion Detective: Identify the Evidence”

The class is divided into groups having six members at most. The teacher gives each group a manila paper, marker and an activity sheet.

Part 1: Case File Analysis

The teacher presents “motion cases”. Learners act as detectives to identify the type of motion described.

1. A delivery rider travels from the shop to a customer’s house 2 km away in a straight line.
2. A car moves steadily at 50 km/h along a highway without changing speed.
3. A basketball rolls faster down a slanted court.
4. A student walks straight from Gate 1 to Gate 2 of the school campus.
5. A bus maintains a constant speed while traveling northbound.
6. A cyclist increases speed when going downhill.

Part 2: Evidence Table

Learners complete the table:

Case	Type of Motion	Evidence (keywords from scenario)
1		
2		
3		
4		
5		
6		

Train moving on tracks	Translational Motion
Ferris wheel rotating	Rotational Motion
Soccer ball rolling on the ground	Both

Guide Question Answers

1. Identifying whether the object moved from one place to another, rotated around an axis, or showed both motions.
2. Looking for clues such as straight movement, spinning, rolling, or turning.
3. Answers may vary. Example: “The rolling basketball was difficult because it both moves forward and spins.”
4. Group discussion helped us compare ideas and understand the differences between translational and rotational motion more clearly.
5. Understanding motion helps explain how vehicles, machines, sports equipment, and other moving objects work in real life.

NOTE TO TEACHER

Let the students master these three quantities before continuing to the next lesson.

During the processing, the teacher should focus on developing the skill in identifying rotational motion and the angular quantities involved.

Sample definitions:

Angular displacement is the angle through which an object rotates about a fixed point or axis, measured in degrees or radians.

Guide questions:

- What words in the scenario helped you identify the motion?
- How did you distinguish velocity from acceleration?
- Why is direction important in some cases?

The teacher explains that in translational motion, all parts of an object move the same distance in the same direction at the same time, sharing the same linear displacement, velocity, and acceleration. This motion is described using linear quantities.

The teacher then introduces angular (rotational) motion, where different points of an object move through angles around a fixed axis. Key ideas such as angular displacement, angular velocity, and angular acceleration are presented to highlight how motion differs from translational motion. Learners are guided to compare linear and angular quantities to clearly distinguish between the two types of motion.

For the learners to understand better the difference between the two types of motion, a table will be shown for comparison.

2. Discussing New Concept

1. The teacher shows a table of Translational Motion and Rotational Motion on the board.
2. The teacher gives printed materials of terms related to translational motion and rotational motion. Learners post the printed material in the appropriate column.

Quantities	Translational Motion	Symbol	SI Unit	Quantities	Rotational Motion	Symbol	SI Unit
Displacement	Change in position	Δx	meter (m)	Angular Displacement	Change in angular position	θ	Radian(rad)
Velocity	Rate of change of displacement	v	meter per second (m/s)	Angular Velocity	Rate of change of angular displacement	ω	radian per second(rad/s)
Acceleration	Rate of change of velocity	a	meter per second squared (m/s^2)	Angular Acceleration	Rate of change of angular velocity	α	radian per second squared (rad/s^2)

Angular velocity is the rate of change of angular displacement over time, describing how fast an object rotates and in what direction.

Angular acceleration is the rate of change of angular velocity over time.

Angular frequency is the rate at which an object completes rotational cycles or oscillations, measured in radians per second.

Oscillations are repeated back-and-forth or to-and-fro movements of an object around a central or equilibrium position.

IDF Relevance

This activity supports the Instruction Development Framework by promoting contextualized learning, critical thinking, and concept differentiation through real-life application of linear motion concepts.

NOTE TO TEACHER

The teacher must explain very well the difference between translational motion and rotational motion together with the different quantities.

Possible Learner's Question: If translational motion and linear motion are different, why are the physical quantities in translational motion referred to as linear quantities?

Suggested Answer: Although they are not identical concepts, the quantities used in translational motion are called linear quantities because displacement, velocity,

Recall also the formulas of uniformly accelerated motion and compare it to the rotational formula.

Quantity	Translational Motion	Rotational Motion
Displacement (Δx)	$\Delta x = x_f - x_i$	$\theta = \theta_f - \theta_i$
Velocity (<i>v</i>)	$\Delta x / \Delta t$ or $x_f - x_i / t_f - t_i$	$\omega = \Delta \theta / \Delta t$
Acceleration (<i>a</i>)	$\Delta v / \Delta t$ or $v_f - v_i / t_f - t_i$	$\alpha = \Delta \omega / \Delta t$

Angular Frequency measures how fast an object rotates or oscillates in terms of angle per time and expressed in radians per second.

The teacher encourages learners to share their misunderstandings, allowing classmates to provide explanations and clarification whenever possible, while the teacher steps in when expert guidance is necessary. The process continues until all identified confusions have been addressed.

3. Developing Mastery

Option 1: “Spin and Describe”

Objective:

Learners will identify and describe the different quantities used in rotational motion.

Materials:

- Toy wheel/electric fan/bicycle wheel
- Stopwatch
- Pictures or videos of rotating objects
- Activity sheet

Procedure:

1. Show learners several rotating objects (fan, clock hands, Ferris wheel, spinning top).
2. Ask learners to observe how the objects move.
3. Divide the class into groups.
4. Each group fills out a table describing:

and acceleration are defined along a straight-line path between the initial and final positions. These measurements are based on the net straight-line displacement, regardless of whether the actual path taken is straight or curved.

Expected Answer:

Rotational Aspect Observed	Correct Rotational Quantity
How far an object rotates	Angular Displacement
How fast it rotates	Angular Velocity
Change in speed of rotation	Angular Acceleration
Number of rotations per second	Angular Frequency

Guide Question Answers:

1. Angle covered → **Angular displacement**
2. How fast it rotates → **Angular velocity**
3. Change in speed → **Angular acceleration**
4. Rotations per second → **Angular frequency**

Rotational Aspect Observed	Correct Rotational Quantity
How far an object rotates	
How fast it rotates	
Change in speed of rotation	
Number of rotations per second	

5. Discuss the rotational quantities.

Guide Questions:

1. Which quantity describes the angle covered by the object?
2. Which quantity describes how fast the object rotates?
3. Which quantity describes the change in rotational speed?
4. Which quantity describes the number of rotations per second?

Option 2: “Rotational Motion Sorting Challenge”

Objective:

Learners will classify situations according to the correct rotational quantity.

Materials:

- Scenario cards
- Manila paper
- Marker

Procedure:

1. Prepare scenario cards describing rotating objects.
2. Learners work in groups.
3. They sort each scenario into:
 - Angular displacement
 - Angular velocity
 - Angular acceleration
 - Angular frequency
4. Groups explain why they classified each scenario.

Expected Answer:

1. A wheel turns 90° clockwise → Angular Displacement
2. A fan rotates at 120 rpm → Angular Velocity
3. A spinning top rotates faster after being pushed → Angular Acceleration
4. A washing machine completes 10 rotations per second → Angular Frequency
5. A Ferris wheel slows down → Angular Acceleration

Guide Question Answers:

- Clue: wording like *angle*, *speed*, *change*, *cycles per second*
- Angular velocity = rate of rotation
- Angular acceleration = change in rotational speed

Angular frequency = repeated cycles per second

	<p>Sample Scenario Cards:</p> <ol style="list-style-type: none"> 1. The wheel turns 90° clockwise. 2. A fan rotates at 120 revolutions per minute. 3. A spinning top rotates faster after being pushed. 4. A washing machine completes 10 rotations every second. 5. A Ferris wheel slows down before stopping. <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What clue helped you identify the rotational quantity? 2. How is angular velocity different from angular acceleration? 3. Why is angular frequency related to repeated cycles? 	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application (30 mins)</p> <p>Option 1: Guess Me Relay Challenge The learners stay in the same groupings. Students will identify the concepts relating to rotational motion (angular displacement, angular velocity, angular acceleration, and angular frequency).</p> <p>Mechanics / Procedure:</p> <ol style="list-style-type: none"> 1. The teacher places a scenario card pile at the starting point. 2. At the signal “Go!”, the first player from each group picks one scenario card. 3. The player reads the scenario aloud. 4. The player runs to the front and decides which station best describes the scenario: <ul style="list-style-type: none"> ○ Angular displacement ○ Angular velocity ○ Angular acceleration ○ Angular frequency 5. Before submitting the card, the learner must explain in one sentence why the scenario belongs to that category. 6. The player runs back and tags the next teammate. 7. The next player repeats the process with a new card. 8. The relay continues until all scenario cards are used. 	<p>Materials:</p> <ul style="list-style-type: none"> • Scenario cards (prepared by the teacher) • 4 labeled stations or answer stations: <ul style="list-style-type: none"> ○ Angular Displacement ○ Angular Velocity ○ Angular Acceleration ○ Angular Frequency • Timer or stopwatch <p>Expected Answer in Scenario Card File</p> <ol style="list-style-type: none"> 1. Angular Displacement 2. Angular Velocity 3. Angular Acceleration 4. Angular Frequency 5. Angular Displacement 6. Angular Acceleration 7. Angular Velocity 8. Angular Velocity 9. Angular Acceleration 10. Angular Frequency <p><i>Expected Answer in Processing Questions:</i></p> <ol style="list-style-type: none"> 1. <i>Those with familiar spinning objects (e.g., fan, wheels) because the motion is clear and easy to visualize.</i>

	<p>Rules:</p> <ul style="list-style-type: none"> • Only one player runs at a time. • Teammates must not help the runner once they are at the station. • Answers must be decided within the time limit (e.g., 10–15 seconds per turn). • Respect and safety while running is required. <p>Safety Reminders</p> <ul style="list-style-type: none"> • Walk, do not run, during relay movements to avoid accidents. • Maintain a clear path between stations to prevent collisions. • Handle all cards/materials carefully to avoid tearing or misplacement. • Observe proper spacing while waiting for turns. • Always follow teacher instructions. • Stop immediately when the signal is given. • Report any discomfort, injury, or hazards to the teacher. <p>Sample Scenario Cards:</p> <ol style="list-style-type: none"> 1. A bicycle wheel turns 90° clockwise before stopping. 2. A ceiling fan rotates at a constant speed of 120 revolutions per minute. 3. A spinning top starts slow, then gradually spins faster after being pushed. 4. A washing machine completes 8 full rotations every second. 5. A Ferris wheel moves from one seat position to another, completing a half turn (180°). 6. A merry-go-round slows down until it completely stops. 7. A clock's minute hand moves steadily without changing speed. 8. A blender blade rotates at a steady speed while mixing ingredients. 9. A car tire rotates faster when the driver presses the accelerator. 10. A wind turbine completes 15 cycles every second during strong wind. 	<ol style="list-style-type: none"> 2. <i>Angular velocity is the rate of rotation, while angular acceleration is the change in that rotation speed.</i> 3. <i>Clues like speed changes, direction, and whether motion is constant or changing.</i> 4. <i>Everyday rotating objects show these concepts in action, such as fans, wheels, and Earth's rotation.</i> <p>Facilitation Tips for the Teacher:</p> <ul style="list-style-type: none"> • <i>Clearly explain the four stations and model one sample scenario before starting.</i> • <i>Emphasize rules, safety, and the “one runner at a time” procedure.</i> • <i>Monitor closely to ensure order, fairness, and safe movement between stations.</i> • <i>Encourage learners to focus on key concepts (angle change, rate, and change in rate) when deciding answers.</i> • <i>Prompt learners with guiding questions when needed, without giving direct answers.</i> • <i>Ensure equal participation by tracking turns and involvement of all members.</i> • <i>Reinforce teamwork, respect, and sportsmanship throughout the activity.</i> • <i>Conduct processing questions immediately after clarifying misconceptions and consolidating learning.</i>
--	---	--

	<p>Processing Questions (After Activity):</p> <ul style="list-style-type: none"> • Which scenarios were easiest to identify? Why? • How did you distinguish angular velocity from angular acceleration? • What helped you decide the correct category? • How does real-life motion relate to these rotational quantities? <p>Option 2: “Spin, Act, and Create!”</p> <ol style="list-style-type: none"> 1. The class will be divided into groups with a maximum of six members each. 2. Each group will complete a creative activity related to rotational motion, which may involve music, role-playing, art, dance, and video making. 3. The presentation or output must clearly demonstrate the concepts of: <ul style="list-style-type: none"> • Angular displacement • Angular velocity • Angular acceleration 4. Learners are encouraged to connect the concepts to real-life situations and present them in a creative, organized, and understandable manner. 5. All group members must actively participate in the planning and presentation of the activity. 6. After sufficient preparation time, each group will present their work to the class. 7. At the end of the presentation, the group must briefly explain how the concepts of rotational motion were shown in their activity. 8. Rubrics on each task are also presented. <p>A. Music Activity: “Rotational Motion Remix” Type: Music + lyric creation</p> <p>Objective: Express physics concepts through song or rap</p>	<p>NOTE TO TEACHER</p> <p><i>This is a group-based performance task with a maximum of six members per group. Learners will creatively present the concepts of rotational motion—angular displacement, angular velocity, and angular acceleration—through formats such as role-playing, music, dance, art, or video.</i></p> <p><i>The activity encourages active participation, collaboration, and real-life application of concepts. Each group will present their output and briefly explain how the target concepts were demonstrated. Assessment will be guided by a rubric.</i></p> <p>Facilitation Tips for the Teacher:</p> <ul style="list-style-type: none"> • <i>Clearly explain the task, objectives, and rubric before group work begins to ensure learners understand expectations.</i> • <i>Guide group formation to ensure balanced participation and avoid uneven group sizes or dominance by certain learners.</i> • <i>Circulate during planning time to monitor progress, clarify misconceptions, and ensure correct application of angular displacement, velocity, and acceleration.</i> • <i>Encourage creativity while reinforcing scientific accuracy in how concepts are represented.</i> • <i>Provide scaffolding prompts for groups that struggle (e.g., examples of real-life</i>
--	---	---

Instructions:

Groups create a short song or rap that explains rotational motion concepts.

Must include:

- Angular displacement
- Angular velocity
- Angular acceleration

Sample Line:

🔊 “When the fan starts to spin, that’s acceleration kicking in!”

Output: 1–2-minute performance

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)
Physics Concepts	Clearly and accurately explains all rotational motion concepts	Most concepts are correct	Some concepts are unclear	Concepts are inaccurate or missing
Creativity	Highly original and engaging	Creative and interesting	Some creativity shown	Minimal creativity
Lyrics/Message Clarity	Message is very clear and understandable	Mostly clear	Sometimes unclear	Difficult to understand
Group Participation	All members actively participate	Most members participate	Few members participate	Limited participation
Presentation	Confident and well-prepared	Mostly organized	Some hesitation	Unprepared presentation

rotational motion like wheels, fans, or dancers).

- *Manage time strictly for planning, preparation, and presentation to ensure all groups have equal opportunity.*
- *Promote inclusive participation by ensuring all members have assigned roles in the performance.*
- *Use questioning during presentations to assess understanding beyond the creative output.*
- *Provide constructive feedback based on both content accuracy and teamwork as guided by the rubric.*

B. Role-Playing: “Amusement Park Drama”**Type:** Skit / dramatization**Objective:** Show real-life rotational motion situations**Scenario options:**

- Ferris wheel ride
- Roller coaster spin section
- Merry-go-round chaos

Requirement:

Students must naturally use physics terms in dialogue:

- angular displacement (change in position)
- angular velocity (steady spin)
- angular acceleration (speeding up/slowing down)

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)
Accuracy of Concepts	Physics concepts are correctly applied throughout	Minor errors present	Several inaccuracies	Concepts not evident
Acting and Delivery	Very expressive and natural	Good performance	Somewhat awkward	Limited effort
Creativity and Humor	Very creative and engaging	Creative presentation	Average creativity	Minimal creativity
Teamwork	Excellent cooperation among members	Good teamwork	Uneven participation	Poor collaboration
Real-Life Application	Concepts strongly connected to real life	Connection is evident	Limited connection	No clear application

By the end of the activities, learners should be able to state:

Option 3 Expected Answer in item number 3:

It is important because it helps control and predict motion. In transportation, it improves vehicle stability; in sports, it helps improve technique; and in machines, it ensures safe and efficient operation.

Option 2 Expected Answer:

*“Rotational motion can be described using **angular displacement, angular velocity, and angular acceleration**, which explain the **change in position, rate of rotation, and change in rotational speed** of a rotating object.”*

This activity strengthens the link between classroom learning and real-life situations by connecting concepts to actual events, objects, and scenarios. It helps bridge theory and practice, making the lesson more meaningful and relevant to learners’ lives, particularly in relation to senior high school exit pathways, and aligns with the goals of the curriculum.

C. Arts Activity: “Rotational Motion Poster Art”**Type:** Drawing / visual representation**Objective:** Represent concepts visually**Task:**

Create a poster showing a rotating object (fan, wheel, blender, etc.)

Must label:

- Angular displacement (path of rotation)
- Angular velocity (speed arrows)
- Angular acceleration (increase/decrease speed indicators)

Bonus: Add color coding for each concept

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)
Visual Creativity	Very attractive and original	Creative and neat	Average design	Minimal effort
Accuracy of Labels/Concepts	All concepts correctly labeled	Minor mistakes	Some incorrect labels	Labels missing/inaccurate
Organization	Information is very organized	Mostly organized	Some clutter	Disorganized
Relevance to Topic	Clearly relates to rotational motion	Mostly relevant	Partially relevant	Weak connection
Explanation	Group explains artwork clearly	Explanation mostly clear	Some unclear explanations	Unable to explain concepts

D. Movement Activity: “Spin Dance Physics”**Type:** Kinesthetic / dance**Objective:** Physically demonstrate rotational motion**Instructions:**

Students perform simple movements:

Slow turn = angular displacement

Steady spin = angular velocity

Speeding up/spinning faster = angular acceleration

	Challenge: Change movement based on teacher's music tempo changes				
	Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)
	Representation of Motion	Movements clearly show all concepts	Most concepts shown	Some concepts unclear	Concepts not shown
	Creativity of Choreography	Highly creative and engaging	Creative performance	Average creativity	Minimal creativity
	Synchronization/Coordination	Very coordinated	Mostly coordinated	Some coordination issues	Poor coordination
	Energy and Participation	All members actively participate	Most members participate	Uneven participation	Limited participation
	Explanation of Concepts	Concepts explained clearly	Mostly understandable	Some unclear explanations	Concepts not explained
E. Creative Video: "Physics TikTok/Short Film" Type: Multimedia project Objective: Real-life application using technology Task: Create a short video showing rotational motion in daily life. Examples: <ul style="list-style-type: none"> • Bike wheel spinning • Blender in action • Ceiling fan starting/stopping **Must include voice-over explaining: <ul style="list-style-type: none"> • Angular displacement • Angular velocity • Angular acceleration 					

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)
Content Accuracy	Concepts are scientifically accurate	Minor errors	Some inaccuracies	Concepts unclear
Creativity and Storyline	Very engaging and original	Creative presentation	Average storyline	Minimal creativity
Video Quality	Clear audio/video and organized editing	Mostly clear	Some technical issues	Difficult to follow
Application to Real Life	Strong real-life connection	Clear application	Limited examples	No clear application
Group Participation	All members contribute equally	Most members participate	Uneven participation	Limited participation

2. Making Generalization

Option 1: “Exit Ticket Generalization”

Instructions:

Answer in 3–5 sentences:

1. What is angular displacement, angular velocity, and angular acceleration?
2. How are they related to real-life motion?
3. Why is understanding rotational motion important in transportation, sports, or machines?

Option 2: Make a Generalization

Complete the statement:

“Rotational motion can be described using _____,
 _____, and _____, which explain the
 _____, _____, and
 _____ of a rotating object.”

	<p>3. Additional Activities</p> <p>The following activity is optional. This may be done if there is extra time beyond the teacher’s allocated budget for this unit or lesson. Moreover, this activity may be given as a performance task.</p> <p>Performance Task: Motion in Real-Life Work and Business</p> <ol style="list-style-type: none">1. The teacher distributes bond paper to each learner.2. Learners are asked to think of their dream job or business and describe, in at least three sentences, a scenario or object in that setting that demonstrates translational and/or rotational motion.3. Learners then create a simple sketch of the chosen scenario or object.4. The class agrees on a rubric based on clarity of explanation and quality of the sketch.5. After completing the task, learners share their work with a partner, and selected students present their outputs to the class.	
<p>V. ASSESSMENT (Assessing Learnings)</p>	<p>I. Multiple Choice: Encircle the best answer.</p> <ol style="list-style-type: none">1. A wheel rotates 90° from its starting position. This is an example of: A. Angular velocity B. Angular displacement C. Angular acceleration D. Angular frequency2. Which describes angular velocity? A. How far it rotates B. How fast it rotates C. Total force applied D. Change in speed of rotation3. What happens when a washing machine increases speed during a spin cycle. A. Angular velocity decreases B. Angular acceleration occurs C. No rotation occurs D. Angular displacement stops4. Which of the following statements is TRUE if a bicycle wheel spins at steady speed. A. Angular acceleration is zero B. Angular velocity changes C. Force increases D. Angular displacement stops5. Why does a spinning ice skater spin faster when pulling arms inward? A. Increases torque B. Stops rotation C. Increases mass D. Reduces moment of inertia, increasing angular velocity6. Which situation shows all three: angular displacement, velocity, and acceleration? A. A stationary wheel B. A stopped fan C. A still object D. A wheel speeding up then slowing down	

7. Which statement is correct?

A. Angular velocity = change in speed	C. Angular frequency = force applied
B. Angular acceleration = total angle	D. Angular displacement = change in angle
8. Why is rotational motion important in machines and transportation?
 - A. It reduces weight
 - B. It stops all motion
 - C. It removes friction completely
 - D. It helps design safe and efficient movement systems
9. A washing machine slows down after the spin cycle ends. What type of motion change is shown?

A. Positive angular acceleration	C. Constant velocity
B. Negative angular acceleration	D. No motion
10. Which best explains why a spinning fan slows down when turned off?

A. Gravity increases	C. Velocity becomes infinite
B. No angular displacement	D. Friction causes negative angular acceleration

II. **Venn Diagram:** Complete the Venn diagram by writing the correct descriptions in the appropriate section:

- Translational Motion (Left Circle)
- Rotational Motion (Right Circle)
- Both (Overlapping Section)

Items to Place in the Venn Diagram:

1. Moves along a straight or curved path without spinning
2. Involves angular displacement
3. All parts of the object move the same distance in the same direction
4. Involves linear displacement
5. Measured using linear velocity (m/s)
6. Objects rotate about an axis
7. Measured using angular velocity (rad/s)
8. Can involve acceleration
9. Example: a moving car traveling on a straight road
10. Example: a spinning wheel or fan
11. Has displacement, velocity, and acceleration concepts
12. Motion can be uniform or non-uniform
13. Motion around a fixed point or axis
14. Example: sliding a book across a table
15. Both describe types of motion in physics

Key Answer:

Translational Motion Only

- Moves along a straight or curved path without spinning
- All parts of the object move the same distance in the same direction
- Involves linear displacement
- Measured using linear velocity (m/s)
- Example: a moving car traveling on a straight road
- Example: sliding a book across a table

Rotational Motion Only

- Involves angular displacement
- Objects rotate about an axis
- Measured using angular velocity (rad/s)
- Example: a spinning wheel or fan
- Motion around a fixed point or axis

Both (Similarities)

- Can involve acceleration
- Has displacement, velocity, and acceleration concepts
- Motion can be uniform or non-uniform
- Both describe types of motion in physics

Rubric: Venn Diagram – Translational vs Rotational Motion

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
1. Correct Placement of Concepts	All 15 items are correctly placed in the appropriate sections (Translational, Rotational, Both)	12–14 items are correctly placed	8–11 items are correctly placed	Fewer than 8 items are correct
2. Understanding of Translational Motion	All translational characteristics are correctly identified and complete	Minor error or 1 missing concept	Several errors or incomplete ideas	Concepts are mostly incorrect or missing

		3. Understanding of Rotational Motion	All rotational characteristics are correctly identified and complete	Minor error or 1 missing concept	Several errors or incomplete ideas	Concepts are mostly incorrect or missing
		4. Understanding of Similarities (Both Section)	All shared characteristics are correctly identified	1 minor error or omission	Several errors or incomplete ideas	No correct similarities identified
		5. Accuracy & Conceptual Understanding	Demonstrates full understanding of motion concepts with no misconceptions	Shows good understanding with minor misconceptions	Shows partial understanding; several misconceptions present	Shows little to no understanding of the concepts
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p>Instruct learners to complete the following statements on a sheet of paper: The most important lesson I learned in this unit is _____.</p> <p>I can apply what I learned by _____.</p> <p>I am still unclear about _____.</p> <p>My learning experience would have been improved if _____.</p> <p>Teacher's Reflection</p> <p>Guide teachers to reflect on the lesson using the following prompts:</p> <ul style="list-style-type: none"> • Was the learning objective achieved? What evidence shows that learning has taken place? • What aspects of the lesson went well, and what factors contributed to this success? • What challenges did I encounter during the lesson, and how did I address them? • In what ways can I improve my teaching strategies to better support learners' understanding? 					
VII. USE OF GENERATIVE AI	<p>In preparing this Lesson Exemplar (LE), the author(s) used ChatGPT to generate ideas for activities and efficiently look for articles, videos, and other online sources used herein. AI-generated images and activities were reviewed for scientific accuracy, accessibility, and copyright/usage suitability. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>					

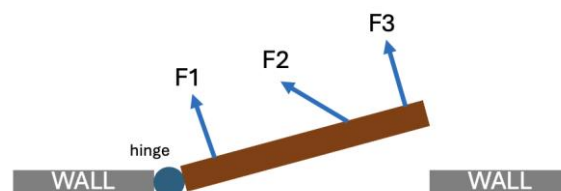
Learning Area	PHYSICS 1	Lesson Exemplar	17
----------------------	-----------	------------------------	----

I. OBJECTIVES	
A. Content Standard	<i>Rotational mechanics can maximize efficiency in physical systems</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>Explain various phenomena involving rotational motion using the concepts of torque, moment of inertia, and angular momentum.</i>
II. REFERENCES and MATERIALS (<i>Selecting Resources and Material</i>)	<p>Department of Education (DepEd), Philippines. 2016. <i>Strengthened Senior High School Curriculum: Physics 1 (Grade 11)</i>. Pasig City: Department of Education.</p> <p>Khan Academy. "Torque and Equilibrium Review." <i>Khan Academy Physics</i>. Accessed May 10, 2026. https://www.khanacademy.org/science/physics/torque-equilibrium</p> <p>OpenStax. "10.5 Calculating Moments of Inertia." <i>University Physics Volume 1</i>. Accessed May 10, 2026. https://openstax.org/books/university-physics-volume-1/pages/10-5-calculating-moments-of-inertia</p> <p>OpenStax. "11.3 Conservation of Angular Momentum." <i>University Physics Volume 1</i>. Accessed May 10, 2026. https://openstax.org/books/university-physics-volume-1/pages/11-3-conservation-of-angular-momentum</p> <p>Silverio, Angelina A., and John Donnie A. Ramos. 2017. <i>Exploring Life Through Science: General Physics 1</i>. Quezon City: Phoenix Publishing House.</p> <p>Young, David P., and Shane Stadler. 2018. <i>Cutnell & Johnson Physics</i>. 11th ed. Hoboken, NJ: John Wiley & Sons.</p>
III. CONTENT (<i>Sequencing Content</i>)	<i>ROTATIONAL MECHANICS</i>
IV. OBJECTIVES (<i>Setting Clear Objectives and Analyzing the</i>	<ol style="list-style-type: none"> 1. State how torque affects rotational motion using real-life situations such as opening a door, using a wrench, and a seesaw. 2. Describe and apply how mass distribution affects the moment of inertia of rotational systems such as wagon wheels and batons.

Tasks)	<p>3. Explain various phenomena such as a spinning ice skater, rotating chair experiment, and a diver performing a somersault using the conservation of angular momentum</p> <p>4. Solve real-life rotational systems problems involving torque, moment of inertia, and angular momentum.</p>
<p>IV. PROCEDURES</p> <p><i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i></p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p>(Each part shall have 2-3 varied activities)</p>	<p>ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>
<p>A. Activating Prior Knowledge</p>	<div> <p>1. Activating Prior Knowledge</p> <p>OPTION 1: Agree or Disagree Statements</p> <ol style="list-style-type: none"> 1. A heavier object always spins slower than a lighter object. 2. The location where you apply force does not matter in rotation. 3. Objects spin faster when their mass is closer to the center. 4. A longer handle makes it easier to turn or rotate an object. 5. An object can change its spinning speed even without external force. <p>OPTION 2: Water Flip Bottle</p> <p>A. Prepare the Bottles The teacher will set up two identical bottles with different water levels.</p> <ul style="list-style-type: none"> • One bottle filled completely with water • One bottle filled to about one-third • Ensure bottles are identical in size and material </div> <div> <p>IDF RELEVANCE for Activating Prior Knowledge</p> <p>Options: This activity follows the IDF by using real-life rotational situations to activate prior knowledge, encourage student sharing, and surface misconceptions. Through guiding questions and inquiry, learners connect everyday experiences to basic physics concepts like force, torque, and lever arms. By moving from observation to analysis, the activity promotes critical thinking and scientific literacy, serving as a bridge from intuitive ideas to formal understanding of rotational motion.</p> <p>Notes to Teacher for OPTION 1: Ask the guiding questions one at a time and let students share their ideas and experiences. Encourage participation and accept all responses. Ask follow-up questions to deepen thinking, then connect their answers to basic ideas of force and motion. For Option 2, this is related to mass</p> </div>

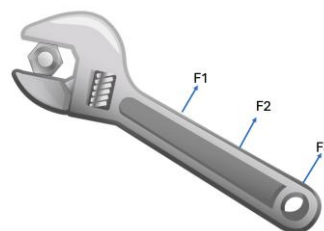
	<p>B. Conduct the Flip Trials Have a student volunteer flip each bottle three times.</p> <ul style="list-style-type: none">• Flip the full bottle three times• Flip the one-third full bottle three times• Observe which lands upright more easily <p>C. Guide Questions:</p> <p>1. Which bottle was easier to land upright? Why do you think that happened?</p> <p>2. Notice how the water moves inside the bottle. How does this affect the bottle’s stability when rotating?</p> <p>The teacher will say: Today, we’ll explain this using the concepts of torque, moment of inertia, and angular momentum, the same ideas that apply to doors, wrenches, see-saws, skaters, and divers.</p> <p>OPTION 3: PICTURE ANALYSIS - Torque and Turning Effects Instructions for Learners:</p> <ul style="list-style-type: none">• Carefully examine each diagram (A, B, and C).• For each system, analyze the forces shown and determine which force application produces the greatest turning effect (torque).• Answer the guiding question provided for each diagram.• Support your answers with reasoning based on the concepts of torque, lever arm, and line of action of force. <table><tr><td>A</td><td><p>Which line of action will create greater torque?</p></td></tr></table>	A	<p>Which line of action will create greater torque?</p> 	<p>distribution. When mass is spread out differently, the moment of inertia changes. A full bottle has more mass farther from the axis, making it harder to stabilize.</p> <p>Expected Answers for Option 1:</p> <p>1. Disagree. (Speed depends on mass distribution, not just mass)</p> <p>2. Disagree. (Distance from the pivot affects torque.)</p> <p>3. Agree. (Smaller moment of inertia means faster rotation, if angular momentum is conserved)</p> <p>4. Agree. (Longer lever arm means greater torque.)</p> <p>5. Agree. It can change speed by changing shapes (moment of inertia), while angular momentum stays constant.</p> <p>Notes to Teacher for OPTION 2:</p> <ul style="list-style-type: none">• Bottle flip stability depends on mass distribution, rotation, fluid motion, and energy loss.• Observation outcome: The one-third full bottle usually lands upright more easily because the moving water lowers the center of mass and reduces rotational energy during the flip.• Highlight energy loss: The water absorbs some rotational energy, helping the bottle land upright.• Use this activity only to spark curiosity before discussing torque, moment of inertia, and angular momentum formally. <p>Notes to Teacher for OPTION 3: For this activity, the teacher should emphasize that its purpose is to help learners understand how torque works in everyday situations. Guide students to study each diagram carefully and ask which force creates the greatest turning effect. Highlight that torque depends on the size of the force, the distance</p>
A	<p>Which line of action will create greater torque?</p> 			

Which position of the line of force will create a better turning effect?



B

Which position of the force applied will give a better turning effect to the wrench?



C.

2. Establishing the Purpose of the Lesson

Transitioning from the initial exploration, the teacher will inform learners that the lesson will focus on explaining real-life phenomena involving rotational motion using the concepts of torque, moment of inertia, and angular momentum. Learners will explore how these concepts influence how objects start to rotate, resist changes in rotation, and maintain or change their motion in various situations such as opening doors, spinning objects, and rotating systems.

from the axis, and the angle of application. Address the misconception that a larger force always produces greater torque. Use examples like steering wheels, levers, and wrenches to connect the lesson to real-life situations and prepare learners for deeper discussions of moment of inertia and angular momentum.

Expected Answers for Option 3: Diagram A – Steering Wheel
(counterclockwise rotation)

Answer: F1

Explanation: Torque is greatest when the force is applied perpendicular (90°) to the radius. F1 is perpendicular to the wheel, so it creates the strongest turning effect. F2 and F3 are not perpendicular, so they produce less torque.

Diagram B – Lever Hinged to a Wall
Answer: F3

Explanation: The farther the force is from the hinge, the greater the torque. Since F3 is applied at the far end, it creates the strongest turning effect.

Diagram C – Wrench

Answer: F3

Explanation: Applying force at the end of the wrench increases the lever arm and produces greater torque. This is why mechanics push at the end of the wrench handle.

IDF RELEVANCE for Establishing the Purpose of the Lesson

Both activities strengthen the lesson alignment with the Inquiry–Discovery–Feedback (IDF) framework. Option 1 uses familiar experiences and multimedia to connect everyday actions to rotational motion, guiding learners through inquiry questions that surface the lesson's focus and relevance. Option

	<p>OPTION 1: Rotational Dynamics in Everyday Life Collage Present a short multimedia collage (images or 30-second video clips) showing everyday situations such as:</p> <ul style="list-style-type: none"> • A door opening • A wrench turning a bolt • A skater spinning • A diver performing a somersault <p>After viewing, instruct students to work in pairs.</p> <p>Guide Question: Identify the common physics idea in all clips. What do these situations have in common, and what do you think our lesson will focus on today?</p> <p>Conclude by showing that these principles are used in engineering (machine design), automotive servicing (using wrenches and bolts), ride safety (roller coasters and amusement rides), sports science (skating and diving), and product design (tools and equipment).</p> <p>OPTION 2: Rotational Dynamics Question Wall</p> <ul style="list-style-type: none"> • The teacher will write or project the three key terms on the board: Torque, Moment of Inertia, Angular Momentum, and give each student one sticky note. • Say: “Think of one real-life situation that involves spinning, turning, or rotating. Write a question about it on your sticky note that asks <i>how</i> or <i>why</i> the motion happens. • Example: “Why is it harder to pedal a bike uphill than on flat ground?” • Students place their sticky notes under the term they think it relates to. • Read a few aloud and briefly connect them to the lesson objectives. • Emphasize that their questions are like real problems in manufacturing (balancing rotating parts), 	<p>2 promotes active learning by having students generate and organize their own questions, linking their ideas to torque, moment of inertia, and angular momentum. Together, these approaches make the lesson meaningful, engaging, and connected to real-world applications.</p> <p>Notes to Teacher for Option 1:</p> <ul style="list-style-type: none"> • Keep clips short (30 seconds max) to maintain focus. • Multimedia links: <ul style="list-style-type: none"> ○ A door opening https://tinyurl.com/2b2pd598 ○ A wrench turning a bolt https://tinyurl.com/3b3cne5y ○ A skater spinning https://www.youtube.com/shorts/VmeM0BNnGR0 ○ A diver performing a somersault https://www.youtube.com/shorts/EBtIqhGvPa4 • Allow pair discussions before whole-class sharing to encourage participation. • Validate multiple answers to the guide question, then synthesize toward torque, moment of inertia, and angular momentum. • Use this as a bridge: “These everyday motions are what rotational dynamics help us explain.” <p>Notes to Teacher for Option 2</p> <ul style="list-style-type: none"> • Provide clear examples of good questions to guide learners. • Remind students to connect their question to something rotating, spinning, or turning. • Read aloud a mix of simple and complex questions to show that all contributions are valued.
--	---	--

	engineering (safe structures), sports science (athlete spins), automotive servicing (wheel torque), and ride safety (stable rotations in rides).	<ul style="list-style-type: none"> Explicitly link student questions to the objectives: “We’ll answer these by exploring torque, moment of inertia, and angular momentum.”
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>OPTION 1: Activity: Try It Yourself Stations (3–5 mins each) Students will rotate in small groups through different learning stations. Clearly state the task at every station, so students stay focused, understand the purpose, and connect their hands-on activities to the lesson's concepts.</p> <p>Station 1: Door Push (Torque Exploration)</p> <ul style="list-style-type: none"> Students push a door near the hinge and then at the handle, applying approximately the same amount of force. Task: Compare the effort required to move the door in each case. Guide Questions: <ol style="list-style-type: none"> Which position makes the door easier to open? How does the distance from the hinge affect the motion? <p>Station 2: Rotating Chair (Angular Motion Exploration)</p> <ul style="list-style-type: none"> A student sits on a rotating chair and spins slowly with arms extended, then pulls their arms inward. Task: Observe and describe the change in rotational motion. Guide Questions: <ol style="list-style-type: none"> What happens to the speed of rotation when the arms are pulled in? What might explain this change? <p>Station 3: Human Balance Beam (Torque and Lever Arm Exploration)</p> <ul style="list-style-type: none"> Students stand and extend both arms sideways. Place equal objects (e.g., books or notebooks) on each hand. 	<p>IDF Relevance for Presenting Examples: These activities use constructivist and inquiry-based learning by engaging students in hands-on exploration and real-life scenarios. Learners connect everyday experiences (doors, batons, rotating chairs, balance beams) to abstract physics concepts, promoting curiosity and understanding. Both options encourage active participation, observation, and analysis, helping students see the relevance of torque, moment of inertia, and angular momentum before formal discussion.</p> <p>Notes for Teacher: Option 1: Try It Yourself Stations</p> <ul style="list-style-type: none"> Organize stations clearly and set time limits (3–5 minutes each) to keep rotations smooth. Provide guiding questions at each station to focus on observations. Circulate prompt deeper thinking and ensure safety (especially with the rotating chair). After rotations, facilitate a short synthesis discussion linking all stations to the three key concepts. <p>Option 2: Example Sets (Door, Baton, Chair)</p> <ul style="list-style-type: none"> Prepare props in advance (textbook, batons, swivel chair with weights) for smooth flow. Use real-life links (e.g., bus vs. Formula 1 steering wheel) to make concepts relatable. Encourage students to verbalize their observations before introducing formulas. Highlight the physics insight after each example to reinforce the connection between everyday phenomena and rotational dynamics.

	<ul style="list-style-type: none"> • Move one object closer to the shoulder while keeping the other extended. • Task: Compare the difficulty of maintaining balance and relate it to how mass distribution affects rotational resistance. <ul style="list-style-type: none"> a. Guide Questions: Which side feels heavier or more difficult to support? b. What happens when the object is farther from the body? <p>OPTION 2: Before starting, tell students: “You will do short activities showing rotational dynamics in real life. At each station, follow the scenario, observe what happens, and answer the questions. Focus on the physics behind the motion and how it applies to engineering, automotive servicing, ride safety, sports science, manufacturing, and product design.”</p> <p>Example Set 1: Torque & The "Heavy" Door</p> <ul style="list-style-type: none"> • The Scenario: Place a heavy textbook on the floor and try to flip it open by pushing the spine/hinge versus pushing at the edge of the cover. • The Analysis: Even though the <i>Force</i> applied is the same, the <i>Turning Effect</i> is vastly different. • Real-Life Link: Show a photo of a Bus Steering Wheel vs. a Formula 1 Steering Wheel. <ul style="list-style-type: none"> a. <i>Question:</i> Why is a bus steering wheel so much larger in diameter? b. <i>Physics Insight:</i> A larger radius (r) allows a driver to exert the same torque with much less effort (F). <p>Example Set 2: The "Baton" Race The Scenario: Present two batons of equal length and equal mass.</p> <ul style="list-style-type: none"> a. Baton A has two weights fixed at the very end. b. Baton B has the same two weights fixed near the center. 	<p>Safety controls: Use a stable chair made for safe rotation. Keep spins slow and controlled (no fast spinning). The student must stay seated at all times. Do not allow sudden release of weights or objects. The teacher must supervise throughout the course. If it is unsafe, use a video demonstration instead.</p> <p>For a smooth transition from Presenting Examples to the Discussing New Concept: The teacher will say: “From the examples we just explored, you noticed how torque, moment of inertia, and angular momentum appear in everyday situations. Let’s now connect your observations to the formal physics concepts behind them. Using your answers as our springboard, we’ll move into discussing the new lesson ideas more deeply.”</p> <p>IDF Relevance: This part of the lesson applies guided inquiry and explicit instruction. Learners first explore phenomena through observation, discussion, and sharing, which builds curiosity and allows them to construct initial ideas. The teacher then connects these ideas to formal physics principles, ensuring that students transition from everyday experiences to scientific understanding. Finally, explicit teaching provides clear definitions, formulas, and worked examples, reinforcing conceptual accuracy and linking theory to practice.</p>
--	--	---

- **The Phenomenon:** Ask two students to try and rotate (twirl) the batons back and forth rapidly. The student with Baton A will struggle significantly more.
- **The Analysis:** Even though they weigh the same (m), their **Moment of Inertia (I)** is different because the mass distribution (r^2) is different.
 - a. *Equation Check:* Show how $I = \sum mr^2$ explains why the "far-out" weights resist change in motion more than the "centered" weights.

Example Set 3: The Rotating Chair & The "Frictionless" Turn

The Scenario: A student sits on a swivel chair, holding two heavy dumbbells. They are given a small initial spin with their arms extended. When they pull their arms in, they speed up drastically.

- **The Phenomenon:** Nothing pushed them to go faster. Where did the extra speed come from?
- **The Analysis:** Introduce the **Conservation of Angular Momentum ($L = I\omega$)**.
 - a. *Logic:* Because the system is closed (no external torque), L must stay the same. If I drops (mass moves inward), ω (angular velocity) **must** increase to compensate.

2. Discussing New Concept

Guided Exploration:

Step 1: Observe and Discuss (Pair/Group Work)

The teacher shows a video of a spinning skater.

In pairs or small groups, learners discuss and record their ideas:

- How did the skater start spinning motion?
- What changes happen when the skater pulls the arms inward?



Notes for Teacher:

Torque

- Emphasize that torque is the *turning effect* of a force, not just the force itself.
- Use simple props (door, wrench, see-saw) to demonstrate how lever arm length changes the ease of rotation.
- Reinforce the sign convention (positive for counterclockwise, negative for clockwise) with clear board diagrams.
- When solving problems, highlight the importance of units (N·m) and balancing torques for equilibrium.

Notes for Teacher:

Moment of Inertia

- Stress in that moment of inertia depends on *mass distribution*, not just total mass.
- Use contrasting examples (weights at the ends vs. weights near the center) to make the concept tangible.
- Show how different formulas apply to different shapes but always connect back to the idea: mass farther from the axis increases rotational resistance.
- Encourage learners to interpret computed values (e.g., "240 kg·m² means the merry-go-round resists spinning more than a lighter or smaller one").

Notes for Teacher:

Angular Momentum

- Clarify that angular momentum is the rotational counterpart of linear momentum.

	<ul style="list-style-type: none"> • How does the speed of spinning change during the motion? What do you think causes change in speed? <p>Step 2: Share Ideas (Rapid Fire Reporting) Each group shares ONE idea only per turn. Rules:</p> <ul style="list-style-type: none"> • Keep answers short (1 sentence only) • No repetition of previous answers • Teacher calls groups randomly <p>Example prompts:</p> <ul style="list-style-type: none"> • “Group 1, how did the spin start?” • “Group 3, what changed when the arms were pulled in?” <p>As groups share, the teacher organizes responses on the board under:</p> <ul style="list-style-type: none"> • Start of motion • Body position change • Change in speed <p>Step 3: Connect Ideas (Teacher Guidance) Now guide them to the concepts:</p> <ul style="list-style-type: none"> • <i>Pushing on the ice helps start rotation → (Torque)</i> • <i>Body position affects how easy or hard it is to spin → (Moment of Inertia)</i> • <i>Spinning faster without pushing shows something is conserved → (Angular Momentum)</i> <p>EXPLICIT TEACHING At this stage, the teacher will explicitly teach the key concepts of rotational motion. Present clear explanations of torque, moment of inertia, and angular momentum, using simple definitions, equations, and real-life examples.</p> <p>Definition of Torque A. Torque (τ) Torque is the turning effect produced when a force acts on a lever arm. It is calculated as the cross product of the force magnitude and the distance r from the axis:</p>	<ul style="list-style-type: none"> • Use the skater or rotating chair example to illustrate conservation: when I decreases, ω increases. • Emphasize the condition: conservation holds only if <i>no external torque</i> acts on the system. • Guide learners through sample problems step-by-step, showing how initial and final values balance to keep L constant. • Connect to real-life contexts (divers tucking, athletes spinning, planets orbiting) to reinforce relevance. • Highlight the law: Angular momentum is conserved unless an external torque acts. • Summarize: “Mass distribution changes the moment of inertia, and conservation of angular momentum explains why speed changes when body position changes.” <p>IDF Relevance: This option emphasizes application of concepts through structured problem solving and analysis. Learners move beyond observation into computation, applying formulas for torque, moment of inertia, and angular momentum to real-life systems. The design follows an experiential-to-analytical progression, reinforcing mastery by requiring step-by-step solutions, interpretation of results, and explicit statements about conservation laws and mass distribution.</p> <p>Notes for Teacher:</p> <p>For Option 1: Torque Problems</p> <ul style="list-style-type: none"> • Remind learners that torque depends on both force magnitude and lever arm length (and angle if not perpendicular).
--	--	--

$$|\vec{\tau}| = |\vec{F} \times \vec{r}| = F r \sin \theta$$

Where:

- **Force (F)** – applied force, in newtons (N)
- **Distance (r)** - distance from axis of rotation to the point where force is applied, in meters (m)
- **θ** = Angle between the force vector and the lever arm

Torque can also be expressed using the lever arm. The lever arm is the perpendicular distance from the axis of rotation to the line of action of the force. A longer lever arm increases torque even if the force is unchanged. In this form, the equation is written as:

$$\tau = F \cdot l$$

where l is the perpendicular distance from the axis of rotation to the line of action of the force. This lever arm version connects directly to the general torque equation: $\tau = F \cdot r \cdot \sin \theta$ because the lever arm is defined as $l = r \cdot \sin \theta$. In other words, using the lever arm is simply a more direct way of measuring the effective distance that produces rotation.

Direction of Torque

- Torque is considered positive if the applied force causes a counter-clockwise rotation about the axis.
- Torque is considered negative if the applied force causes a clockwise rotation about the axis.

SI Unit of Torque:

The unit of torque in the International System (SI) is the newton-meter (N·m).

Understanding the Lever Arm

The diagram illustrates two key ideas: the **line of action** and the **lever arm**.

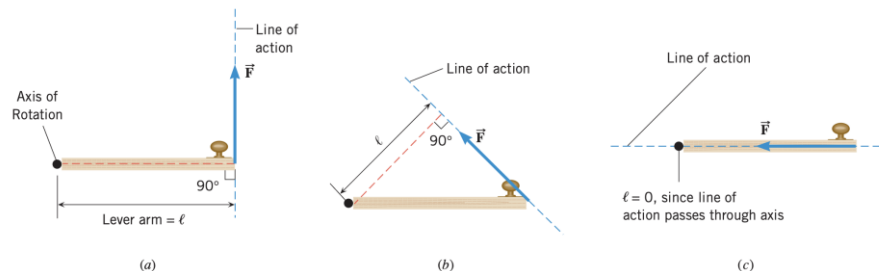
- The **line of action** is an imaginary straight line drawn along the direction of the applied force.
- The **lever arm** is the **perpendicular distance** between this line of action and the axis of rotation.

- Emphasize unit consistency: torque is expressed in N·m.
- For angled forces, guide students to use the perpendicular component: $\tau = F \cdot r \cdot \sin \theta$.
- Encourage learners to check whether torque is clockwise or counterclockwise when solving equilibrium problems.

Moment of Inertia Problems

- Reinforce that mass distribution affects rotational resistance, not just total mass.
- Use the diver example to highlight how pulling into a tuck decreases I , making rotation faster.
- Ask students to verbalize the physical meaning of their answers (e.g., “The diver spins faster because mass is closer to the axis”).
- Connect calculations back to real-life contexts like batons, wheels, or playground rides.

- The torque (τ) depends on both the size of the force and the length of this lever arm.



Sample Problem:

A child weighing 300 N sits 1.5 meters from the pivot of a see-saw. What torque does the child produce about the pivot?

Given: Force (F) = 300 N

radius (r) = 1.5 meters

Required: Torque (τ) = ?

Formula: $\tau = r F$

Solution: $\tau = 1.5 \text{ m} \cdot 300 \text{ N} = 450 \text{ N}\cdot\text{m}$

Another child weighing 400 N sits on the opposite side of the pivot. At what distance from the pivot should the second child sit to balance the see-saw?

Solution: For balance, the clockwise and counterclockwise torques must be equal:

$$\begin{aligned}\tau_1 &= \tau_2 \\ F_1 \cdot l_1 &= F_2 \cdot l_2 \\ 300 \text{ N} \times 1.5 \text{ m} &= 400 \text{ N} \times l_2 \\ 450 \text{ N}\cdot\text{m} &= 400 \text{ N} \times l_2 \\ l_2 &= \frac{450 \text{ N}\cdot\text{m}}{400 \text{ N}} = 1.125 \text{ m}\end{aligned}$$

Answer: The second child must sit 1.125 m from the pivot to balance the see-saw.

B. Moment of Inertia (I):

Moment of Inertia (I) is the measure of a rigid body's resistance to changes in its rotational motion. It is also known as rotational mass.

Moment of Inertia Problems

- Reinforce that mass distribution affects rotational resistance, not just total mass.
- Use the diver example to highlight how pulling into a tuck decreases I , making rotation faster.
- Ask students to verbalize the physical meaning of their answers (e.g., "The diver spins faster because mass is closer to the axis").
- Connect calculations back to real-life contexts like batons, wheels, or playground rides.

Angular Momentum Problems

- Stress the Law of Conservation of Angular Momentum: $L = I \cdot \omega$ remains constant if no external torque acts.
- Guide learners to compare initial and final states (before and after mass distribution changes).
- Use the rotating chair and diver examples to make the principle tangible.
- Clarify misconceptions: dropping weights removes them from the system, so the person's speed does not change because the angular momentum of the remaining system is conserved.

Suggested Answers for Developing Mastery Option 1:

a. $\tau = F \cdot r = 50 \text{ N} \cdot 0.4 \text{ m} = \mathbf{20 \text{ Nm}}$

b. When a diver changes from a straight position to a tight tuck, the moment of inertia decreases because the body mass moves closer to the axis of rotation. As the moment of inertia becomes smaller, the diver spins faster to conserve angular momentum.

c. $\tau = F \cdot r \sin \theta = 50 \text{ N} \cdot 0.25 \text{ m} (\sin 30^\circ)$

$\tau = \mathbf{6.25 \text{ Nm}}$

For a point mass, it is defined as the product of the mass (m) and the square of its perpendicular distance (r) from the axis of rotation:

$$I = mr^2$$

(S.I. Unit: kg m^2)

Moment of Inertia Equations for Common Systems

Use these formulas depending on the object's shape and axis of rotation. Notice how mass farther from the axis increases the moment of inertia.

Object/System	Equation	Meaning of the variables in the equation	Description
Point Mass/ Hollow Ring with symmetry axis	$I = mr^2$	m: mass of the particle or ring r: distance from the axis of rotation	Shows directly how increasing r (distance from axis) increases I .
System of objects	$I_s = \sum mr^2$	$\sum$: sum of all parts m: mass of each individual object r: distance of each object from the pivot	Useful for real-life cases like wheels with spokes, batons, or bottles with water at different levels.
Solid Cylinder / Disk	$I = \frac{1}{2}mr^2$	m: mass of the cylinder or disk	Real-life example: wheels, rolling cans.

d. When a diver curls into a ball, their moment of inertia is cut in half. Because angular momentum must stay the same when no external torque acts, the angular velocity doubles. In short, halving inertia makes the diver spin twice as fast.

e. When the weights are dropped, they leave the system, but no external torque is applied to the person-chair setup. This means the angular momentum of the system is conserved, so the rotational speed of the chair does not change. In short, the speed stays the same because dropping the weights does not create torque.

Notes For Option 2:

Activity 1: Net Torque Analysis

- Remind learners that torque depends on both force magnitude, lever arm length, and angle.
- Guide them to resolve angled forces into perpendicular components using $\tau = F \cdot r \cdot \sin \theta$.
- Encourage clear step-by-step solutions: list each torque, indicate direction (clockwise/counterclockwise), then sum for net torque.
- Ask students to interpret the final sign (positive/negative) as the rotational direction.

		r: distance from the axis of rotation	
Rod (axis at the center)	$I_{center} = \frac{1}{12}mL$	m: Total mass of the rod	Demonstrates how distribution along the length affects I.
Rod (axis at the end)	$I_{end} = \frac{1}{3}mL^2$	L: Total length of the rod	Shows how shifting the axis changes I.

Sample Problem:

A playground merry-go-round can be modeled as a solid disk of mass 120 kg and radius 2 m. What is the moment of inertia of the merry-go-round about its central axis?

Given: mass (m) = 120 kg
radius (r) = 2 m

Required:

Formula for a solid disk: $I = \frac{1}{2}mr^2$

Solution:

$$I = \frac{1}{2} (120 \text{ kg})(2 \text{ m})^2$$

$$I = \frac{1}{2} (120 \text{ kg})(4 \text{ m}^2) = 240 \text{ kg m}^2$$

Answer: The moment of inertia of the merry-go-round is 240 kg·m². The computed value, 240 kg·m², tells us the rotational “resistance” of the merry-go-round. A bigger radius or more mass would increase this value, making it harder to spin.

C. Angular Momentum (L):

Definition: Angular momentum is the rotational analog of linear momentum, representing the product of an object's moment of inertia (I) and its angular velocity (ω). In equation:

$$L = I\omega$$

where: L: angular momentum.
I: moment of inertia

ω: angular velocity

Activity 2: Angular Momentum of a Rotating Disk

- Reinforce the law of conservation of angular momentum: $L = I\omega$ remains constant if no external torque acts.
- Highlight the difference between initial and final inertia when mass is added to the system.
- Emphasize the physical meaning: when the child jumps on, the system's inertia increases, so angular velocity decreases to conserve L.
- Ask learners to explain results in words, not just numbers (e.g., “The merry-go-round slows down because mass moved outward”).

	<p>Law of Conservation: Angular momentum is conserved only when net external torque is zero. If no external torque acts on a system, its angular momentum remains constant. Mathematically: $L_f = L_i$ then , $I_f \omega_f = I_i \omega_i$.</p> <p>where:</p> <p>$L_i$ = initial angular momentum before any change L_f = final angular momentum after the change. I = moment of inertia (depends on how mass is distributed relative to the axis). ω = angular velocity (how fast the object spins).</p> <p>Since L must stay constant (if no external torque acts), any change in I must be balanced by a change in ω.</p> <ul style="list-style-type: none"> • If mass moves closer to the axis $\rightarrow I$ decreases $\rightarrow \omega$ increases $\rightarrow$ spin gets faster. • If mass moves farther from the axis $\rightarrow I$ increases $\rightarrow \omega$ decreases $\rightarrow$ spin slows down. <p>Sample Problem:</p> <p>A skater spins with arms stretched out. Her moment of inertia is $5 \text{ kg}\cdot\text{m}^2$ and her angular velocity is 2 rad/s. She then pulls her arms in, reducing her moment of inertia to $2 \text{ kg}\cdot\text{m}^2$. What is her new angular velocity after pulling her arms in, assuming no external torque acts?</p> <p>Given: moment of inertia (I) = $5 \text{ kg}\cdot\text{m}^2$ Angular velocity (ω) = 2 rad/s Required: final angular velocity (ω_f) = ?</p> <p>Solution:</p> $L_f = L_i$ $I_f \omega_f = I_i \omega_i$ <p>Substitute values:</p> $(5 \text{ kg}\cdot\text{m}^2)(2 \text{ rad/s}) = (2 \text{ kg}\cdot\text{m}^2)(\omega_f)$ $10 \text{ kg}\cdot\text{m}^2/\text{s} = (2 \text{ kg}\cdot\text{m}^2)(\omega_f)$ $\omega_f = \frac{10 \text{ kg}\cdot\text{m}^2/\text{s}}{2 \text{ kg}\cdot\text{m}^2}$ $\omega_f = 5 \text{ rad/s}$ <p>Answer: The skater's new angular velocity is 5 rad/s. She spins faster because pulling her arms in decreases her</p>	<p>Activity 3: Moment of Inertia of a Wagon Wheel</p> <ul style="list-style-type: none"> • Guide learners to compute inertia by summing contributions from spokes and rim separately. • Stress the principle: mass farther from the axis increases inertia. • Use the “mass transfer” question to reinforce conceptual understanding — moving mass from spokes to rim makes the wheel harder to spin. • Encourage justification in both mathematical terms ($I = \Sigma mr^2$) and conceptual terms (distribution effect).
--	---	--

moment of inertia, and to conserve angular momentum, her spin speed must increase.

3. Developing Mastery

OPTION 1:

Problem Solving / Concept Check:

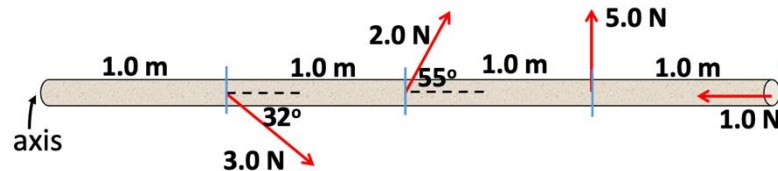
- A mechanic applies a 50 N force perpendicular to a 0.4 m wrench. What is the torque?
- A diver goes from a straight "pencil" position into a tight "tuck." What happens to their Moment of Inertia? What happens to their rotational speed?
- Calculate the torque required to loosen a bolt if you apply 50 N at a 30° angle on a 0.25 m wrench.
- If a diver curls into a ball, reducing their moment of inertia by half, what happens to their angular velocity?
- If you are sitting on a frictionless rotating chair holding weights and you drop them, does your speed change? Why or why not?

OPTION 2:

Activity 1: Net Torque Analysis of a Non-Uniform System

Learners will analyze the rigid rod system shown in the diagram. Forces act at different points and angles along the rod, with the axis fixed at the left end.

Instruction: Determine the magnitude and direction of the resultant torque acting on a rigid rod about a fixed axis.



Solution Guide:**Step 1: Recall the torque formula**

$$\tau = F \cdot r \cdot \sin \theta$$

- F = force magnitude
- r = distance from axis (lever arm)
- θ = angle between force and rod

Positive torque $\rightarrow$ counterclockwise (CCW) Negative torque $\rightarrow$ clockwise (CW)

Step 2: Compute each torque.

1. At 1.0 m, 3.0 N at 32° S of E

$$\tau = (3.0 \text{ N})(1.0 \text{ m}) \sin 32^\circ = 1.59 \text{ Nm (CW)}$$

2. At 2.0 m, 2.0 N at 55° S of E

$$\tau = (2.0 \text{ N})(2.0 \text{ m}) \sin 55^\circ = 3.28 \text{ Nm (CCW)}$$

3. At 3.0 m, 5.0 N upward

$$\tau = (5.0 \text{ N})(3.0 \text{ m}) \sin 90^\circ = 15.0 \text{ Nm (CCW)}$$

4. At 4.0 m, 1.0 N left

$$\tau = (5.0 \text{ N})(3.0 \text{ m}) \sin 0^\circ = 0 \text{ Nm}$$

Step 3: Compute for the net torque. Assign the + or - according to the direction.

$$\tau_{\text{net}} = (-1.59 \text{ Nm}) + (3.28 \text{ Nm}) + (15.0 \text{ Nm}) + (0 \text{ Nm})$$

$$\tau_{\text{net}} = \mathbf{16.7 \text{ Nm (CCW)}}$$

Final Answer:

The resultant torque is about **16.7 N·m counterclockwise**.

Activity 2: Angular Momentum of a Rotating Disk

Learners will apply the concept of angular momentum and the law of conservation of angular momentum to a rotating system.

Problem: A playground merry-go-round is modeled as a solid disk of mass 120 kg and radius 2.0 m. It rotates at an angular velocity of 3 rad/s. A child of mass 30 kg runs and jumps onto the edge of the disk, sticking to it.

- Compute the initial angular momentum of the merry-go-round.
- Compute the new angular velocity of the system after the child jumps on.

- State whether angular momentum is conserved and explain briefly.

Solution Guide:

- Formula for disk moment of inertia:

$$I_{\text{disk}} = \frac{1}{2} mr^2$$

- Initial inertia of disk:

$$I_{\text{disk}} = \frac{1}{2} (120 \text{ kg})(2.0 \text{ m})^2 = 240 \text{ kg} \cdot \text{m}^2$$

- Initial angular momentum:

$$L_i = I_{\text{disk}} \cdot \omega = (240 \text{ kg} \cdot \text{m}^2)(3 \text{ rad/s}) = 720 \text{ kg} \cdot \text{m}^2/\text{s}$$

- Child's inertia (point mass at edge):

$$I_{\text{child}} = mr^2 = (30 \text{ kg})(2.0 \text{ m})^2 = 120 \text{ kg} \cdot \text{m}^2$$

- Total final inertia:

$$I_f = I_{\text{disk}} + I_{\text{child}} = 240 + 120 = 360 \text{ kg} \cdot \text{m}^2$$

- Conservation:

$$L_f = L_i = 720 \text{ kg} \cdot \text{m}^2/\text{s}$$

- Final angular velocity:

$$\omega_f = \frac{L_f}{I_f} = \frac{720 \text{ kg} \cdot \text{m}^2/\text{s}}{360 \text{ kg} \cdot \text{m}^2} = 2 \text{ rad/s}$$

Answer: The new angular velocity of the system is 2 rad/s.

Explanation: Angular momentum is conserved. When the child jumps on, the system moment of inertia increases, so the merry-go-round slows down to keep total angular momentum constant.

Activity 3: Moment of Inertia

What is the moment of inertia of a wagon wheel with 8 spokes, each length is 0.5 m and mass 0.75 kg and a rim of 2.8 kg?



If the engineers moved 0.5 kg of mass from the spokes to the rim, would the wheel become easier or harder to start spinning? Justify your answer using the concept of mass distribution.

Solution Guide:**A. Moment of Inertia of the Wagon Wheel**

The wheel has 8 spokes and a rim.

- **Spokes:** Each spoke is like a slender rod of length $L=0.5$ m and mass $m=0.75$ kg, rotating about one end.

$$I_{\text{spoke}} = \frac{1}{3}mL^2$$

$$I_{\text{spoke}} = \frac{1}{3}(0.75 \text{ kg})(0.5 \text{ m})^2 = 0.0625 \text{ kg}\cdot\text{m}^2$$

$$\text{For 8 spokes: } I_{\text{spoke}} = 8 \times 0.0625 \text{ kg}\cdot\text{m}^2 = 0.50 \text{ kg}\cdot\text{m}^2$$

- **Rim:** Treated as a thin hoop of radius $r = 0.5$ m and mass $m=2.8$ kg. Formula for a hoop:

$$I_{\text{rim}} = mr^2$$

$$I_{\text{rim}} = (2.8 \text{ kg})(0.5 \text{ m})^2 = 0.70 \text{ kg}\cdot\text{m}^2$$

- **Total Moment of Inertia:**

$$I_{\text{total}} = I_{\text{spoke}} + I_{\text{rim}}$$

$$I_{\text{total}} = 0.50 \text{ kg}\cdot\text{m}^2 + 0.70 \text{ kg}\cdot\text{m}^2 = 1.20 \text{ kg}\cdot\text{m}^2$$

Answer:

The moment of inertia of the wagon wheel is **1.20 kg·m²**.

B. Effect of Moving Mass from Spokes to Rim

If engineers move 0.5 kg of mass from the spokes to the rim:

- The rim's mass increases, so more of the wheel's mass is concentrated farther from the axis.
- Moment of inertia depends on r^2 . Mass farther out increases I .

	<p>◦ A larger I means the wheel resists changes in rotational motion more strongly.</p> <p>Answer: The wheel would become harder to start spinning, because shifting mass outward increases the moment of inertia.</p>									
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Learners will apply their understanding of torque, moment of inertia, and angular momentum to authentic scenarios. This activity transfers classroom knowledge into real-life contexts and scaffolds the upcoming performance task.</p> <p>Rotational Motion in Real Life</p> <p>PART I: The class will be divided into four groups. Each group will be assigned one presentation option through a random draw:</p> <ul style="list-style-type: none">• The teacher will prepare slips of paper with the four options written on them (Interactive Demonstration, Community Awareness Campaign, Simulation Role-Play, Video Explainer).• Each group representative will draw one slip to determine their assigned task. <p>Group Tasks and Expected Outputs</p> <p>A. Option A – Interactive Demonstration</p> <p>Build a simple model (mini seesaw, spinning chair, or bottle-flip setup).</p> <p>Demonstrate how torque, inertia, and angular momentum affect motion.</p> <p>Expected Output: A live demo with short explanations showing the lesson objective in action.</p> <p>Rubric:</p> <table><tr><th>Criteria</th><th>3 pts (Excellent)</th><th>2 pts (Satisfactory)</th><th>1 pt (Needs Improvement)</th></tr><tr><td>Clarity of Explanation</td><td>Explains clearly in short sentences, directly connects to lesson objective</td><td>Explanation partly clear, some connection to concept</td><td>Explanation unclear or off topic</td></tr></table>	Criteria	3 pts (Excellent)	2 pts (Satisfactory)	1 pt (Needs Improvement)	Clarity of Explanation	Explains clearly in short sentences, directly connects to lesson objective	Explanation partly clear, some connection to concept	Explanation unclear or off topic	<p>IDF Relevance:</p> <p>This activity emphasizes authentic application and transfer of learning. By engaging learners in creative tasks such as demonstrations, campaigns, role plays, or video explainers, they connect classroom concepts of torque, moment of inertia, and angular momentum to real-life contexts. It scaffolds the upcoming performance task by encouraging collaboration, communication, and problem-solving, while reinforcing the relevance of rotational dynamics in everyday life and community settings.</p> <p>Notes for Teacher:</p> <p>For this activity, the teacher should ensure smooth facilitation by preparing materials in advance and clearly explaining each group’s assigned task. Emphasize that learners must connect torque, moment of inertia, and angular momentum to real-life contexts through their chosen format (demonstration, campaign, role play, or video). Encourage creativity but maintain scientific accuracy, guiding students to explain why the motion happens, not just show it. Provide time limits to keep outputs concise, remind groups to use simple and clear language for audiences beyond the classroom, and reinforce safety when handling props or demonstrations. Highlight the importance of collaboration and presentation skills, as these outputs scaffold the upcoming performance task and strengthen learners’ ability to transfer classroom knowledge into authentic scenarios.</p>
Criteria	3 pts (Excellent)	2 pts (Satisfactory)	1 pt (Needs Improvement)							
Clarity of Explanation	Explains clearly in short sentences, directly connects to lesson objective	Explanation partly clear, some connection to concept	Explanation unclear or off topic							

	Demonstration Setup	Model is well-prepared, safe, and works as intended	Model is functional but has minor issues	Model incomplete or unsafe
	Concept Connection	Shows how torque, inertia, and angular momentum affect motion	Shows one or two concepts but not all	No clear link to physics concepts
	Engagement	Actively involves peers, keeps attention	Some engagement but limited	Little or no engagement
	Safety	Demonstration follows all safety guidelines	Minor lapses in safety	Unsafe practices observed
	Total Score: 15 points			
	B. Option B – Community Awareness Campaign			
	Design posters or flyers explaining how rotational motion principles keep playgrounds safe.			
	Highlight torque in seesaws, inertia in merry-go-rounds, and angular momentum in swings.			
	Expected Output: A visual product that communicates science concepts to the public.			
	Rubric:			
	Criteria	3 pts (Excellent)	2 pts (Satisfactory)	1 pt (Needs Improvement)
	Clarity of Message	Poster/flyer explains concepts clearly and is easy to understand	Message partly clear, some confusion	Message unclear or difficult to follow
	Visual Appeal	Design is attractive, organized, and engaging	Design is acceptable but lacks impact	Design is messy or unappealing
	Concept Accuracy	Correctly shows torque, inertia, and angular momentum in playground examples	Shows some concepts correctly, minor errors	Concepts missing or inaccurate
	Creativity	Uses creative visuals or ideas to connect science to playground safety	Some creativity shown but limited	Little or no creativity
	Relevance to Audience	Content is age-appropriate and communicates safety effectively	Some relevance but not fully engaging	Not suitable or fails to connect with audience
	Total Score: 15 points			
	Notes for Teacher:			
	<ul style="list-style-type: none">Remind learners that the goal is to connect the three concepts together, not just recall definitions.Encourage concise responses that highlight relationships and real-life applications.Use prompts (exit ticket, engineer's perspective, or concept map) to scaffold generalization in different formats.Guide students to see that torque initiates rotation, moment of inertia governs resistance, and angular momentum explains conservation.Collect outputs for quick formative assessment and highlight common insights during closure to reinforce the “big picture” of rotational motion.			
	Reflection Guide:			
	Rotational Motion in Real Life			
	After completing the group presentation (demo, campaign, role-play, or video), let the students answer the following prompts individually or in pairs:			
	1. Concept Connection			
	a. Which rotational motion concept (torque, moment of inertia, angular momentum) was most visible in your group's activity?			
	b. How did you see it applied in your chosen scenario?			
	2. Learning Transfer			
	a. How does understanding rotational motion help explain everyday phenomena (e.g., playground rides, sports, tools, or vehicles)?			
	b. Give one example outside the classroom where you can apply this knowledge.			

	C. Option C – Simulation Role-Play Act as engineers presenting to the city council. One explains torque, another inertia, another angular momentum, using playground examples. Expected Output: A short skit showing how physics ensures safety and fun. Rubric:	<table><tr><th>Criteria</th><th>3 pts (Excellent)</th><th>2 pts (Satisfactory)</th><th>1 pt (Needs Improvement)</th></tr><tr><td>Clarity of Explanation</td><td>Each engineer explains torque, inertia, and angular momentum clearly with playground examples</td><td>Explanations partly clear, some confusion</td><td>Explanations unclear or off-topic</td></tr><tr><td>Teamwork</td><td>Smooth coordination among presenters, roles well divided</td><td>Some coordination but uneven participation</td><td>Poor coordination, one or two dominate</td></tr><tr><td>Concept Accuracy</td><td>All physics concepts are correct and linked to playground safety</td><td>Most concepts correct, minor errors</td><td>Concepts missing or inaccurate</td></tr><tr><td>Creativity</td><td>Skit is engaging, imaginative, and connects science to real life</td><td>Some creativity shown but limited</td><td>Little or no creativity</td></tr><tr><td>Audience Engagement</td><td>Keeps council (audience) interested and communicates safety effectively</td><td>Some engagement but not consistent</td><td>Fails to engage or connect with audience</td></tr></table>	Criteria	3 pts (Excellent)	2 pts (Satisfactory)	1 pt (Needs Improvement)	Clarity of Explanation	Each engineer explains torque, inertia, and angular momentum clearly with playground examples	Explanations partly clear, some confusion	Explanations unclear or off-topic	Teamwork	Smooth coordination among presenters, roles well divided	Some coordination but uneven participation	Poor coordination, one or two dominate	Concept Accuracy	All physics concepts are correct and linked to playground safety	Most concepts correct, minor errors	Concepts missing or inaccurate	Creativity	Skit is engaging, imaginative, and connects science to real life	Some creativity shown but limited	Little or no creativity	Audience Engagement	Keeps council (audience) interested and communicates safety effectively	Some engagement but not consistent	Fails to engage or connect with audience	<div>3. Collaboration Insight a. What role did you play in your group’s presentation? b. How did teamwork help you understand the concepts better?</div> <div>4. Personal Takeaway a. What is one new insight you gained about rotational motion? b. How will this help you in future science learning or real-life problem solving?</div>
	Criteria	3 pts (Excellent)	2 pts (Satisfactory)	1 pt (Needs Improvement)																							
	Clarity of Explanation	Each engineer explains torque, inertia, and angular momentum clearly with playground examples	Explanations partly clear, some confusion	Explanations unclear or off-topic																							
	Teamwork	Smooth coordination among presenters, roles well divided	Some coordination but uneven participation	Poor coordination, one or two dominate																							
	Concept Accuracy	All physics concepts are correct and linked to playground safety	Most concepts correct, minor errors	Concepts missing or inaccurate																							
	Creativity	Skit is engaging, imaginative, and connects science to real life	Some creativity shown but limited	Little or no creativity																							
	Audience Engagement	Keeps council (audience) interested and communicates safety effectively	Some engagement but not consistent	Fails to engage or connect with audience																							
	D. Option D – Video Explainer Record a 2–3-minute video demonstrating rotational concepts with everyday objects. Expected Output: A creative video that explains the lesson objective clearly and engagingly. Rubric:	<table><tr><th>Criteria</th><th>Excellent (4 pts)</th><th>Proficient (3 pts)</th><th>Developing (2 pts)</th><th>Beginning (1 pt)</th></tr><tr><td><u>Accuracy of Physics Concepts</u></td><td>Correctly explains torque, moment of inertia, and angular momentum</td><td>Mostly correct explanations with minor errors.</td><td>Partial understanding; explanations show gaps or misconceptions.</td><td>Minimal or incorrect explanation of concepts.</td></tr></table>	Criteria	Excellent (4 pts)	Proficient (3 pts)	Developing (2 pts)	Beginning (1 pt)	<u>Accuracy of Physics Concepts</u>	Correctly explains torque, moment of inertia, and angular momentum	Mostly correct explanations with minor errors.	Partial understanding; explanations show gaps or misconceptions.	Minimal or incorrect explanation of concepts.	Notes for Teacher (Reflection Guide) Encourage learners to answer thoughtfully, linking their group activity back to the key concepts of torque, moment of inertia, and angular momentum. Remind them to give specific real-life examples for transfer, reflect on their role in collaboration, and share at least one personal takeaway. Use reflections for quick formative assessment or as a basis for a short class discussion to reinforce how rotational motion applies beyond the classroom.														
	Criteria	Excellent (4 pts)	Proficient (3 pts)	Developing (2 pts)	Beginning (1 pt)																						
	<u>Accuracy of Physics Concepts</u>	Correctly explains torque, moment of inertia, and angular momentum	Mostly correct explanations with minor errors.	Partial understanding; explanations show gaps or misconceptions.	Minimal or incorrect explanation of concepts.																						

		with precise reasoning.				
	<u>Application to Scenario</u>	Strong, explicit connection to the chosen task (demo, campaign, role-play, video) with clear real-life relevance.	Clear connection with adequate explanation.	Weak or partial connection; lacks depth.	No clear connection to real-life application.	
	<u>Creativity & Engagement</u>	Highly creative and engaging; presentation captures attention and shows originality.	Appropriate creativity and engagement; presentation is interesting.	Limited creativity; presentation is somewhat engaging.	Minimal creativity; presentation lacks effort.	
	<u>Clarity of Communication</u>	Clear, well-organized, easy to follow; visuals or performance enhance understanding.	Organized and understandable, though some parts lack clarity.	Presentation is somewhat unclear or disorganized.	Presentation is confusing, incomplete, or missing key parts.	
	<u>Collaboration & Participation</u>	All group members actively contribute, and roles are well-balanced.	Most members contribute; roles are fairly balanced.	Few members contribute; roles unevenly distributed.	Minimal participation; one or two members dominate.	
	<p>2. Making Generalization</p> <p>Option 1: Exit Ticket – Rotational Motion Reflection</p> <p>Instructions for Learners: Before leaving class, answer these two quick prompts on a slip of paper or digitally:</p> <p>1. Key Concept Learned</p> <ul style="list-style-type: none"> What is one important idea you learned today about torque, moment of inertia, or angular momentum? 					

	<p>2. Real-Life Connection</p> <ul style="list-style-type: none"> ○ Give one everyday situation (playground, sports, tools, vehicles, etc.) where you can apply this concept. <p>3. Self-Check</p> <ul style="list-style-type: none"> ○ Ask yourself: "Which concept is still unclear to me and why?" <p>OPTION 2: Think Like an Engineer A prompt-based discussion or written statement focusing on the "Why."</p> <ul style="list-style-type: none"> • The Task: Complete this sentence: <i>"In rotational dynamics, mass alone does not determine motion; instead, the distribution of mass determines resistance (I), which requires Torque to change, while the total Quantity of Motion (L) remains constant unless an outside force interferes."</i> • Question: "If you were designing a racing drone, why would you care about all three of these concepts?" • Goal: To synthesize the technical definitions into a single coherent understanding of physical behavior. <p>OPTION 3: The "Rotational Symmetry" Concept Map Students create or complete a visual map that connects the "Big Three" concepts.</p> <ul style="list-style-type: none"> • Draw a central circle labeled "Rotational Motion." Branch out into three arms: Torque (τ), Moment of Inertia (I), and Angular Momentum (L). • Under each branch, students must write one "Real-Life Rule." <ul style="list-style-type: none"> ○ <i>Example:</i> "To increase τ, I must increase the distance from the pivot." ○ <i>Example:</i> "If I change my shape, I change my I, which changes my ω." • Goal: To visualize the interconnectedness of the variables. 	
--	--	--

V. ASSESSMENT
(Assessing
Learnings)

Part I. Multiple Choice. Choose the best answer.

1. Which situation best shows torque at work?

A. Pushing a door near its hinge	C. Sitting still on a chair
B. Pushing a door at the handle	D. Dropping a ball straight down

2. Torque increases when:

A. Angle is smaller	C. Lever arm distance is longer
B. Mass is reduced	D. Force is applied closer to the axis

3. A force of 20 N is applied perpendicularly to the end of a wrench that is 0.25 m long. What is the magnitude of the torque applied to the bolt?

A. 1.0 Nm	C. 20 Nm
B. 5.0 Nm	D. 80 Nm

4. On a seesaw, a lighter child can balance a heavier child by:

A. Sitting closer to the pivot	C. Standing up
B. Sitting farther from the pivot	D. Jumping off

5. What affects the size of the torque in a system?

A. Only the force applied	C. Force, distance from the axis, and angle
B. Only the mass of the object	D. Only the rotation speed involved

6. An engineer stands on a wagon wheel and a solid disk of the same total mass and radius on a ramp. Why does the wagon wheel have a larger moment of inertia than the solid disk?

A. The solid disk distributes its mass entirely at its exact center.	B. The wagon wheel experiences less friction as it attempts to rotate.
C. The wagon wheel weighs more because of its spokes.	D. Most of the wagon wheel's mass is concentrated far from the axis along the outer rim.

7. A spinning ice skater pulls arms inward. What happens?

A. Spins slower.	C. Stops spinning
B. Spins faster	D. Spins at same speed

8. A baton spins faster when weights are moved:
- A. Toward the ends
 - B. Toward the center
 - C. Away from the axis
 - D. Spread evenly
9. If moment of inertia halves and angular momentum is conserved, angular velocity
- A. Doubles
 - B. Halves
 - C. Stays the same
 - D. Becomes zero
10. When a student pulls their arms closer while spinning on a chair, what happens?
- A. Mass increases
 - B. Torque increases
 - C. Rotational speed increases
 - D. Angular momentum decreases.

Expected Answers:

- | | | | |
|------|------|------|-------|
| 1. B | 4. B | 7. B | 10. C |
| 2. C | 5. C | 8. B | |
| 3. B | 6. D | 9. A | |

Part II. Performance Task: Investigating Rotational Motion in Everyday Objects

Instructions/Caption: Learners will design and carry out a simple investigation to explain a real-life phenomenon involving rotational motion. They will apply the concepts of torque, moment of inertia, and angular momentum to analyze their chosen system.

Task:

Each group will design and carry out a simple investigation using everyday objects (e.g., seesaw/ruler on a fulcrum, spinning chair, bicycle wheel, bottle flip, or sports ball).

They must:

1. Identify the rotational concept most relevant to their chosen setup.
2. Perform a demonstration or experiment (e.g., measure forces, observe spin speed, test balance).
3. Collect observations or simple measurements.
4. Apply formulas and explain the physics behind their results.
5. Present their findings in a creative and clear format.

Expected Output:

- A short written report or presentation including:
 - Description of the chosen scenario.
 - Step-by-step explanation of the demonstration.
 - Application of formulas and concepts.
 - Clear conclusion linking the real-life observation to rotational motion principles.
 -

Purpose: This task allows learners to transfer theoretical knowledge into authentic contexts, demonstrating how physics explains everyday rotational phenomena. It also develops skills in observation, explanation, and communication — preparing them for more complex problem-solving in rotational dynamics.

RUBRIC:

Criteria	4 pts (Excellent)	3 pts (Proficient)	2 pts (Developing)	1 pt (Beginning)
Torque Accuracy	Explanation of torque is precise, with correct use of examples and formulas	Mostly accurate, minor errors in explanation or examples	Some understanding shown, but with noticeable errors	Little or no understanding of torque
Moment of Inertia Accuracy	Clear and correct explanation of inertia, with accurate link to mass distribution	Mostly correct, minor errors in concept or application	Partial understanding, some misconceptions	Misunderstood or missing explanation
Angular Momentum Accuracy	Concept explained correctly, with clear link to conservation and real-life examples	Mostly correct, minor errors in explanation	Partial understanding, weak connection to conservation	Misunderstood or missing explanation
Computation Accuracy	All formulas applied correctly, calculations accurate	Minor computational errors but overall correct process	Frequent errors in formulas or steps	Incorrect or missing computations
Clarity & Organization	Work is well-structured, easy to follow, explanations concise	Generally clear, minor lapses in organization	Some clarity but disorganized or incomplete	Difficult to follow, unclear presentation

		Connection to Real-Life	Strong, accurate links to playground or everyday examples	Some relevant connections made	Few or weak connections	No real-life connection shown	
		Creativity & Engagement	Highly engaging, creative presentation or product	Some creativity and engagement	Limited creativity, somewhat engaging	Minimal creativity, not engaging	
VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p>Learner's Reflection</p> <p>Ask learners to complete the following sentences on a piece of paper:</p> <ol style="list-style-type: none"> 1. The most important lesson I learned about rotational dynamics is _____. 2. I will apply what I learned about torque, moment of inertia, or angular momentum by _____. 3. I am still unsure about _____ in rotational motion. 4. My learning experience could have been better if _____. <p>Teacher's Reflection</p> <p>Guide questions for teacher self-evaluation:</p> <ol style="list-style-type: none"> 1. Were the objectives of torque, moment of inertia, and angular momentum achieved? What evidence shows learning? 2. What parts of the lesson went well (activities, examples, problem-solving), and why? 3. What challenges did I face in teaching rotational dynamics, and how did I handle them? 4. How can I improve my teaching to better help students understand rotational motion? 						
VII. USE OF GENERATIVE AI	<p>In preparing this Lesson Exemplar (LE), the author(s) used Microsoft Copilot, and Google Gemini to generate instructional ideas, refine the lesson structure, and develop targeted assessments. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>						

Learning Area	PHYSICS 1	Lesson Exemplar	18
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>Rotational mechanics can maximize efficiency in physical systems</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	Design a prototype applying concepts of rotational motion to improve processes involved in various fields such as the automotive industry, amusement park rides, and manufacturing
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<p>Department of Education (DepEd), Philippines. 2016. <i>Strengthened Senior High School Curriculum: Physics 1 (Grade 11)</i>. Pasig City: Department of Education.</p> <p>Idema, Timon. <i>Rotational Motion, Torque and Angular Momentum</i>. In <i>University Physics: Mechanics and Relativity</i>. Physics LibreTexts, Delft University of Technology. Accessed May 11, 2026. https://phys.libretexts.org/Bookshelves/Classical_Mechanics/University_Physics_Mechanics_and_Relativity_(Idema)/05%3A_Rotational_Motion_Torque_and_Angular_Momentum(phys.libretexts.org in Bing)</p> <p>MIT OpenCourseWare. <i>Angular Momentum and Motion of Rotating Rigid Bodies</i>. Mechanical Engineering, Engineering Dynamics. Massachusetts Institute of Technology. Accessed May 11, 2026. https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/pages/angular-momentum-and-motion-of-rotating-rigid-bodies/ (ocw.mit.edu in Bing)</p> <p>Silverio, Angelina A., and John Donnie A. Ramos. 2017. <i>Exploring Life Through Science: General Physics 1</i>. Quezon City: Phoenix Publishing House.</p> <p>Young, David P., and Shane Stadler. 2018. <i>Cutnell & Johnson Physics</i>. 11th ed. Hoboken, NJ: John Wiley & Sons.</p>
III. CONTENT (Sequencing Content)	ROTATIONAL MECHANICS
IV. OBJECTIVES (Setting Clear Objectives and	1. Examine how torque, moment of inertia, and angular momentum are used in automotive, amusement rides, and manufacturing systems.

<i>Analyzing the Tasks)</i>	<ol style="list-style-type: none"> 2. Apply physics concepts to assess efficiency, stability, and motion control, and suggest improvements in the chosen field (e.g., safer amusement ride design, more efficient automotive systems, or improved manufacturing processes). 3. Create and present a model that applies rotational motion principles to solve a practical problem in one of the fields.
<p>IV. PROCEDURES</p> <p><i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i></p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p>(Each part shall have 2-3 varied activities)</p>	<p>ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>
<p>A. Activating Prior Knowledge</p>	<p>1. Activating Prior Knowledge</p> <p>OPTION 1: Concept Connection Toss</p> <ul style="list-style-type: none"> • The teacher tosses a soft ball to a student and says a concept (e.g., “Torque”). • Students must give one example (e.g., “Opening a door”). • That student then tosses the ball to another peer and calls out a different concept. • Continues until all three concepts have been recalled multiple times. • Keeps students alert and engaged while reinforcing connections. <p>OPTION 2: Spin the Concept Wheel</p> <ul style="list-style-type: none"> • The teacher prepares a “wheel” (can be drawn on the board or improvised with slips of paper). <p>IDF Relevance: These activities help learners recall prior knowledge and understand the purpose of the lesson by connecting everyday experiences to the concepts of torque, moment of inertia, and angular momentum. The activities encourage participation, teamwork, observation, and critical thinking through recall, real-life examples, and physical demonstrations. By engaging in these interactive tasks, learners strengthen their understanding of rotational motion concepts and become more prepared for the lesson discussion and problem-solving activities.</p>

	<ul style="list-style-type: none"> • Sections: Torque, Moment of Inertia, Angular Momentum. • A student spins or draws a slip. • They must give: <ul style="list-style-type: none"> ◦ One formula, ◦ One everyday example • Quick turns keep the energy high, and students enjoy the randomness. <p>OPTION 3: Charade Challenge: “Guess the Rotation Concept!”</p> <ul style="list-style-type: none"> • Each group sends one representative to pick up a folded sheet of paper containing a situation or action to act out. • The representative silently acts out the situation through body movements only. No speaking or sound effects are allowed. • The class observes the performance and identifies which concept is being shown: <ul style="list-style-type: none"> ◦ Torque ◦ Moment of Inertia ◦ Angular Momentum • After guessing, learners briefly explain why the action represents the concept. <p>Example situations inside the folded papers: For Torque</p> <ul style="list-style-type: none"> • Opening a stuck jar lid using more force • Pushing a door near the hinge and far from the hinge • Carrying a heavy bag farther from the body • Using a long wrench to loosen a tight bolt • Pushing a seesaw near the center vs. near the end • Pedaling a bicycle harder to start moving • Turning a wrench using more force 	<p>Notes to the teacher: Since three options are provided, the teacher may select only one activity based on available time, class size, and available materials or resources. This ensures that the lesson remains manageable while still achieving the intended learning objectives.</p> <p>Facilitation Tips for Option 1:</p> <ul style="list-style-type: none"> • Use a soft ball for safety. • Keep pace brisk to maintain alertness. • After several rounds, pause and ask students to explain <i>why</i> their examples fit the concept. • This activity works well as a warm-up before deeper exploration. <p>Facilitation Tips for Option 2:</p> <ul style="list-style-type: none"> • Prepare slips of paper or a simple board wheel divided into three sections. • Encourage students to give different examples each time to avoid repetition. • Use this activity to transition into problem-solving tasks, since formulas are recalled. • Works well for mixed-ability groups because randomness levels the playing field. <p>Facilitation Tips for Option 3:</p> <ul style="list-style-type: none"> • Prepare clear situation cards (examples already listed).
--	--	---

	<p>For Moment of Inertia</p> <ul style="list-style-type: none"> • A skater spinning with arms stretched out, then pulling them in • Spinning while holding heavy books, then bringing them close to the body • Rolling a large drum versus a small ball • Turning around while carrying objects far from the body <p>For Angular Momentum</p> <ul style="list-style-type: none"> • A spinning top that continues rotating • A bicycle wheel spinning even after being released • A carousel continuing to rotate after being pushed • A basketball spinning in the air after a shot • A fan continuing to spin for a while after being turned off <p>This activity develops learners' understanding of rotational motion concepts through movement, observation, and analysis.</p> <p>2. Establishing the Purpose of the Lesson</p> <p>OPTION 1: Match and Justify – Rotational Motion in Action</p> <p>Group Matching (5 minutes)</p> <ul style="list-style-type: none"> • Divide students into small groups. • Give each group the three system images (car wheel, Ferris wheel, conveyor roller). • Ask them to match each system to the concept that best explains its operation. <p>Justification (10 minutes)</p> <ul style="list-style-type: none"> • Each group writes a short explanation: <ul style="list-style-type: none"> ◦ <i>Car wheel</i> → <i>Torque</i>: because force applied at the rim produces rotation. ◦ <i>Ferris wheel</i> → <i>Moment of Inertia</i>: because mass distribution affects how easily it spins. ◦ <i>Conveyor roller</i> → <i>Angular Momentum</i>: once rotating, it resists changes in motion. • Encourage them to include a simple computation if possible. Here are some sample problems: 	<ul style="list-style-type: none"> • Remind students: no speaking or sound effects — only body movement. • After guessing, require a short explanation to connect the action to the physics principle. • This activity is especially effective for visual and bodily-kinesthetic learners. <p>Option 1: Match and Justify – Rotational Motion in Action</p> <p>IDF Relevance: This activity fosters collaborative analysis and concept-to-system matching, helping learners see how torque, inertia, and angular momentum operate in real systems. The justification step develops reasoning and computation skills, while group sharing builds communication and reinforces connections across contexts.</p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> • Provide clear images of systems (car wheel, Ferris wheel, conveyor roller). • Encourage groups to include simple computations for accuracy. • Highlight connections to design improvements in real systems during sharing.
--	---	--

	<p>a. A mechanic applies a force of 150 N on a wrench at 0.25 m from the center of a car wheel nut. What is the torque produced?</p> $\tau = F \cdot r = 150 \text{ N} \cdot 0.25 \text{ m} = \mathbf{37.5 \text{ Nm}}$ <p>b. A Ferris wheel has 10 seats, each with a mass of 50 kg, located 5 m from the center. Calculate the total moment of inertia of the seats (ignore the wheel's mass).</p> $I = \Sigma mr^2 = 10 \cdot (50 \text{ kg}) (5 \text{ m})^2 = \mathbf{12,500 \text{ kg} \cdot \text{m}^2}$ <p>c. A conveyor roller has a moment of inertia of $2.5 \text{ kg} \cdot \text{m}^2$ and rotates with an angular velocity of 12 rad/s. What is its angular momentum?</p> $L = I \cdot \omega = 2.5 \text{ kg} \cdot \text{m}^2 \cdot 12 \text{ rad/s} = \mathbf{30 \text{ kg} \cdot \text{m}^2/\text{s}}$ <p>Sharing (5 minutes)</p> <ul style="list-style-type: none"> Each group presents one matched pair and their justification. The teacher highlights how all three concepts connect to design improvements in real systems. <p>OPTION 2: Prototype Teaser</p> <p>The teacher will show a picture or short video clip of a car engine, Ferris wheel, or roller coaster ride. Learners will observe how the objects move and rotate.</p> <p>Guide questions:</p> <ul style="list-style-type: none"> “What makes the object rotate or spin?” “Why do some parts move faster or slower?” “How can the design be improved to make the motion safer, smoother, or more efficient?” “If you were the designer or engineer, which rotational motion principle would you apply—torque, moment of inertia, or angular momentum? Why?” 	<p>Option 2: Prototype Teaser</p> <p>IDF Relevance: This activity uses visual prompts (pictures/videos) to spark curiosity and motivate learners by showing the practical importance of rotational motion. Guiding questions scaffold observation into analysis, preparing students to think like engineers who apply torque, inertia, and momentum to improve designs.</p> <p>Facilitation Tips:</p> <ul style="list-style-type: none"> Choose engaging visuals (car engine, Ferris wheel, roller coaster). <p>Multimedia links: Ferris wheel https://tinyurl.com/yc44pmre Roller Coaster Ride https://tinyurl.com/3976ck7p</p> <ul style="list-style-type: none"> Ask open-ended guiding questions to elicit multiple perspectives. Connect student responses to the lesson goal: applying rotational motion to real-world systems <p>Option 3: Motivation Hook</p> <p>IDF Relevance: This activity taps into emotional engagement by linking rotational motion to safety concerns in rides. It motivates learners by showing the real-world stakes of torque, inertia, and momentum, making the</p>
--	---	--

	<p>Extension for Local Relevance: After the discussion, ask learners to identify one local system they want to improve, such as tricycle wheel balance, fan efficiency, playground safety, or a simple pulley/crane. Learners will share initial ideas based on their observations and chosen local systems.</p> <p>The teacher will then connect their responses to the lesson by explaining that understanding rotational motion helps engineers, athletes, and designers improve machines, vehicles, rides, and other real-life systems. This activity motivates learners by showing the practical importance of the lesson and introducing the learning goals for rotational motion.</p> <p>OPTION 3: Motivation Hook The teacher will show a picture or short video of a roller coaster or amusement ride in motion and ask the learners: “Would you ride a roller coaster if its spinning or turning motion was unstable? Why or why not?” Learners will briefly share their thoughts and concerns about safety, balance, and motion. The teacher will then explain that engineers use the principles of torque, moment of inertia, and angular momentum to design rides that are safe, stable, and enjoyable.</p> <p>The teacher will connect the discussion to the lesson by stating that understanding rotational motion helps explain how rotating systems work in real life, from amusement rides and vehicles to sports and machines. This activity introduces the relevance and purpose of the lesson while motivating learners to explore the concepts behind rotational motion.</p>	<p>lesson purpose clear and personally relevant.</p> <p>Facilitation Tips: Use a short video or image of a roller coaster or ride in motion. Multimedia links: https://tinyurl.com/yc44pmre https://tinyurl.com/3976ck7p</p> <ul style="list-style-type: none"> • Ask learners to share quick reactions about safety and stability. • Transition by explaining how engineers apply rotational principles to ensure safe, enjoyable designs.
B. Instituting New Knowledge	<p>1. Presenting Examples Before starting the activity, the teacher should use the provided blank worksheet template and enlarge it (print in A4 or larger size) so students can easily write their answers. Distribute the worksheet to guide learners in recording their observations,</p>	<p>IDF Relevance: This activity engages learners in experiential exploration by rotating through stations that connect real-world systems (automotive, rides,</p>

calculations, and improvement ideas during the Exhibit Walk and Quick Analysis steps.

System	Rotational Concept	Evidence / Observation	Simple Calculation	Observed Problem	Improvement Idea
Automotive					
Amusement Ride					
Crane					
Wind Turbine					

Step 1 – Exhibit Walk

Set up four stations around the classroom, each with a prop or image:

- Automotive: Steering wheel + brake disc diagram.
- Amusement Ride: Toy car + cardboard loop track.
- Manufacturing Crane: Ruler boom + coins as loads/counterweights.
- Wind Turbine: Paper pinwheel with short vs. long blades.

At each station, groups identify the dominant concept (torque, inertia, angular momentum, equilibrium).

Step 2 – Quick Analysis

Each station has a mini-problem card:

- Automotive: *“If the steering wheel radius doubles, how does torque change?”*
- Amusement Ride: *“If the coaster car mass doubles, how does inertia affect stability?”*
- Crane: *“If the boom length increases, how does torque affect equilibrium?”*
- Wind Turbine: *“How does blade length affect torque and efficiency?”*

Groups compute or reason, then write one improvement suggestion (e.g., larger wheel radius, balanced cars, counterweights, longer blades).

cranes, turbines) to rotational motion concepts. It integrates active learning (hands-on props, mini problems) with collaborative analysis, allowing students to compute, reason, and propose prototype improvements. This aligns with constructivist principles, as learners build understanding through observation, problem-solving, and design thinking.

Facilitation Tips:

- Prepare clear props or images at each station with problem cards. Suggested multimedia links:
Automotive: <https://tinyurl.com/ymymwsnk>,
Amusement Ride: <https://tinyurl.com/yzx5k6y7>
Manufacturing Crane: <https://tinyurl.com/22ut87td>
Wind Turbine: <https://tinyurl.com/3797943v>
- Keep timing structured (5–7 minutes per station).
- Encourage groups to write one improvement idea per system.
- End with a prototype pitch to connect exploration to design application.
- Use this as a bridge into deeper conceptual discussion (equilibrium, inertia, momentum).

Step 3 – Prototype Pitch

- Each group chooses one system they find most interesting.
- They sketch or describe a mini-prototype idea (safer crane, balanced coaster, efficient turbine, improved automotive system).
- Present in 1–2 minutes, explicitly linking their design to rotational equilibrium, torque, inertia, or angular momentum.

Rubric:

Criteria	3 – Excellent	2 – Satisfactory	1 – Needs Improvement
Identification of Concept	Correctly identify the dominant rotational concept at each station and explain it clearly.	Identifies the concept, but explanation lacks clarity or detail.	Misidentifies or gives an incomplete explanation of the concept.
Analysis and Calculation	Provides accurate reasoning and/or correct computation based on the mini-problem card.	Shows partial understanding or minor errors in reasoning/calculation.	Shows little understanding or incorrect computation.
Improvement Idea	Suggests a creative and practical improvement linked to the concept.	Suggests an improvement but lacks clear connection to the concept.	Suggestion is vague or unrelated to the concept.
Prototype Presentation	Clearly links design to rotational principles; presentation is organized and confident.	Presentation shows partial connection to concepts; delivery is fair.	Presentation lacks connection to concepts or is unclear.

2. Discussing New Concept

OPTION 1:

Connect student observations to the new concept.

- Ask: “What happened when forces weren’t balanced at the stations?”
- Recall tipping cranes, unstable coaster cars, uneven braking.
- Highlight: These are cases of rotational disequilibrium.

IDF Relevance:

This activity transitions learners from observation to formal conceptualization, introducing rotational equilibrium as the condition for stability ($\sum \tau = 0$). It combines direct instruction (definition, formula) with hands-on demonstration (meter stick balance), reinforcing abstract principles through tangible experience. By linking equilibrium to safety in cars, rides, cranes, and turbines, it emphasizes authentic relevance and prepares learners to integrate torque, inertia, and angular momentum into applied contexts.

	<p>Define Rotational Equilibrium Introduce the formal definition and condition. Rotational Equilibrium: A rigid body is in rotational equilibrium when the vector sum of all torques acting on it equals zero.</p> $\sum \tau = 0 \rightarrow \text{Stable system}$ <p>This means clockwise torques and counterclockwise torques balance each other, preventing angular acceleration thus; stability is achieved.</p> <p>Connect to Real Systems Show how equilibrium ensures safety in real contexts.</p> <ul style="list-style-type: none"> • Automotive: Balanced brake torque prevents skidding. • Amusement rides: Equal mass distribution keeps rides stable. • Manufacturing cranes: Counterweights balance torque to prevent tipping. • Wind turbines: Symmetrical blades maintain efficiency and stability. <p>Stability & Safety</p> <ul style="list-style-type: none"> • Rotational equilibrium is directly tied to structural safety. • Engineers design systems so that torques balance, ensuring no unwanted rotation. • Example: A crane boom must satisfy $\sum \tau = 0$ to remain upright while lifting loads. <p>Hands-On Make equilibrium tangible with a simple classroom experiment.</p> <ul style="list-style-type: none"> • Balance a meter stick on your finger. • Place weights at different distances. • Show how equilibrium is restored when torques balance. • Ask students to compute torque values for each side. 	<p>Facilitation Tips:</p> <ul style="list-style-type: none"> • Use simple classroom materials (meter stick, pivot, weights). • Guide learners step-by-step in torque calculations, then let them predict counterweight positions. • Highlight the safety connection: equilibrium prevents instability in real systems. • Use discussion prompts (“What happens when torques are unequal?”) to deepen reasoning. • Conclude by synthesizing: torque starts rotation; inertia resists; momentum sustains — all tied to stability and efficiency. • As an alternative to the meter stick demonstration, the teacher may use the PhET “Balancing Act” simulation. This tool lets learners place virtual masses on a plank and see how torque and equilibrium work. It reinforces the concepts of lever arms, clockwise and counterclockwise torques, and rotational equilibrium with clear visual feedback. Link:
--	--	---

	<p>Materials Needed</p> <ul style="list-style-type: none"> • 1 meter stick (or ruler, broom handle, or wooden strip) • 1 pivot (fulcrum) — e.g., a pencil, eraser, or block placed under the center • Small weights — coins, erasers, washers, or small bottles • Tape or rubber bands (to secure weights if needed) <p>Procedure</p> <p>Step 1: Set up the meter stick Prepare the system with pivots and masses.</p> <ul style="list-style-type: none"> • Place the pivot at the 50 cm mark. • Place a 100 g mass at the 20 cm mark (left side). • Place a 50 g mass at the 40 cm mark (right side). • Ask learners: <i>Is the system in rotational equilibrium?</i> <p>Step 2: Guide Force Conversion Help learners convert mass to force using $F = mg$.</p> <ul style="list-style-type: none"> • Convert 100 g $\rightarrow$ 0.1 kg $\rightarrow$ 0.98 N • Convert 50 g $\rightarrow$ 0.05 kg $\rightarrow$ 0.49 N <p>Step 3: Measure Lever Arms Learners calculate distances from the pivot.</p> <ul style="list-style-type: none"> • Left mass: $50 - 20 = \mathbf{30\text{ cm} = 0.30\text{ m}}$ • Right mass: $50 - 40 = \mathbf{10\text{ cm} = 0.10\text{ m}}$ <p>Step 4: Torque Calculation Tell learners that the measured distances from the pivot are the lever arm distances used in torque calculations. Using the torque equation: $\tau = rF$ Guide the learners by calculating the torques on both sides. The left torque is calculated as:</p> $\tau_{left} = 0.98\text{ N} (0.30\text{ m}) = 0.294\text{ Nm, CCW}$ <p style="text-align: center;">while the right torque is:</p> $\tau_{right} = 0.49\text{ N} (0.10\text{ m}) = 0.049\text{ Nm, CW}$	
--	--	--

	<p>Ask learners to compare the two values and observe that they are not equal, meaning the system is not in rotational equilibrium.</p> <p>Step 5: Finding Equilibrium Position</p> <p>The teacher then asks learners to determine the correct position of the 50 g mass so that the meter stick becomes balanced. Using the condition for rotational equilibrium:</p> $\tau_{left} = \tau_{right}$ <p>Learners solve for the unknown distance:</p> $0.98(0.30) = 0.49(d)$ $d = \frac{0.294}{0.49} = \mathbf{0.60m}$ <p>The teacher explains that the 50 g mass must be placed 0.60 m from the pivot, corresponding to the 60 cm mark on the meter stick, for the torques to balance and equilibrium to be achieved.</p> <p>Conclude by emphasizing that equilibrium is achieved when torques on both sides are equal.</p> <p>Repeat with variations</p> <ul style="list-style-type: none"> ○ Try different weights and distances. ○ Let students predict where to place the counterweight before testing. ○ Emphasize the condition: $\sum \tau_{clockwise} = \sum \tau_{counterclockwise}$ <p>Discussion Prompts</p> <ul style="list-style-type: none"> ● “What happens when torques are unequal?” → instability. ● “How does balancing torques restore stability?” → equilibrium. ● “Where in real life do we see this?” → cars (balanced brakes), cranes (counterweights), rides (mass distribution), turbines (symmetrical blades). 	
--	---	--

	<p>Say: “We have seen how torque and rotational equilibrium keep systems stable when forces are balanced. Now, we will connect these ideas with moments of inertia and angular momentum to better understand stability and motion in real-life systems such as cars, amusement rides, cranes, and turbines. These concepts help explain how engineers improve safety, balance, and efficiency in rotating systems.”</p> <p>Moment of Inertia Say: “<i>Based on what we have previously discussed about moment of inertia, let’s now connect it to equilibrium and stability.</i>” Definition: Moment of inertia is the resistance of a body to changes in rotational motion. It depends not only on the total mass but also on how that mass is distributed relative to the axis of rotation. Real-world link: Guide Questions: 1. How does placing counterweights farther from the pivot affect the crane’s stability? 2. How does the mass distribution of the blades influence the turbine’s efficiency and resistance?</p> <p>Angular Momentum Say: “<i>Based on what we have previously discussed about angular momentum, we shall proceed to see how it sustains rotational motion and connects to safety.</i>” Definition: Angular momentum is the product of moment of inertia and angular velocity, $L = I \cdot \omega$. Principle: Conservation of angular momentum — once a system is spinning, it tends to keep spinning unless an external torque acts. Real-world link: In amusement rides, roller coasters and spinning rides rely on angular momentum to maintain smooth, controlled motion.</p>	<p>Facilitation Tips: After teaching torque, moment of inertia, and angular momentum individually, guide learners to synthesize the three concepts in a connected explanation. Emphasize that torque initiates or alters rotation; moment of inertia resists or controls changes in rotation, and angular momentum sustains motion unless acted upon by external torque. Use real-world examples such as engines turning car wheels, turbine blades maintaining a steady pace, or amusement rides continuing to spin even after the motor stops. Conclude by highlighting that together these principles explain efficiency, stability, and safety in modern systems, and serve as a bridge toward applying the concepts in prototype design and improvement tasks.</p>
--	--	---

	<p>In automotive systems, rotating wheels conserve angular momentum, affecting braking and stability.</p> <p>OPTION 2: “Torque Tug-of-War” Objective: Students will explore how balanced and unbalanced torques affect rotational equilibrium, then connect this to real-world systems (cars, rides, cranes, turbines).</p> <p>Step 1 – Setup (5 minutes)</p> <ul style="list-style-type: none"> Place a meter stick (or broom handle) on a pivot (fulcrum at the center). Provide weights (coins, erasers, small bottles). Label one side “Team A” and the other “Team B.” <p>Step 2 – Student Exploration (10 minutes)</p> <ul style="list-style-type: none"> Round 1: Team A places a weight at 20 cm, Team B places the same weight at 40 cm. → Stick tips toward Team B. Round 2: Adjust distances until the stick balances. Round 3: Try different weights and distances, recording torque values ($\tau = F \cdot r$). <p>Students discover that equilibrium occurs when sum of clockwise torques = sum of counterclockwise torques.</p> <p>Step 3 – Guided Discussion (10 minutes)</p> <ul style="list-style-type: none"> Ask: “What happens when torques are unequal?” Expected Answer: When torques are unequal, the system becomes unstable and the meter stick tilts toward the stronger torque. Ask: “How does balancing torques restore stability?” → Expected Answer: Balancing torques restores stability because equal clockwise and counterclockwise torques create rotational equilibrium, keeping the meter stick level. Connect to real systems: 	<p>Sample Solution for Round 3 in Torque Tug-of-War (as guide):</p> <p>Example 100 g mass at 20 cm Force = 0.98 N, Distance = 0.20 m Torque = 0.196 Nm (counterclockwise).</p> <p>50 g mass at 40 cm Force = 0.49 N, Distance = 0.40 m Torque = 0.196 Nm (clockwise).</p> <p>Result: Torques balance → stick is in equilibrium.</p>
--	---	---

	<ul style="list-style-type: none"> • Automotive Brakes: <i>“How does equal torque in braking systems help prevent skidding?”</i> • Amusement Rides: <i>“Why is balanced mass important for keeping rides stable?”</i> • Cranes: <i>“How do counterweights placed on cranes prevent tipping?”</i> • Turbines: <i>“In wind turbines, how does symmetrical blade design maintain efficiency and reduce resistance?”</i> <p>Step 4 – Reflection (5 minutes)</p> <ul style="list-style-type: none"> • Students write a quick note: “Rotational equilibrium ensures stability because...” • Share answers in pairs or small groups. <p>3. Developing Mastery</p> <p>Option 1: Recall the Expo Contexts</p> <ul style="list-style-type: none"> • Begin by reminding students of the four systems they explored: <ul style="list-style-type: none"> ○ Automotive ○ Amusement rides ○ Manufacturing cranes ○ Wind turbines <p>This primes them to connect the problems to real-life examples they already interacted with.</p> <p>Distribute Guided Problem Cards</p> <p>Each card contains a short scenario + computation task + guiding question. For example:</p> <ul style="list-style-type: none"> • Automotive: <i>A steering wheel of radius 0.25 m requires a force of 40 N. Calculate the torque. If the radius is doubled, what happens to the torque?</i> → Students compute and explain why larger wheels reduce effort. • Amusement Ride: <i>A coaster car of 500 kg enters a loop of radius 10 m at 15 m/s. Calculate its centripetal force. Discuss how inertia affects stability.</i> • Crane: <i>A 600 N load is placed 3 m from the pivot. What counterweight at 1.5 m is needed for equilibrium?</i> → Students calculate torque balance. 	<p>IDF Relevance (Torque Tug-of-War):</p> <p>This activity uses experiential learning by letting students manipulate weights on a pivot to observe torque and rotational equilibrium. It makes the concept of ($\sum \tau = 0$) concrete through hands-on investigation. Learners work together to adjust distances; compute torques and explain stability. A short discussion and reflection help connect their observations to real-life systems like cars, cranes, turbines, and amusement rides, moving from hands-on experience to understanding and application.</p> <p>FACILITATION TIPS:</p> <ul style="list-style-type: none"> • Use simple, safe materials (meter stick, pivot, coins/erasers). Label sides clearly as “Team A” and “Team B” to gamify the activity. • Encourage students to record torque values for each round. Prompt them to predict outcomes before testing to build anticipation. • Use guiding questions (“What happens when torques are unequal?”) to connect observations to equilibrium. Explicitly tie results to real systems (brakes, rides, cranes, turbines). • Keep the written note short (1–2 sentences) but require
--	---	---

	<ul style="list-style-type: none"> • Wind Turbine: <i>A blade 2 m long experiences a force of 100 N at its tip. Calculate torque. Compare with a 1 m blade under the same force.</i> <p>Guide Students Through One Example Solve the first problem together on the board: Automotive: <i>A steering wheel of radius 0.25 m requires a force of 40 N. Calculate the torque. If the radius is doubled, what happens to the torque?</i> Solution Guide: $\tau = r F = 0.25 \text{ m} \times 40 \text{ N} = 10 \text{ Nm}$ The torque is 10 Nm.</p> <p>If the radius is doubled: $r = 0.50 \text{ m}$ $\tau = 0.50 \text{ m} \times 40 \text{ N} = 20 \text{ Nm}$ The torque becomes 20 Nm.</p> <p>After computing the torque, explain: <i>Why do larger steering wheels reduce the effort needed to turn?</i></p> <p>Independent/Group Practice Assign the remaining problems to groups.</p> <p>Amusement Ride: <i>A 500 kg coaster car enters a loop of radius 10 m at 15 m/s. Calculate its centripetal force.</i> Solution: $F_c = \frac{mv^2}{r} = F_c = \frac{(500 \text{ kg})(15 \text{ m/s})^2}{10 \text{ m}} = \mathbf{11,250 \text{ N}}$</p> <p><i>Discuss how inertia affects stability.</i> Inertia makes the coaster car continue moving in a straight line. As the car enters the loop, the track must provide enough centripetal force to change its direction and keep it moving in a circle. If the force is not enough, the car may lose contact with the track. When balanced properly, inertia helps the coaster move smoothly and safely through the loop.</p>	<p>sharing in pairs/groups to reinforce peer learning.</p> <ul style="list-style-type: none"> • Allocate 5 minutes setup, 10 minutes exploration, 10 minutes discussion, 5 minutes reflection. • Challenge advanced learners to design a “counterweight solution” for a crane or turbine based on their torque calculations. <p>IDF RELEVANCE: The Developing Mastery activities deepen learners’ understanding of rotational motion by shifting from guided exploration to applied practice. Through problem-solving tasks, hands-on activities, and real-world case analysis, learners apply torque, moment of inertia, angular momentum, and equilibrium in context. These activities promote collaboration, computation, experimentation, and critical thinking. By engaging in varied tasks, learners strengthen their understanding and apply rotational motion concepts to real-life systems such as cars, rides, cranes, and turbines.</p>
--	---	---

	<p>Crane: A 600 N load is placed 3 m from the pivot. What counterweight at 1.5 m is needed for equilibrium?</p> $\sum \tau_{\text{left}} = \sum \tau_{\text{right}}$ $F_1 \cdot r_1 = F_2 \cdot r_2$ $600 \text{ N} \cdot 3 \text{ m} = F_2 \cdot 1.5 \text{ m}$ $1800 \text{ Nm} = 1.5 \text{ m} \cdot F_2$ $F_2 = \frac{1800 \text{ Nm}}{1.5 \text{ m}} = \mathbf{1200 \text{ N}}$ <p>Final Answer: The counterweight needed at 1.5 m is 1200 N.</p> <p>Wind Turbine: A blade 2 m long experiences a force of 100 N at its tip. Calculate torque. Compare with a 1 m blade under the same force.</p> $\tau = r F$ <p>For 2 m blade: $\tau = 2 \text{ m} \times 100 \text{ N} = 200 \text{ Nm}$ For 1 m blade: $\tau = 1 \text{ m} \times 100 \text{ N} = 100 \text{ Nm}$</p> <p>Final Answer:</p> <ul style="list-style-type: none"> • 2 m blade: Torque = 200 Nm • 1 m blade: Torque = 100 Nm <p>The longer blade produces twice the torque under the same force. This shows that increasing the lever arm (blade length) amplifies rotational effect, improving efficiency in capturing wind energy. It also increases structural stress and resistance, which engineers must balance stability and durability.</p> <ul style="list-style-type: none"> • After solving the problems answer the guide question: “How does equilibrium ensure stability in this system?” • Encourage peer discussion and critique. <p>Formative Assessment</p> <ul style="list-style-type: none"> • Collect quick outputs: solved computations + short written explanations. • Use exit slips or oral sharing to check understanding. • Provide immediate feedback and clarify misconceptions. <p>Option 2: Hands-On Simulation</p> <ul style="list-style-type: none"> • Students use rulers, coins, and erasers to physically test torque balance. 	<p>Facilitation Tips:</p> <p>Recall the Expo Contexts:</p> <ul style="list-style-type: none"> • Distribute problem cards with clear computation + guiding questions. • Solve one example together, then let groups handle the rest. • Collect quick outputs (exit slips or oral sharing) for formative assessment. <p>Group Worksheet & Peer Collaboration:</p> <ul style="list-style-type: none"> • Provide worksheets with varied scenarios. • Require groups to exchange and critique answers. • Highlight peer feedback as a tool for clarifying misconceptions. <p>Hands-On Simulation:</p> <ul style="list-style-type: none"> • Prepare rulers, coins, and erasers for torque balance challenges. • Let students predict before testing, then compute torque values. • Emphasize the equilibrium condition. <p>Real World Case Analysis:</p> <ul style="list-style-type: none"> • Present short case studies (crane tipping, ride instability).
--	---	--

	<ul style="list-style-type: none"> Teacher gives challenges: <ul style="list-style-type: none"> “Balance a 100 g coin at 20 cm with another coin at 40 cm.” “Now try balancing two different weights at different distances.” Students record torque values and explain why equilibrium is achieved. Students apply concepts through experimentation. <p>Option 3: Real-World Case Analysis</p> <ul style="list-style-type: none"> Present short case studies with real-world scenarios: <ul style="list-style-type: none"> Crane Accident: A crane tipped over because the load was placed too far from the pivot. Amusement Ride Instability: A ride became unstable when cars were unevenly distributed around the loop. Student Task: <ul style="list-style-type: none"> Identify the torque imbalance in each scenario. Calculate torque values where applicable. Propose solutions using equilibrium principles (e.g., counterweight placement, balanced distribution). Example Case (Crane): <ul style="list-style-type: none"> Load = 800 N at 4 m → Torque = 3200 Nm. Counterweight needed at 2 m → 1600 N. Students suggest proper counterweight placement to restore equilibrium. 	<ul style="list-style-type: none"> Guide students to calculate torque imbalance and propose solutions. Encourage them to connect safety failures to equilibrium principles. <p>Rubric for Real-World Case Analysis</p> <table> <tr> <th>Criteria</th><th>Description</th><th>Points</th></tr> <tr> <td>Accuracy of Calculation</td><td>Correct torque values and proper identification of equilibrium conditions.</td><td>0–4 pts</td></tr> <tr> <td>Conceptual Understanding</td><td>Clear explanation of torque imbalance and its effect on stability/safety.</td><td>0–3 pts</td></tr> <tr> <td>Quality of Proposed Solution</td><td>Practical and feasible improvement ideas (e.g., counterweight placement, redistribution).</td><td>0–2 pts</td></tr> <tr> <td>Clarity of Presentation</td><td>Organized explanation, correct use of terms, and logical reasoning.</td><td>0–1 pt</td></tr> </table>	Criteria	Description	Points	Accuracy of Calculation	Correct torque values and proper identification of equilibrium conditions.	0–4 pts	Conceptual Understanding	Clear explanation of torque imbalance and its effect on stability/safety.	0–3 pts	Quality of Proposed Solution	Practical and feasible improvement ideas (e.g., counterweight placement, redistribution).	0–2 pts	Clarity of Presentation	Organized explanation, correct use of terms, and logical reasoning.	0–1 pt
Criteria	Description	Points															
Accuracy of Calculation	Correct torque values and proper identification of equilibrium conditions.	0–4 pts															
Conceptual Understanding	Clear explanation of torque imbalance and its effect on stability/safety.	0–3 pts															
Quality of Proposed Solution	Practical and feasible improvement ideas (e.g., counterweight placement, redistribution).	0–2 pts															
Clarity of Presentation	Organized explanation, correct use of terms, and logical reasoning.	0–1 pt															
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Say: “We have examined torque, moment of inertia, and angular momentum, and applied them to real systems. Now, let’s move to the next stage: developing initial representations such as sketches, posters, infographics, or short role plays that show how these principles solve practical problems in chosen fields.”</p> <p>Step 1: Group Task Assignment</p> <ul style="list-style-type: none"> Divide the class into small groups. Each group selects one field: 	<p>Facilitation Tips</p> <ul style="list-style-type: none"> Divide students into small groups and let them choose a field to increase ownership. Provide clear guidelines: models can be posters, mini-prototypes, infographics, or role plays—keep it simple and classroom-friendly. Remind groups to explicitly show torque, inertia, and 															

	<ul style="list-style-type: none"> ○ Automotive industry ○ Amusement park rides ○ Manufacturing systems (e.g., cranes, conveyor belts, rotating machinery) <p>Step 2 – Model Design Guidelines</p> <ul style="list-style-type: none"> ● Groups prepare an initial representation of their chosen system. ● This may be a sketch, poster, infographic, or short role play — simple, classroom-friendly, and creative. ● The design must clearly illustrate: <ul style="list-style-type: none"> a. Torque – how forces cause rotation. b. Moment of Inertia – how mass distribution affects stability. c. Angular Momentum – how motion is sustained or controlled <p>Step 3 – Presentation</p> <ul style="list-style-type: none"> ● Each group presents their design to the class. ● They explain: <ul style="list-style-type: none"> a. The practical problem in their chosen system (e.g., tipping crane, unstable ride, inefficient turbine). b. How torque, inertia, and angular momentum interact to address the problem. c. Suggested improvements for efficiency, stability, or safety. <p>Expected Outputs</p> <ul style="list-style-type: none"> ● Group designs (sketch, poster, infographic, or role play). ● Clear explanation of how torque, inertia, and angular momentum apply to real systems. ● Suggested improvements for efficiency, stability, and safety. 	<p>angular momentum in their design.</p> <ul style="list-style-type: none"> ● Allocate 10–15 minutes for creation and 5–7 minutes per group for presentation. ● During presentations, prompt with guiding questions: <i>“What problem does your system solve?”</i> and <i>“How do the three principles interact here?”</i> ● Synthesize by highlighting how each group’s model connects to real-world engineering solutions.
--	---	---

	<div><div>RUBRIC:</div><table><tr><th>Criteria</th><th>Excellent (3)</th><th>Satisfactory (2)</th><th>Needs Improvement (1)</th></tr><tr><td>Group Design</td><td>Design is clear, creative, and well-constructed (sketch, poster, infographic, or role play).</td><td>Design is understandable but lacks detail or creativity.</td><td>Design is incomplete, unclear, or missing.</td></tr><tr><td>Explanation of Concepts</td><td>Clear and accurate explanation of torque, inertia, and angular momentum applied to real systems.</td><td>Partial explanation; some concepts are correct but not fully connected to real systems.</td><td>Minimal or incorrect explanation; concepts not applied to real systems.</td></tr><tr><td>Improvement Ideas</td><td>Practical, relevant suggestions for efficiency, stability, or safety improvements.</td><td>Suggestions are somewhat relevant but lack depth or feasibility.</td><td>Suggestions are vague, unrealistic, or missing.</td></tr><tr><td>Group Presentation</td><td>Presentation (5–7 minutes) is clear, organized, and shows balanced participation.</td><td>Presentation is understandable but lacks organization or balanced participation.</td><td>Presentation is unclear, too short/long, or shows minimal participation.</td></tr></table><div><div>2. Making Generalization</div><div>Exit Ticket</div><div>Question 1: In your own words, explain how torque, moment of inertia, and angular momentum work together to improve stability, efficiency, or safety in systems such as cars, amusement rides, or manufacturing machines.</div><div>Question 2: Which concept (torque, moment of inertia, or angular momentum) is most difficult for you to understand, and why?</div><div>Question 3: How can rotational mechanics help solve problems in your community or everyday life?</div></div></div>	Criteria	Excellent (3)	Satisfactory (2)	Needs Improvement (1)	Group Design	Design is clear, creative, and well-constructed (sketch, poster, infographic, or role play).	Design is understandable but lacks detail or creativity.	Design is incomplete, unclear, or missing.	Explanation of Concepts	Clear and accurate explanation of torque, inertia, and angular momentum applied to real systems.	Partial explanation; some concepts are correct but not fully connected to real systems.	Minimal or incorrect explanation; concepts not applied to real systems.	Improvement Ideas	Practical, relevant suggestions for efficiency, stability, or safety improvements.	Suggestions are somewhat relevant but lack depth or feasibility.	Suggestions are vague, unrealistic, or missing.	Group Presentation	Presentation (5–7 minutes) is clear, organized, and shows balanced participation.	Presentation is understandable but lacks organization or balanced participation.	Presentation is unclear, too short/long, or shows minimal participation.	
Criteria	Excellent (3)	Satisfactory (2)	Needs Improvement (1)																			
Group Design	Design is clear, creative, and well-constructed (sketch, poster, infographic, or role play).	Design is understandable but lacks detail or creativity.	Design is incomplete, unclear, or missing.																			
Explanation of Concepts	Clear and accurate explanation of torque, inertia, and angular momentum applied to real systems.	Partial explanation; some concepts are correct but not fully connected to real systems.	Minimal or incorrect explanation; concepts not applied to real systems.																			
Improvement Ideas	Practical, relevant suggestions for efficiency, stability, or safety improvements.	Suggestions are somewhat relevant but lack depth or feasibility.	Suggestions are vague, unrealistic, or missing.																			
Group Presentation	Presentation (5–7 minutes) is clear, organized, and shows balanced participation.	Presentation is understandable but lacks organization or balanced participation.	Presentation is unclear, too short/long, or shows minimal participation.																			
<div><div>V. ASSESSMENT</div><div><i>(Assessing Learnings)</i></div></div>	<div><div>Part I. Multiple Choice. Choose the best answer.</div><div><div>1. When a mechanic uses a longer wrench to loosen a tight bolt, the increased length provides:</div><div><div>a. Smaller moment of inertia</div><div>b. Greater angular momentum</div><div>c. Reduced rotational efficiency</div><div>d. Greater torque due to larger lever arm</div></div></div><div><div>2. Roller coaster cars are designed with wide bases and heavy frames mainly to:</div><div><div>a. Increase moment of inertia for stability</div><div>b. Increase torque for faster rotation</div><div>c. Reduce angular momentum</div><div>d. Reduce efficiency</div></div></div><div><div>3. Which change would make a crane less likely to tip over?</div><div><div>a. Increasing torque at the base.</div><div>b. Increasing angular velocity</div><div>c. Reducing moment of inertia</div><div>d. Reducing safety checks</div></div></div></div>																					

4. When a ride operator increases the distance of the seat from the axis of rotation, the torque required to start rotation will:

- a. Decrease
- b. Increase
- c. Remain constant
- d. Vanish

5. Which factor most directly increases the moment of inertia of a car wheel?

- a. Adding mass farther from the axis
- b. Increasing torque at the axle
- c. Reducing angular velocity
- d. Reducing friction

Expected Answers:

- 1. d 3. a 5. a
- 2. a. 4. b

Performance Task

In groups, students will design and present a prototype/model that demonstrates how torque, moment of inertia, and angular momentum can be applied to improve stability, efficiency, or safety in a chosen system.

Steps:

1. **Select a Field**

- Automotive industry
- Amusement park rides
- Manufacturing systems

2. **Identify a Practical Problem**

- Define a real issue that needs improvement (e.g., uneven braking in cars, unstable ride motion, tipping cranes, inefficient rotating machinery).

3. **Design a Prototype/Model**

- Create a design using physical materials, paper prototypes, digital sketches, or simulated models.
- Options include mini-models, posters, infographics, or simulations.
- Must clearly show:
 - **Torque** – how forces initiate rotation.
 - **Moment of Inertia** – how mass distribution affects stability.
 - **Angular Momentum** – how motion is sustained or controlled.

4. **Present the Model**

- Deliver a group presentation (5–7 minutes).
- Explain the chosen system and problem.
- Demonstrate how the three principles interact to solve the problem.
- Suggest improvements for efficiency, stability, or safety.

5. Assign Individual Roles

- **Designer** – plans and creates the prototype/model (physical, paper, digital, or simulated).
- **Recorder** – documents the process, notes observations, and organizes improvement ideas.
- **Presenter** – delivers the group's explanation during the presentation.
- **Analyst**– handles computations and analysis related to torque, moment of inertia, and angular momentum.
- **Safety Checker** – ensures the design and suggested improvements consider safety and feasibility.

Expected Outputs

- A prototype/model using physical materials, paper prototypes, digital sketches, or simulated designs.
- Clear explanation of torque, moment of inertia, and angular momentum in the chosen system, presented orally, visually, or through video.
- Practical improvement of ideas for stability, efficiency, or safety in the system studied.
- Group presentation (5–7 minutes) showcasing the prototype/model and explanation of concepts.

Criteria	Excellent (4 pts)	Proficient (3 pts)	Developing (2 pts)	Beginning (1 pt)
<u>Accuracy of Physics Concepts</u>	Correctly applies torque, moment of inertia, and angular momentum with precise reasoning and computations.	Mostly correct applications with minor errors in reasoning or computation.	Partial understanding; explanations show gaps or misconceptions.	Minimal or incorrect explanation of concepts.
<u>Application to Practical Problem</u>	Strong, explicit connection to a real problem in automotive, amusement rides, or manufacturing; clear improvements suggested.	Clear connection with adequate explanation; some improvement ideas.	Weak or partial connection; lacks depth or improvement ideas.	No clear connection to a practical problem.
<u>Creativity & Innovation</u>	Highly creative and original prototype/model; shows innovative thinking in solving the problem.	Appropriate creativity; prototype/model is interesting and functional.	Limited creativity; prototype/model is basic or predictable.	Minimal creativity; prototype/model lacks effort.
<u>Clarity of Presentation</u>	Clear, well-organized, easy to follow; visuals or demonstration enhance understanding.	Organized and understandable, though some parts lack clarity.	Presentation is somewhat unclear or disorganized.	Presentation confusing, incomplete, or missing key parts.
<u>Collaboration & Participation</u>	All group members actively contribute; roles are well-balanced.	Most members contribute; roles are fairly balanced.	Few members contribute; roles unevenly distributed.	Minimal participation; one or two members dominate.

<p>VI. REFLECTION <i>(Feedback and Continuous Improvement)</i></p>	<p>Learner's Reflection Ask learners to complete the following sentences on a piece of paper:</p> <ol style="list-style-type: none"> 1. The most important lesson I learned about how torque, moment of inertia, and angular momentum are used in cars, rides, or machines is _____. 2. I will apply what I learned about efficiency, stability, and motion control by suggesting improvements such as _____. 3. I am still unsure about _____ when applying rotational motion concepts to real systems. 4. My learning experience could have been better if _____ during the model creation and presentation. <p>Teacher's Reflection Guide questions for teacher self-evaluation:</p> <ol style="list-style-type: none"> 1. Were the objectives of examining torque, moment of inertia, and angular momentum in automotive, amusement rides, and manufacturing systems achieved, and what evidence from student work or presentations shows this learning? 2. Did learners successfully apply physics concepts to assess efficiency, stability, and motion control, and suggest practical improvements? 3. What challenges did I face in guiding learners through the design and presentation of models, and how did I address them? 4. How can I improve my teaching practice to better support learners in connecting rotational motion principles to solving practical problems?
<p>VII. USE OF GENERATIVE AI</p>	<p>In preparing this Lesson Exemplar (LE), the author(s) used Microsoft Copilot, and Google Gemini in order to generate instructional ideas, refine the lesson structure, and develop targeted assessments. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	19
----------------------	------------------	------------------------	----

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that simple harmonic motion can be characterized by periodic motion.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners draw on personal experiences and secondary sources to demonstrate through simple activities the concept of simple harmonic motion in natural and human-made situations.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<ul style="list-style-type: none"> • Serway, R. A., & Jewett, J. W. (2018). <i>Physics for scientists and engineers with modern physics (10th ed.)</i>. Cengage Learning. https://www.scirp.org/reference/referencespapers?referenceid=3155438 • The Physics Classroom. "Properties of Periodic Motion" Accessed May 2026. https://www.physicsclassroom.com/class/waves/lesson-0/properties-of-periodic-motion • Walker, J., Halliday, D., & Resnick, R. (2014). <i>Fundamentals of physics (10th ed.)</i>. Wiley. https://dl.icdst.org/pdfs/files4/39e1817b05cf155433309dbb2f3289fe.pdf • YouTube. (n.d.). <i>Swaying tree in the wind</i> [YouTube Short]. https://www.youtube.com/shorts/re7aNJOjwqk • YouTube. (n.d.). <i>Child on a playground swing</i> [YouTube Short]. https://www.youtube.com/shorts/WV-DQGtgzUg • YouTube. (n.d.). <i>Water waves / ripples demonstration</i> [YouTube Short]. https://www.youtube.com/shorts/9QukkuNo1Kg
III. CONTENT (Sequencing Content)	Periodic motion <ol style="list-style-type: none"> 1. Oscillations 2. Simple harmonic motion

<p>IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)</p>	<p>At the end of the lesson, the learners will be able to:</p> <ol style="list-style-type: none"> Define simple harmonic motion (SHM). Describe the key characteristics of SHM (restoring force, periodic motion, and equilibrium position). Identify examples of simple harmonic motion (SHM) in natural situations (e.g., swaying branches, oscillating leaves, water waves) and human-made systems (e.g., pendulum clocks, playground swings, vibrating strings) from personal experiences and secondary sources. Demonstrate simple harmonic motion by performing simple activities (e.g., pendulum or spring system) to explain its observed key characteristics. 		
<p>IV. PROCEDURES (Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</p> <p>This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension.</p> <p>(Each part shall have 2-3 varied activities)</p>	<p>ANNOTATIONS</p> <p><i>*Instruction to the teacher on how to facilitate the activities.</i></p> <p><i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i></p>		
<p>A. Activating Prior Knowledge</p>	<table border="1"> <tr> <td> <p>1. Activating Prior Knowledge</p> <p>Option 1: The "Pattern Hunt"</p> <p>For the Teacher: Prepare the room by clearing space for groups to post their Manila papers. Have your localized "Meta-cards" (recycled colored paper) ready. Ensure you have a clear transition signal (like a bell or a clap) to keep the fast-paced 5-minute intervals on track.</p> <p>Activity Instructions for Students</p> <p>A. Form Groups: Sit with your assigned learning team (3–4 members).</p> </td><td> <p>Activity 1: The "Pattern Hunt"</p> <p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Circulate: Maintain a high-energy, low-stakes atmosphere. Prompt groups focusing only on mechanics toward nature: "What happens to a tree branch after a bird flies off?" • Ask students: Clarify categories by asking: "Does a clock hand reverse its path or complete a loop?" This distinguishes periodic motion from the direction reversal of oscillation. </td></tr> </table>	<p>1. Activating Prior Knowledge</p> <p>Option 1: The "Pattern Hunt"</p> <p>For the Teacher: Prepare the room by clearing space for groups to post their Manila papers. Have your localized "Meta-cards" (recycled colored paper) ready. Ensure you have a clear transition signal (like a bell or a clap) to keep the fast-paced 5-minute intervals on track.</p> <p>Activity Instructions for Students</p> <p>A. Form Groups: Sit with your assigned learning team (3–4 members).</p>	<p>Activity 1: The "Pattern Hunt"</p> <p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Circulate: Maintain a high-energy, low-stakes atmosphere. Prompt groups focusing only on mechanics toward nature: "What happens to a tree branch after a bird flies off?" • Ask students: Clarify categories by asking: "Does a clock hand reverse its path or complete a loop?" This distinguishes periodic motion from the direction reversal of oscillation.
<p>1. Activating Prior Knowledge</p> <p>Option 1: The "Pattern Hunt"</p> <p>For the Teacher: Prepare the room by clearing space for groups to post their Manila papers. Have your localized "Meta-cards" (recycled colored paper) ready. Ensure you have a clear transition signal (like a bell or a clap) to keep the fast-paced 5-minute intervals on track.</p> <p>Activity Instructions for Students</p> <p>A. Form Groups: Sit with your assigned learning team (3–4 members).</p>	<p>Activity 1: The "Pattern Hunt"</p> <p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Circulate: Maintain a high-energy, low-stakes atmosphere. Prompt groups focusing only on mechanics toward nature: "What happens to a tree branch after a bird flies off?" • Ask students: Clarify categories by asking: "Does a clock hand reverse its path or complete a loop?" This distinguishes periodic motion from the direction reversal of oscillation. 		

	<p>B. Brainstorm: On the provided meta-cards or manila paper, list as many objects or phenomena as possible that move in a repeating, back-and-forth, or circular way. Think of things in nature, at home, or in machinery.</p> <p>C. Categorize: Look at your list. Group these movements into categories based on how they return to their starting point.</p> <ul style="list-style-type: none"> • <i>Group A:</i> Things that go around. • <i>Group B:</i> Things that bounce or swing back and forth. • <i>Group C:</i> Things that vibrate rapidly. <p>D. The "Challenge Question": Pick one item from your "Back and Forth" group. Be ready to explain to the class: <i>"What specific force or 'thing' makes this object come back to the center instead of just flying away?"</i></p> <p>Option 2: Connect learners' experiences with oscillatory motion.</p> <p>A. Ask: <i>Have you seen a swing or branch moving back and forth?</i></p> <p>B. Show short video clips of oscillating systems (trees, swings, waves). Tree (https://www.youtube.com/shorts/re7aNJOjwqk) Swing (https://www.youtube.com/shorts/WV-DQGtgzUg) Waves (https://www.youtube.com/shorts/9QukkuNo1Kg?feature=share)</p> <p>C. Conduct a quick Think-Pair-Share on everyday oscillations.</p> <p>Guide Questions:</p> <ol style="list-style-type: none"> 1. What makes that motion repeat? 2. Where is the motion fastest? Slowest? 3. Can you think of a center or resting position? 4. What specific force or 'thing' makes this object come back to the center instead of just flying/moving/rolling away? 	<ul style="list-style-type: none"> • Validate: Use local terms like "tightness" or "gravity" to bridge intuition to the concept of a pull toward equilibrium. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Building the Concept: Synthesize everyday terms into the formal concept of the Restoring Force. Explain that for an object to swing, it must always be pulled toward its "Home" (Equilibrium Position). • Clearing Misconceptions: Distinguish SHM from general periodic motion. Explain that a Ferris wheel is periodic but not SHM because it never reverses direction; SHM requires the "back-and-forth" struggle between displacement and return. <p>IDF Application (DepEd SHS Curriculum) This activity utilizes Contextualization by using local observations to build scientific literacy. It maps to the Relational level of the SOLO Taxonomy, as students move from identifying isolated examples to comparing the underlying mechanics (path reversal vs. continuous loops) that define Simple Harmonic Motion.</p>
--	--	---

	<p>Teacher's guide for misconceptions: periodic but not SHM</p> <table border="1"> <thead> <tr> <th>Observe if learners...</th><th>Likely Misconception</th><th>Suggested Teacher Follow-Up</th></tr> </thead> <tbody> <tr> <td>Say all repeating motions are SHM</td><td>Equating periodic motion with SHM</td><td>"Does the motion always involve a restoring force toward equilibrium?"</td></tr> <tr> <td>Describe waves as objects traveling forward</td><td>Confusing wave propagation with oscillation</td><td>"Does the water itself travel far, or mainly move up and down?"</td></tr> <tr> <td>Ignore equilibrium position</td><td>No understanding of center/rest position</td><td>"Where would the object naturally stop?"</td></tr> <tr> <td>Think motion is fastest at the ends</td><td>Misunderstanding energy transfer</td><td>"At which point does the object pass through most quickly?"</td></tr> <tr> <td>Cannot identify restoring force</td><td>Lack of force-based explanation</td><td>"What causes the object to reverse direction?"</td></tr> </tbody> </table> <p>2. Establishing the Purpose of the Lesson <i>*Introduce first the learning objectives in verbatim manner, "At the end of the lesson, I will be able to (state the objectives)."</i></p> <p>Teacher Prompt: <i>"Today, we will study a type of motion that repeats itself in a regular way. You will learn how to identify it in nature, in everyday life, and through a simple experiment. This is important because SHM explains how many tools, systems, and natural events move."</i></p> <p>Option 1: "The "Silent Metronome" For the Teacher: Before the class begins, test your DIY pendulum. Ensure the string is securely tied to a fixed point (like a desk edge or a meter stick) and that the "bob" (weight) is heavy enough to minimize air resistance. Practice hiding the motion mid-swing while keeping the pendulum moving freely behind the barrier.</p> <p>Materials Needed</p> <ul style="list-style-type: none"> A physical metronome or a simple DIY pendulum (a 50cm string with a heavy nut or washer tied to the end). 	Observe if learners...	Likely Misconception	Suggested Teacher Follow-Up	Say all repeating motions are SHM	Equating periodic motion with SHM	"Does the motion always involve a restoring force toward equilibrium?"	Describe waves as objects traveling forward	Confusing wave propagation with oscillation	"Does the water itself travel far, or mainly move up and down?"	Ignore equilibrium position	No understanding of center/rest position	"Where would the object naturally stop?"	Think motion is fastest at the ends	Misunderstanding energy transfer	"At which point does the object pass through most quickly?"	Cannot identify restoring force	Lack of force-based explanation	"What causes the object to reverse direction?"	<p>Activity: The "Silent Metronome" Facilitation Strategy Start the pendulum with a wide, steady arc for 5–6 cycles to let students "catch" the rhythm. Hide the motion smoothly to avoid breaking the string path.</p> <ul style="list-style-type: none"> Watch Out: Discourage counting; encourage feeling the tempo. The Misconception: Students often think smaller swings (decreased amplitude) are faster. If claps accelerate as the motion dies down, stop and demonstrate that the "beat" remains constant. In SHM, the period is independent of amplitude for small angles. <p>Processing and Wrapping Up Ask: <i>"Why did our claps stay synchronized?"</i> * Building the Concept: Introduce Predictability. SHM follows strict mathematical rules (restoring force), making the object's position predictable at any moment.</p> <ul style="list-style-type: none"> Clearing Misconceptions: Explain that while distance (amplitude) fades, the time (period) does not. Real-World Link: Use the "Bridge vs. Wind" analogy. Engineers must understand a bridge's natural "rhythm" to prevent wind from causing out-of-control oscillations. <p>Transition to the Next Part of the Lesson <i>"As our claps just proved, this type of motion is incredibly predictable"</i></p>
Observe if learners...	Likely Misconception	Suggested Teacher Follow-Up																		
Say all repeating motions are SHM	Equating periodic motion with SHM	"Does the motion always involve a restoring force toward equilibrium?"																		
Describe waves as objects traveling forward	Confusing wave propagation with oscillation	"Does the water itself travel far, or mainly move up and down?"																		
Ignore equilibrium position	No understanding of center/rest position	"Where would the object naturally stop?"																		
Think motion is fastest at the ends	Misunderstanding energy transfer	"At which point does the object pass through most quickly?"																		
Cannot identify restoring force	Lack of force-based explanation	"What causes the object to reverse direction?"																		

	<ul style="list-style-type: none"> • A large cardboard sheet or book (to hide the motion). • Timer (optional). <p>Activity Instructions for Students</p> <p>A. Observe the Motion: Watch your teacher demonstrate the motion of a weighted string (pendulum) or a metronome. Focus on the timing of each "tick" or "swing."</p> <p>B. Predict the Stop: Your teacher will start the motion and then suddenly hide it (behind a book or under a desk).</p> <p>C. Synchronize: Based only on the rhythm you observed, clap your hands exactly when you think the weight has returned to its starting position.</p> <p>D. Reflect (The "So What?" Discussion): Turn to your seatmate and answer:</p> <ul style="list-style-type: none"> ○ "How were we able to clap in time even when we couldn't see the object?" ○ "If this motion were unpredictable (random), how would that affect a clock, a heart monitor, or a skyscraper in an earthquake?" 	<p>because it repeats in a strict rhythm. Now, let's see how this exact same predictability plays out in the real world, from the sway of giant trees in the wind to the engineered systems we build every day, as we dive into our next activities!"</p> <p>IDF Application (DepEd SHS Curriculum) This phase applies to the Inquiry-based and Reflective approach by co-constructing the lesson's "value" with students. It connects abstract physics to societal safety (Value-Laden).</p>
B. Instituting New Knowledge	<p>1. Presenting Examples</p> <p>Option 1: The "Home Base" Scavenger Hunt</p> <p>For the Teacher: Prepare the "Media Deck" beforehand. This can be printed with photos, sketches on flashcards, or a looped video presentation. If resources allow, having a physical guitar or a plastic ruler (to simulate the tree) helps kinesthetic learners.</p> <p>Activity Instructions for Students</p> <p>A. Analyze the "Media Deck": Your group will receive a set of four "Local Motion Cards" (or a short video loop) showing:</p> <ul style="list-style-type: none"> ○ A Guitar String (<i>Gitarang de-kwerdas</i>) being plucked. 	<p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Inquiry-Based Support: Avoid giving direct answers. Use "Testing Questions" to bridge everyday vocabulary (stiffness, tightness) to physics. <ul style="list-style-type: none"> ○ <i>Bangka:</i> "If you push it down, what makes it pop back up?" (Buoyancy) ○ <i>Niyog:</i> "What if the trunk were made of cooked noodles? Would it stand back up?" (Internal Elastic Force)

- A **Coconut Tree** (*Puno ng Niyog*) swaying in a breeze.
- A **Timbangan** (hanging market scale) bouncing after a fish is removed.
- A **Banca** (*Bangka*) bobbing up and down on water waves.

- B. **Locate "Home Base":** For each item, identify the **Equilibrium Position**—the exact spot where the object would naturally stay if no one touched it.
- C. **Identify the "Pull-Back":** Discuss with your group: "What is the specific force or 'thing' that pulls/pushes the object back to Home Base when it moves away?" (Is it the string's tightness? Gravity? The wood's stiffness?)
- D. **Fill the Comparison Table:** Complete the table below on your group's Manila paper:

Object	Home Base	What pulls it back? (Restoring Force)
Guitar String	Straight line position	Tension / Elasticity
Swaying Niyog		
Timbangan		
Bangka		

Sample answer to the table above:

Object	Home Base	What pulls it back? (Restoring Force)
Guitar String	Straight line position	Tension / Elasticity
Swaying Niyog	Vertical/upright position	Internal elastic force / Stiffness of the trunk
Timbangan	Resting/unloaded zero position	Spring tension / Elasticity of the internal spring
Bangka	Flat/still water surface level	Buoyancy (Water pushing upward)

- **Watch Out:** Students often mistake the cause of motion (wind/plucking) for the **Restoring Force**. Clarify that while the wind disturbs the tree, the tree's own properties restore it. SHM requires this "internal desire" to return to center.

Processing and Wrapping Up

- **Building the Concept:** Formally define **Restoring Force**. Emphasize that it always points **opposite** to the displacement (if the tree sways right, the force pulls left).
- **Clearing Misconceptions:** Correct the idea that the "wave" is the restoring force for a Bangka. The wave is the **disturbance**; buoyancy is the **restoring force**.
- **Summary:** SHM requires a "Home Base" (**Equilibrium**) and a "Rubber Band effect" (**Restoring Force**).

This activity embodies the **Collaborative and Reflective approach** of the DepEd IDF by promoting a "Community of Learners" where knowledge is synthesized collectively. By allowing students to define the relationships between terms, the teacher facilitates **Metacognition**, ensuring the lesson concludes with a holistic understanding.

	<p>Option 2: “Examples Around Us” For the Teacher: Present images, short videos, or printed examples of:</p> <ul style="list-style-type: none"> * Swaying branches * Water waves * Playground swings * Oscillating leaves * Pendulum clocks * Vibrating strings <p>Activity Instructions for Students In pairs, you will classify examples into:</p> <ul style="list-style-type: none"> • Natural examples • Human-made examples <p>Guide Questions:</p> <ul style="list-style-type: none"> • Which examples move back and forth? • Which seems to repeat at regular intervals? <p>Expected idea: Learners begin noticing that SHM is not just in physics class; it happens in real life.</p> <p>2. Discussing New Concept</p> <p>Option 1: The "Model Building" Session For the Teacher: Ensure the "Lab Stands" (desk edges or wooden sticks) are stable enough to handle the weight of the "plomo" or stones without tipping. Check that the springs or rubber bands used are not overstretched (deformed) before the activity starts.</p> <p>Core Focus: <i>Keep student attention on the concept of the restoring force—how its strength and direction change relative to the resting position. Do not require mathematical calculations during core activity.</i></p>	<p>Facilitation Strategy: "Model Building" <i>Transform sensory observations into formal physics language by using "guiding vocabulary." If a student describes a "harder snap," identify it as the Restoring Force and ask if it pulls with or against them.</i></p> <ul style="list-style-type: none"> • Watch Out: Correct the idea that force is constant; emphasize it is zero at equilibrium and strongest at maximum stretch. • Measurement Tip: Ensure students measure displacement (distance from zero) rather than the total length of the spring.
--	--	--

	<p>Localized Materials</p> <ul style="list-style-type: none"> • Springs: Common hardware store springs or recycled springs from old clicky pens (for smaller scale). • Masses: Large metal nuts, fishing sinkers (<i>plomo</i>), or small stones wrapped in plastic. • Measuring Tool: Plastic rulers or a piece of cardboard with 1cm markings. • Support: A makeshift "Lab Stand" using a sturdy wooden stick or a desk edge. <p>I. Activity Instructions for Students</p> <p>A. Set Up the System: Hang the provided spring from a stand and attach a small mass (e.g., a heavy stone or metal weight) to the bottom. Let it come to a complete rest.</p> <p>B. Mark "Zero": Place a ruler behind the mass and mark the resting position. This is your Equilibrium.</p> <p>C. The "Urge" Test:</p> <ul style="list-style-type: none"> ○ Trial A: Pull the mass down gently by only 2cm. Feel the tension in your fingers before you let go. ○ Trial B: Pull the mass down further to 10cm. Notice the difference in how spring "feels." <p>D. Draft a Law: As a group, discuss the relationship between how far you pull the mass (Displacement) and how strong the spring pulls back (Restoring Force).</p> <p>E. The Definition Challenge: On your whiteboard or paper, complete this sentence: "<i>The further the mass moves from its 'Zero' point, the [stronger/weaker] the force becomes that pulls it back, and this force always points toward [up/down/the center].</i>"</p> <p>Option 2: Teacher Discussion: Definition and Characteristics</p> <p>Introduce SHM in simple terms: Simple Harmonic Motion is a repeated back-and-forth motion in which an object moves around an equilibrium position and is pulled back by a restoring force.</p>	<p>Processing and Wrapping Up * Clearing Misconceptions: Use the rubber band analogy: pull a little, it snaps a little; pull a lot, it snaps a lot. This strict proportionality defines motion as "Simple" and "Harmonic."</p> <p>Enrichment Section: Taking it Further <i>(Optional conceptual support for advanced learners; not required for the basic competency)</i> <i>If your students grasp the concept quickly, you can introduce these foundational ideas as a bridge to formal physics tracking:</i></p> <p>Hooke's Law (The Math Behind the "Urge") <i>Introduce Hooke's Law ($F = -kx$) as the "mathematical nickname" for their discovery. Explain that the negative sign represents the force of "fighting" in the displacement.</i></p> <p>The Period Formula (The Timing) <i>If you timed how long it took for the mass to complete one full bounce up and down (the Period, T), you would find that adding more weight slows it down, but using a stiffer spring speeds it up. It looks like this:</i></p> $T = 2\pi\sqrt{\frac{m}{k}}$
--	--	--

Explain the key characteristics:

- **Equilibrium position:** the middle or resting position.
- **Restoring force:** the force that pulls the object back toward equilibrium.
- **Periodic motion:** the motion repeats at equal time intervals.

Use a visual model or diagram of a pendulum or spring.

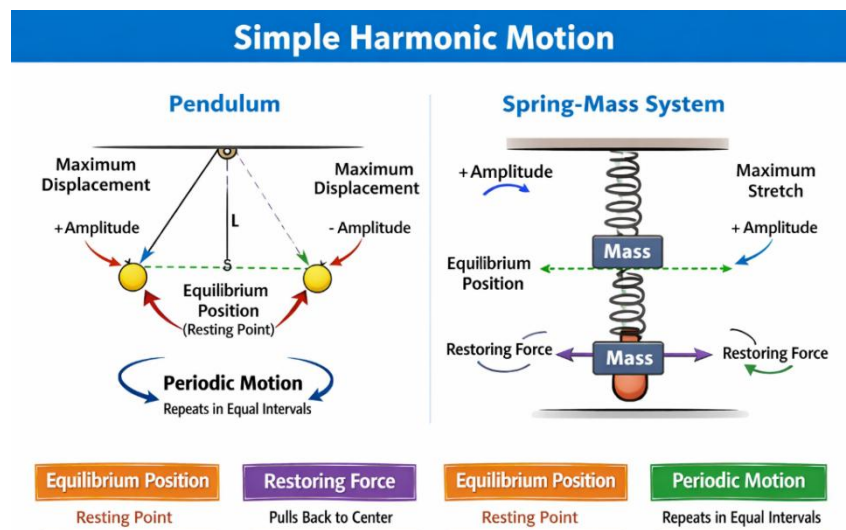


Illustration is created by Microsoft Copilot

Guided Questions:

- What happens when the object is displaced from the center?
- What force brings it back?
- Does the motion repeat?

Mini-activity:

Learners trace the motion path of a pendulum on a diagram and label:

- Displacement
- Equilibrium position
- Restoring force

IDF Application (DepEd SHS Curriculum)

*This phase applies to the **Constructivist and Inquiry-Based Approach** of the DepEd IDF by allowing students to build the definition of SHM through hands-on discovery. By focusing on the relationship between displacement and restoring force, the teacher facilitates **Deeper Learning** and responsiveness to learner needs. The use of simple, local materials ensures **Contextualization**, proving that high-level physics is accessible and relevant to the students' daily lives.*

Activity: The "Variable Control" Lab (The Eureka Challenge)

Facilitation Strategy Resist the urge to correct "wrong" hypotheses. If a group believes a heavier rock slows down a pendulum, let them test it. The resulting **cognitive dissonance** when the timing remains identical is a powerful learning tool.

• Watch Out for "Mass Fallacy":

Students may subconsciously delay stopping the watch to make data fit their theory. Check their timing technique.

	<p>Check for understanding: Ask learners to explain SHM in their own words.</p> <p>3. Developing Mastery</p> <p>Option 1: The "Variable Control" Lab (The Eureka Challenge)</p> <p>For the Teacher: Divide the class so that half the groups work with pendulums (Groups A) and the other half work with springs/rubber bands (Groups B). Ensure the abaca twine or threads are pre-cut to at least 1 meter to allow for a wide range of length adjustments. If using rubber bands, link or double them up to ensure they can support the weights without snapping.</p> <p>Localized Materials</p> <ul style="list-style-type: none"> • For Pendulums: Abaca twine or sewing thread, different sized stones or fishing sinkers (<i>plomo</i>) or "bob", and a bamboo stick to hang them from. • For Springs: Improvised springs or heavy-duty rubber bands (to observe elastic oscillation). • Timing: Students' smartphones (stopwatch app) or a common classroom wall clock with a second hand. <p>Team Roles (Assign Before Starting)</p> <ol style="list-style-type: none"> 1. The Timer: Holds the stopwatch/phone; calls out "Start" and counts the 10 cycles aloud. 2. The Manipulator: Changes the weights, adjusts the string length, or pulls the system back. 3. The Recorder: Fills out the data tables and drafts the group's "Mistake Log." 4. The Speaker: Leads the final oral presentation to the class. <p>Activity Instructions for Students</p> <p>A. The Mission: Your goal is to manipulate a system (either a Pendulum or a Spring) to change its Period (the time it takes for one full back-and-forth cycle). You must find out exactly what makes it "faster" or "slower."</p>	<ul style="list-style-type: none"> • The Amplitude Myth: Use a Socratic prompt: "The object travels further, but is it also moving faster? Do these cancel out?" • Contrast: Ensure students notice that mass matters for springs but not for pendulums. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Building the Concept: Introduce the formal formulas for period: <p>1. The Pendulum Formula When your Pendulum groups are presenting their findings, introduce this formula on the board to validate their "Eureka" moments:</p> $T = 2\pi\sqrt{\frac{L}{g}}$ <p>Where: T = Period (The time it takes for 1 complete swing, in seconds) L = Length of the abaca twine or string (in meters) g = Acceleration due to gravity (constant at approximately 9.8m/s²)</p> <ul style="list-style-type: none"> • Highlight that m (mass) is absent in the pendulum formula but critical in the spring formula. <p>2. The Mass-Spring System Formula When your Spring or Rubber Band groups present, introduce this formula to contrast it with the pendulum:</p> $T = 2\pi\sqrt{\frac{m}{k}}$
--	---	---

- B. **Formulate a Hypothesis:** Before touching the equipment, write down one "If-Then" statement.
- Example: "If I use a heavier stone, then the pendulum will swing slower."
- C. **Conduct the Mini-Experiment:**
- Variable A (Mass):** Keep the string length the same but change the number of weights/stones. Time 10 swings and divides by 10.
 - Variable B (Length/Stiffness):** Keep the weight the same but change the length of the string or use a different spring. Time: 10 cycles.
 - Variable C (Amplitude):** Pull it back just a little, then pull it back very far. Does the time change?

For **PENDULUM** Groups:

Test Parameter	Variable Changed	Total Time (10 Swings)	Period (Total Time ÷ 10)
Test 1: Base Test	Short String (approx. 30cm) + Light Weight		
Test 2: Change Mass	Short String (approx. 30cm) + Heavy Weight		
Test 3: Change Length	Long String (approx. 90cm) + Light Weight		
Test 4: Change Angle	Short String + Light Weight + Pull back very far		

For **SPRING / RUBBER BAND** Groups:

Test Parameter	Variable Changed	Total Time (10 Bounces)	Period (Total Time ÷ 10)
Test 1: Base Test	Single Rubber Band + Light Weight		
Test 2: Change Mass	Single Rubber Band + Heavy Weight		

where:

T = Period (The time it takes for 1 complete bounce up and down, in seconds)

m = Mass of the plomo or stone hanging at the bottom (in kilograms)

k = Spring Constant (The stiffness of the rubber band or spring, in N/m)

Explain the Mass Factor: Point out that, unlike the pendulum, mass (**m**) is in this formula. Because it is on top, adding more mass increases inertia, which drags the system down and increases the time (**T**) it takes to complete a bounce.

• **Clearing Misconceptions:** Explain that for pendulums, gravity's stronger pull on a heavier mass is exactly offset by its greater **inertia**. In springs, the "pull" (stiffness **k**) remains constant regardless of mass, making the system slower as weight increases.

Students often struggle to understand why pulling the pendulum higher or stretching the spring further doesn't change the time. You can use these two foundational relationships to clear up that final misconception:

The Frequency Formula:

$$f = \frac{1}{T} \quad \text{or} \quad f = \frac{\text{cycles}}{\text{time}}$$

	Test 3: Change Stiffness	Double/Thicker Rubber Bands + Light Weight			IDF Application (DepEd SHS Curriculum) <i>This activity applies to the Scientific Inquiry and Discovery Learning components of the DepEd IDF by emphasizing the process of verification over rote answers. By using "Mistake Logs," the lesson fosters metacognition and responsiveness to learner needs. It honors the Learner-Centered principle, transforming students into primary investigators who derive physical laws through evidence-based reasoning.</i>																											
	Test 4: Change Stretch	Single Rubber Band + Light Weight + Pull down very far																														
<p>D. Create a "Mistake Log": In your notebook, record what you <i>expected</i> to happen versus what <i>actually</i> happened. Highlight any "Eureka" moments where your prediction was wrong.</p> <p>E. Group Presentation: Briefly share with the class: "We tried to change the period by [Variable], and we discovered that it [did/did not] work because..."</p> <p>Option 2: Sorting and Matching For the Teacher: Give learners cards with examples and characteristics.</p> <ol style="list-style-type: none">1. Work in pairs2. Match all 4 cards in each set3. Explain why each match is correct4. Ready? Show your teacher your output! <p>They match:</p> <ul style="list-style-type: none">• Example → Natural or human-made• Motion → SHM or not SHM• Feature → restoring force, periodic motion, equilibrium																																
<table><tr><th>Example Cards</th><th>Natural/Hu man-made</th><th>SHM or Not</th><th>Feature</th></tr><tr><td>Playground swing</td><td></td><td></td><td></td></tr><tr><td>Swaying branch</td><td></td><td></td><td></td></tr><tr><td>Guitar string</td><td></td><td></td><td></td></tr><tr><td>Rolling ball</td><td></td><td></td><td></td></tr><tr><td>Pendulum clock</td><td></td><td></td><td></td></tr><tr><td>Water waves</td><td></td><td></td><td></td></tr></table>						Example Cards	Natural/Hu man-made	SHM or Not	Feature	Playground swing				Swaying branch				Guitar string				Rolling ball				Pendulum clock				Water waves		
Example Cards	Natural/Hu man-made	SHM or Not	Feature																													
Playground swing																																
Swaying branch																																
Guitar string																																
Rolling ball																																
Pendulum clock																																
Water waves																																

	<p>Formative Activity 2: Quick Response Questions</p> <p>Ask learners to answer:</p> <ol style="list-style-type: none"> 1. What is SHM? 2. What is the role of the restoring force? 3. Give one natural and one human-made example of SHM. 4. A ball rolling back and forth in a flat tray is <i>not</i> in SHM. What critical mechanical ingredient is missing from its motion? 5. Imagine the restoring force suddenly disappears the moment a playground swing passes its center point. Predict what would happen to the motion of the swing. <p>Peer Check: Learners' exchange answers and correct using an answer guide.</p>	
<p>C. Demonstrating Knowledge and Skills</p>	<p>1. Finding Practical Application</p> <p>Activity: The "Seismic Solution" Workshop (Bantay-Alon Design Challenge)</p> <p>For the Teacher: Set the stage by showing photos of local coastal communities or a <i>taping-dagat</i> setting. Emphasize that in many rural areas, high-tech sensors are unavailable, making mechanical, physics-based solutions lifesaving. Organize the "Recycled Design Tools" into a central "supply station" where groups can pick materials that mimic real-world components.</p> <p>Localized Materials</p> <ul style="list-style-type: none"> • Recycled Design Tools: Used cardboard, empty plastic bottles (to represent buoys), string/straw, and old bottle caps (to represent the bell). • Stationery: Manila paper, crayons/markers, or even charcoal on recycled wood. • Visual Aids: Pictures of local Filipino coastal villages or <i>Bangkas</i> for context. 	<p>Facilitation Strategy Act as a "Safety Consultant" to prioritize physical logic over artistic skill. If a bell is placed too close to the float, ask: "<i>If a 5cm ripple moves the buoy, will it trigger a false alarm?</i>" This helps students treat Amplitude as a critical safety threshold.</p> <ul style="list-style-type: none"> • Watch Out: Students often assume the wave "does all the work." Remind them that without a Restoring Force (buoyancy pushing up or gravity pulling down into a trough), the buoy won't oscillate. Emphasize that the water level represents a shifting equilibrium. <p>Processing and Wrapping Up * Building the Concept: Connect their prototypes to Resonance and Thresholds. Explain that the physical "Distance to the Bell" represents the Amplitude (A) of the wave.</p>

	<p>Activity Instructions for Students</p> <ol style="list-style-type: none"> 1. The Mission: Your "Team" group) has been hired to design a Low-Cost Tsunami/Storm Surge Warning Bell. The device must be powered solely by the Simple Harmonic Motion of ocean waves. 2. The Design Criteria: <ul style="list-style-type: none"> ○ The Float: Use a bobbing object (buoy) that stays at a specific Equilibrium Position during calm seas. ○ The Trigger: A bell must ring <i>only</i> when the wave displacement (x) is high enough to indicate a storm or surge. ○ The Restoring Force: Explain what will pull your buoy back down or push it back up to ensure it keeps "oscillating" with the waves. 3. The Sketching Phase (20 Mins): On your Manila paper, draw a detailed, labeled blueprint of your prototype. Instead of focusing on artistic decorations, your drawing must explicitly label: <ul style="list-style-type: none"> • The Equilibrium Position ($x = 0$) relative to calm sea level. • The exact Amplitude (A) threshold gap (the distance in centimeters between the resting striker and the warning bell). • Arrows indicating the direction of the Restoring Force when a wave lifts the float up. 4. The Inquiry Defense (20 Mins): Your group must answer these "Safety Consultant" questions: <ul style="list-style-type: none"> ○ "If the tide rises (changing the baseline water level), how does your Equilibrium Position shift?" ○ "How do you prevent the bell from ringing during normal, small ripples?" 	<ul style="list-style-type: none"> • Clearing Misconceptions: Address the "Rising Tide" issue. In SHM, the Equilibrium Position can be dynamic; as the sea level rises, the "Zero" point shifts. A successful design must account for this, so the bell doesn't ring simply due to high tide. • Summary: Physics uses the predictable rhythms of nature—like the restoring force of buoyancy—to build tools that protect our community. <p>IDF Application (DepEd SHS Curriculum) This activity exemplifies the Contextualization and Disaster Risk Reduction (DRR) Integration of the DepEd IDF. By designing a "Seismic Solution" for coastal safety, the lesson becomes Service-Oriented and Value-Laden, showing that science is a vital tool for public welfare. It promotes Active Citizenship and 21st Century Skills by requiring students to apply equilibrium and displacement principles to complex, real-world Filipino challenges.</p>
--	---	---

	<p>5. Gallery Walk (20 Mins): Post your designs. Use sticky notes to give "constructive feedback" to other groups. Do not comment on how pretty the drawing looks. Instead, leave feedback on physics viability:</p> <ul style="list-style-type: none"> • <i>"Is their amplitude gap wide enough to prevent false alarms?"</i> • <i>"Will their restoring force snap or tangle if a large wave hits?"</i> <p>2. Making Generalization</p> <p>Activity: The "Hugnayan" (Connection) Concept Map</p> <p>For the Teacher: Prepare the "Anchor Nodes" in advance using large, bold lettering on colored cards. Clear a wide space on the chalkboard or a wall to ensure the entire class can see the map as it grows. Have different colored markers ready to distinguish between "concepts" and "links."</p> <p>Activity Instructions for Students</p> <p>A. Gather at the "Community Board": The class will converge around a large Manila paper or a designated section of the chalkboard.</p> <p>B. Identify Anchor Nodes: Your teacher has placed four "Core Concepts" on the board:</p> <ul style="list-style-type: none"> ○ Simple Harmonic Motion (SHM) ○ Equilibrium Position ○ Restoring Force ○ Periodic Motion <p>C. Draw the "Ugnayan" (Connections): Volunteers will step forward to draw arrows between these nodes.</p> <p>D. Label the Relationship: On each arrow, you must write a short phrase (in English or Filipino) that explains the link.</p>	<p>Activity Name: The "Hugnayan" (Connection) Concept Map</p> <p>Facilitation Strategy Act as the Synthesizer. Use "Verification Questions" to guide students as they draw connections. If a student links Periodic Motion to SHM, ask: <i>"Is every repeating motion SHM? What special force is required?"</i> This encourages them to connect to the Restoring Force.</p> <p>• Watch Out: Correct the idea that motion "ends" at Equilibrium. Remind them of the <i>Duyan</i> (swing): <i>"It doesn't stop at the bottom because it has momentum."</i> Equilibrium is where forces balance, not necessarily where movement stops.</p> <p>Processing and Wrapping Up</p> <p>• Building the Concept: Solidify the "Big Picture." Explain SHM as a specific Periodic Motion where the Restoring Force is proportional to displacement. Trace the "Cycle of SHM" on the map: Displacement → Restoring Force → Acceleration → Momentum → Displacement.</p>
--	--	---

	<ul style="list-style-type: none">○ <i>Example:</i> Between Restoring Force and Equilibrium, you might write: "<i>Pulls the object back to...</i>" <p>E. Final Summary: Once the map is complete, one student representative will explain the "story" of the map in two sentences to summarize what makes a motion "Simple Harmonic."</p> <p>Exit Slip: "Check Your Rhythm" Directions: Answer the two questions below briefly on a quarter sheet of paper.</p> <ol style="list-style-type: none">1. The Core Rule: Complete the statement below using the words increases, decreases, away from, or toward: <i>"In Simple Harmonic Motion, the restoring force always points _____ the equilibrium position, and its strength _____ the further the object moves from the center."</i>2. The Test Case: A kid jumps continuously up and down on a localized bamboo trampoline at a perfectly steady rhythm. Is this general Periodic Motion, or is it Simple Harmonic Motion (SHM)? Justify your answer using the concept of a <i>restoring force</i>.	<ul style="list-style-type: none">• Clearing Misconceptions: Contrast Force and Motion. Use the map to show that the Restoring Force is zero at equilibrium (where speed is maximal) and maximal at the furthest points (where speed is zero).• Summary: "<i>The beauty of SHM is balance—the further you push it away, the harder it tries to come back Home.</i>" <p>IDF Application (DepEd SHS Curriculum) This activity aligns with the Collaborative and Reflective approach of the DepEd IDF by fostering a "Community of Learners" that synthesizes knowledge collectively. By defining the relationships between terms, students engage in Metacognition and Critical Thinking, ensuring a holistic rather than fragmented understanding. The visual map promotes Inclusivity and Universal Design for Learning (UDL), providing a graphic organizer that helps diverse learners visualize the logical structure of physics.</p>
V. ASSESSMENT (Assessing Learnings)	<p>A. Multiple Choice</p> <ol style="list-style-type: none">1. Which of the following best defines Simple Harmonic Motion?<ol style="list-style-type: none">A. Any motion that repeats itself in a circular path at a constant speed.B. A type of periodic motion where the restoring force is proportional to the displacement from equilibrium.C. The movement of an object in a straight line with constant acceleration.D. A random vibration caused by external friction.	

2. At the Equilibrium Position of a vibrating spring system, what is the status of the restoring force?
 - A. It is at its maximum value.
 - B. It is equal to the mass of the object.
 - C. It is zero.
 - D. It pulls the object away from the center.
3. Which of the following is a natural example of SHM observed in a local Philippine setting?
 - A. A tricycle driving in a straight line along a highway.
 - B. The rotating blades of an electric fan in the classroom.
 - C. A stalk of palay swaying back and forth in a gentle breeze.
 - D. A stone falling from the top of a Mayon Volcano.
4. In a traditional *Duyan* (Filipino hammock), what serves as the restoring force that keeps the child swinging back to the center?
 - A. The air resistance pushing against the hammock.
 - B. The tension in the ropes and the component of gravity.
 - C. The push provided by the parent.
 - D. The friction of the ropes against the beam.
5. During a classroom experiment with a pendulum, if a student increases the Amplitude (pulls it back further) but keeps the length the same, what happens to the Period?
 - A. The period increases significantly.
 - B. The period decreases significantly.
 - C. The period remains practically unchanged.
 - D. The pendulum stops moving immediately.

B. EXPLANATION

1. Define Simple Harmonic Motion in your own words, making sure to mention what happens to the force as the object moves further away from the center.
2. List and briefly describe the three key components of SHM.
3. Compare the movement of a clock second hand (rotating) with the movement of a guitar string (vibrating). Explain why only the guitar string is considered SHM by focusing on the "path" and the "restoring force."
4. Using the results from your "Variable Control" lab, explain why a child on a playground swing and an adult on the same swing will have the same "rhythm" (period), even though the adult is much heavier.

5. You are an engineer in a coastal town. You need to build a "Tsunami Warning Buoy." Using your knowledge of SHM, explain how you would design the buoy, so it only triggers an alarm during large-amplitude waves (surges) but stays silent during normal, small ripples.

Answer Key:

Multiple choice

1. B
2. C
3. C
4. B
5. C

Scoring Rubric for B. Explanation Items

Use this rubric to grade each question. Each explanation item is worth a maximum of 3

Criteria	3 – Proficient	2 – Developing	1 – Beginning
Q1: Definition of SHM + restoring force	Clearly defines SHM as periodic motion and explicitly states restoring force is proportional to displacement and directed toward equilibrium.	Defines SHM correctly but weak or incomplete explanation of restoring force relationships.	Incorrect or vague definition; no mention of restoring force behavior.
Q2: Key components of SHM	Correctly lists and clearly describes all three components (Amplitude, Period, Frequency/Phase) with accurate explanations.	List all or most components, but explanations are partial or slightly unclear.	Missing components or incorrect identification with little/no explanation.
Q3: Rotation vs SHM comparison	Clearly distinguishes circular motion vs SHM using path and restoring force; explains why guitar string is SHM and fan is not.	Mentions differences, but the explanation lacks clarity in restoring force or motion type.	Does not correctly compare or confuse SHM with rotational motion.
Q4: Swing investigation (Variable Control lab application)	Correctly explains why period is independent of mass using SHM principles (length governs period; restoring force relationship).	Partially correct explanation; mentions key ideas but lacks full reasoning or clarity.	Incorrect reasoning (e.g., mass incorrectly affects period or no SHM concept used).
Q5: Engineering application (Tsunami buoy design)	Applies SHM concept creatively and correctly: distinguishes amplitude effect, uses threshold concept for large oscillations, shows clear engineering reasoning.	Shows partial understanding of SHM in design; idea is present but not fully scientifically justified.	Lacks SHM concept or gives unrelated/incorrect engineering explanation.

<p>VI. REFLECTION <i>(Feedback and Continuous Improvement)</i></p>	<p><i>For the Teacher:</i></p> <ol style="list-style-type: none"> 1. Which part of the lesson sequence was most difficult for learners to understand, and what do you think caused this difficulty? 2. What immediate adjustments did you make during the lesson to clarify misconceptions or improve understanding? 3. Which part of the SHM lesson (Pattern hunt, Variable Control Lab, etc.) produced the strongest learner engagement? What evidence shows this? 4. Which part of the lesson showed the highest level of curiosity, participation, or inquiry from learners? 5. If you teach this SHM lesson again, what will you improve in the design or delivery of activities? <p><i>For the Students:</i></p> <ol style="list-style-type: none"> 1. How did you feel at the beginning of the lesson (curious, confused, excited, unsure)? Why? 2. Did you experience any confusion about how variables (mass, length, amplitude, stiffness) affect motion? Explain. 3. What part of the SHM activities (Pattern hunt, Variable Control Lab, etc) helped you understand the concept best? Explain why. 4. How did hands-on activities (pendulum/spring experiments) help you understand SHM compared to just listening to explanations? 5. What additional support (examples, demonstrations, or guidance) would have helped you understand SHM better?
<p>VII. USE OF GENERATIVE AI</p>	<p>In preparing this Lesson Exemplar (LE), the author(s) used Gemini AI to structure activities and localize physics examples to the Philippine context. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	20
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that simple harmonic motion can be characterized by periodic motion.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners describe simple harmonic motion in terms of amplitude, period, frequency, phase, and how its principles are applied in the design of everyday systems.</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<ul style="list-style-type: none"> • Connor, Jerome J. 2003. <i>Introduction to Structural Motion Control</i>. Upper Saddle River, NJ: Prentice Hall. • Earthquake Engineering Research Institute. 2015. "Taipei 101 Tuned Mass Damper Shaking During Earthquake." YouTube Video, 0:34. Shorts Link. https://www.youtube.com/shorts/7wRcrJzyskM. • Flipped Physics. 2014. "Introduction to Simple Harmonic Motion (SHM) - Displacement, Velocity, and Acceleration." YouTube Video, 8:46. https://www.youtube.com/watch?v=1wVrkhB52LE&t=4s. • McDermott, Lillian C., and Peter S. Shaffer. 2002. <i>Tutorials in Introductory Physics</i>. Upper Saddle River, NJ: Prentice Hall. • Mechanic's Eye. 2023. "Jeepney Multi-Leaf Spring Suspension Road Shock Simulation." YouTube Video, 0:12. Shorts Link. https://www.youtube.com/shorts/vjLT2QIRGHo. • University of Colorado Boulder. n.d. "Masses and Springs." PhET Interactive Simulations. Accessed May 20, 2026. https://phet.colorado.edu/en/simulations/masses-and-springs. • Vecteezy. 2022. "Animation Cartoon Where a Girl Swings on a Swing." Stock Video Footage, 0:10. https://www.vecteezy.com/video/13772406-animation-cartoon-where-a-girl-swings-on-a-swing.

III. CONTENT <i>(Sequencing Content)</i>	Periodic motion 1. Oscillations 2. Simple harmonic motion	
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	At the end of the lesson, the learners will be able to: 1. Define amplitude, period, frequency, and phase in the context of simple harmonic motion. 2. Describe how amplitude, period, frequency, and phase characterize simple harmonic motion. 3. Explain how the principles of simple harmonic motion are applied in the design of everyday systems (e.g., pendulum clock, car suspension, playground swing, vibrating strings).	
IV. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i> This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension. (Each part shall have 2-3 varied activities)		ANNOTATIONS <i>*Instruction to the teacher on how to facilitate the activities.</i> <i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i>
A. Activating Prior Knowledge	1. Activating Prior Knowledge Variation 1: The "Oscillation Duel" For the Teacher: Prepare two stations for each group. Instruct the learners to prepare the setup a day before the activity. Ensure springs are not over-stretched, and pendulum bobs are securely tied. Keep a "Word Bank" on the board to catch learners-generated descriptions. Safety Protocols: Securely tie pendulum bobs to prevent detaching. Do not pull springs past their elastic limit (over-stretching). Establish a clear "no-flight zone" around each	Facilitation Strategy <ul style="list-style-type: none">● Prompting: If learners struggle with "faster," ask: "What happens if you shorten the string?" or "What happens if you use a heavier weight or a stiffer spring?"● Non-Technical Validation: Accept and write down learners' terms like "swing-width," "tightness," or "bounciness" on the board.● Observation Focus: Guide them to notice that increasing the "width"

	<p>workstation to prevent learners from being struck by moving masses.</p> <p>Activity Instructions for Learners</p> <p>A. Set Up: Assemble your pendulum and mass-spring system. Ensure they can move freely without hitting the table or floor.</p> <p>B. The "More & Faster" Challenge:</p> <ul style="list-style-type: none"> • Setup 1: Find a way to make both systems move "more" (greater distance/wider path). • Setup 2: Find a way to make both systems move "faster" (more cycles in a short burst). <p>C. Observation Log: On a piece of paper, complete these observations:</p> <ul style="list-style-type: none"> • To increase distance/amplitude, we changed... • To increase speed/frequency, we changed... • When it moved faster, the time for one complete swing felt... <p>D. The "Sync" Challenge: Try to make the pendulum and the spring move at the exact same rhythm (hit the bottom at the same time). Discuss: Is it easier to change the "distance" or the "speed" to make them match?</p> <p>Variation 2: "Guess My Motion" Mirror Game</p> <p>For the Teacher: Model the first round. Emphasize safe movements (no wild swinging that risks hitting others). Prepare a visible Word Bank on the board: Amplitude (how far/wide), Frequency (how fast/repeats), Period (time per cycle). Keep materials simple and identical per group.</p> <p>Materials: Pendulum (string + washer/bottle) and mass-spring (rubber band or spring + weight) per group of 4.</p> <p>Activity Instructions for Learners</p> <p>A. Warm-Up Round: One member is the "Motion Maker." They secretly decide to change either "bigness" (pull harder)</p>	<p>(Amplitude) doesn't necessarily make it "faster" (Frequency).</p> <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Building the Concept: Transition "swing-width" to Amplitude, "cycles per second" to Frequency, and "time per cycle" to Period. • Clearing Misconceptions: Address the common error that pulling a pendulum further makes it swing significantly faster. Use their observations to show that length or mass often dictates the "rhythm," not the starting push. <p>IDF Application (DepEd SHS Curriculum)</p> <p>This activity applies to the Instructional Design Framework (IDF) by fostering the Learner Agency through an inquiry-based "challenge" that moves from the concrete to the abstract. By leveraging previous knowledge of basic systems (pendulums and springs), it ensures Curricular Continuity while utilizing Discovery Learning to let learners define variables in their own language before formalization. This approach encourages learners to compare the underlying mechanics and relationships between different oscillating systems, making the learning experience both contextualized and responsive to their initial intuitions.</p>
--	---	---

	<p>or "quickness" (change length subtly or push faster). Perform the motion for 10–15 seconds.</p> <p>B. <i>Mirror Challenge</i>: The rest of the group must mirror the exact motion using their own system. Then discuss: What did the Motion Maker change to make it "more" vs. "faster"?</p> <p>C. <i>Observation Log</i>:</p> <ul style="list-style-type: none"> • <i>To increase distance/amplitude, we changed...</i> • <i>To increase speed/frequency, we changed...</i> • <i>When it moved faster, the time for one complete swing felt...</i> <p>D. <i>Sync Duel</i>: Pairs try to make their two systems hit the lowest point at exactly the same time. Discuss: Was it easier to match by changing distance or by changing rhythm? Why?</p> <p>2. Establishing the Purpose of the Lesson</p> <p>Activity: The "Earthquake & Jeepney Ride" Challenge</p> <p>For the Teacher: Prepare two short clips or photos: one of a Jeepney/Car bouncing on a pothole-filled road and another of a high-rise building swaying during an earthquake. Ensure the focus is on the "rhythm" and "control" of the movement.</p> <p>Activity Instructions for Learners</p> <p>A. Local Context Observation: Look at the two scenarios:</p> <ul style="list-style-type: none"> • The Jeepney (Car): Watch how the leaf spring suspension bounces after hitting a pothole. https://www.youtube.com/shorts/vjLT2QIRGHo • The Earthquake Damper: Watch how a "tuned mass damper" (like a giant pendulum) inside a skyscraper moves to counteract the shaking of the ground. https://www.youtube.com/shorts/7wRcrJzyskM <p>B. The "Ligtas-Disenyo" (Safety Design) Discussion: Brainstorm in your groups. Focus explicitly on how</p>	<p>Teacher Facilitation and Processing Guide</p> <p>Begin the processing by revisiting the two scenarios; the jeepney and the skyscraper. Ask learners to explain which motions appeared more dangerous and why. Guide them to realize that “shaking” is not just one kind of movement but is described by different characteristics involving both distance and timing.</p> <p>Lead the discussion toward the “big picture” of the lesson: Engineers and scientists must understand and measure motion to predict, control, and reduce dangerous vibrations in vehicles, buildings, bridges, and other structures.</p> <p>Explicitly connect learner observations to the formal SHM quantities:</p>
--	---	---

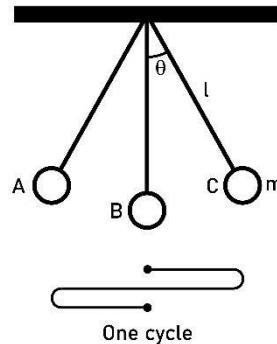
	<p>controlling these vibrations directly impacts human life, disaster preparedness, and community resilience:</p> <ul style="list-style-type: none"> • The Jeepney (Car): If the chassis oscillation never stopped or was unchecked, what risks arise for passengers/cargo? Which variables must mechanics calculate (amplitude of bounce, period of oscillation, frequency of vibration)? • The Building: During a strong earthquake, what risks occur if the building swings too far or too fast? Which variables must engineers control (amplitude of sway, phase difference between damper and building, frequency of oscillation)? <p>C. The "Why We Care" Pitch:</p> <p>* The Question: "Why are we learning this?"</p> <ul style="list-style-type: none"> • Expected Answer: From the Jeepney/Car suspension, to ensuring buildings and our bridges and homes survive an Earthquake, we must master the "DNA of Motion." • Your Goal: Today, you are the designers. You will learn to measure Amplitude, Period, Frequency, and Phase—the four tools needed to keep the world steady and "in sync." 	<ul style="list-style-type: none"> • "How far the object moves from the center" → Amplitude Example: A building that sways too far side-to-side during an earthquake has a large amplitude, which may damage the structure. • "How fast the motion repeats" → Frequency Example: A vehicle vibrating rapidly on a rough road has a high frequency of oscillation. • "How long one complete vibration takes" → Period Example: If a swing takes 2 seconds to move back and forth once, that time is called the period. A longer period means slower oscillation. • "Whether motions move together or out of sync" → Phase Example: Two buildings during an earthquake may sway differently even if they move at the same speed. One may move left while another moves right at the same moment. This difference in timing or synchronization is called a phase. <p>Processing and Wrapping Up</p> <p>To prevent accidents and disasters, engineers must measure the size, timing, speed, and synchronization of oscillations using Amplitude, Period, Frequency, and Phase. These quantities form the mathematical foundation of Simple Harmonic Motion and help engineers design systems that remain stable, safe, and "in sync" with their environment.</p>
--	--	---

	<p>Option 2: "The Fragile Cargo Challenge" For the Teacher: Prepare a simple “shaky table” setup using a flat board placed on two PVC pipes/dowels as rollers. Place a transparent tray with a glass of colored water on top. If learners struggle with descriptions, guide them by asking:</p> <ul style="list-style-type: none"> • “Was it the size of the motion or the timing of the shaking that caused the spill?” • “Which movement repeated more quickly?” • “Which movement moved farther from the center?” <p>Materials: A flat board, two round PVC pipes/dowels (rollers), a transparent tray, and a glass of water (colored for visibility).</p> <p>Activity Instructions for Learners</p> <ol style="list-style-type: none"> 1. Set Up: Place the board on the rollers to create a "shaky table." Place the tray and water glass on top. Ensure the setup is stable before testing. 2. The Engineer’s Mission: You are transportation engineers who are tasked to design a safer delivery system for fragile cargo during earthquakes or rough road travel. <p>Challenge A: “Large Motion”</p> <ol style="list-style-type: none"> 1. Move the board back and forth slowly but over a large distance. 2. Observe the motion of the water carefully. <p>Guide Questions:</p> <ul style="list-style-type: none"> • What happened to the water? • How did the movement affect the spill? • Which characteristic of motion became more noticeable? <p>Challenge B: “Rapid Motion”</p> <ol style="list-style-type: none"> 1. Move the board back and forth over a short distance but very quickly. 2. Observe the water again. 	<p>Processing of this activity: Allow learners to explore the setup through direct manipulation and observation before introducing scientific terminology. Encourage <i>learners</i> to compare the effects of large motion versus rapid motion on the water.</p> <p>The "Why": Guide the learners toward recognizing that oscillations differ in size, speed, timing, and synchronization. During processing, connect learner observations to the formal SHM variables: amplitude, frequency, period, and phase.</p> <p>IDF Application (DepEd SHS Curriculum) By using familiar Filipino experiences, like riding a jeepney or earthquake preparedness, the lesson ensures the curriculum is responsive to the learners' environment.</p>
--	--	---

	<p>Guide Questions:</p> <ul style="list-style-type: none">• What differences did you observe compared to Challenge A?• Did the water react differently?• Which characteristic of motion became more noticeable? <p>C. The “Variable Hunt” Report As a group, complete the table below:</p> <table><tr><th>Situation Observed</th><th>SHM Variable Involved</th></tr><tr><td>1. Large side-to-side movement of the board</td><td></td></tr><tr><td>2. Rapid repeated shaking</td><td></td></tr><tr><td>3. Time needed for one back-and-forth cycle</td><td></td></tr><tr><td>4. Two motions moving together or not synchronized</td><td></td></tr></table> <p>Choose from:</p> <ul style="list-style-type: none">• Amplitude• Frequency• Period• Phase <p>D. Reflection Complete the statement: “Understanding oscillations is important because _____.”</p>	Situation Observed	SHM Variable Involved	1. Large side-to-side movement of the board		2. Rapid repeated shaking		3. Time needed for one back-and-forth cycle		4. Two motions moving together or not synchronized		
Situation Observed	SHM Variable Involved											
1. Large side-to-side movement of the board												
2. Rapid repeated shaking												
3. Time needed for one back-and-forth cycle												
4. Two motions moving together or not synchronized												
<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples</p> <p>Option 1: The "Cycle Search" Station Rotation For the Teacher: Prepare the materials/set in advance. Set up three distinct stations around the room. If physical objects are unavailable, use tablets or printed "action</p>	<p>Facilitation Strategy</p> <ul style="list-style-type: none">• Scaffolding the "Cycle": <i>Many learners think a half-cycle is a full cycle (e.g., just going from left to right). Ask: "If the object stops there, has it returned to its original state and direction?"</i>										

	<p>sequence" photos. Provide one small handheld whiteboard and marker per group.</p> <p>Materials Needed:</p> <ul style="list-style-type: none"> • Station A: A DIY Pendulum (weighted string) • Station B: An acoustic guitar or a single taut nylon string fixed between two points. • Station C: A video loop/GIF of a child on a <i>swing</i> or a <i>duyan</i> (hammock). https://www.vecteezy.com/video/13772406-animation-cartoon-where-a-girl-swings-on-a-swing • Group Tools: Small whiteboards, markers, and "Cycle Stickers" (optional). <p>Activity Instructions for Learners</p> <p>A. Rotation: Move with your group to your assigned station. Spend 5 minutes observing the motion of the object.</p> <p>B. The "Trace the Path" Task:</p> <ul style="list-style-type: none"> • Identify the Equilibrium (Home) position—where the object sits when it is not moving. • Using your whiteboard, draw a simple line diagram of the movement. • The Challenge: Mark the exact starting point, the furthest point reached, and the exact moment "one complete cycle" is finished. <p>C. Compare & Contrast:</p> <ul style="list-style-type: none"> • Station A (The Pendulum): Is one cycle "left to right" or "left-right-left"? 	<ul style="list-style-type: none"> • Visualizing the Invisible: For the guitar string (Station B), encourage learners to pluck it gently and look at the "blur." Ask them to draw the upper and lower limits of that blur. • Prompting Observation: Use the "Slow-Mo" technique. Ask learners to mimic the motion with their hands in slow motion to better identify the start and end points. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Standardizing the "Cycle": Use the learner diagrams to introduce the technical definition of a Cycle (one complete round trip). • Connecting to the Lesson: Explain that today's goal is to measure exactly how long these cycles take (Period) and how many happen every second (Frequency). <p>IDF Application (DepEd SHS Curriculum)</p> <p>By using relatable objects like a guitar and a duyan, the lesson ensures Contextualization and Responsiveness to the learners' interests, sparking curiosity before formal definitions are introduced. This structured rotation promotes Alignment by focusing on the fundamental "unit" of SHM—the cycle—ensuring learners to have a</p>
--	---	--

- **Station B (The String):** The movement is very fast—how do you define the "end" of its path?
- **Station C (The Swing/Duyan):** Does the cycle change if the person swings higher?



D. Synthesis: Return to your seats and prepare to show your "Cycle Diagram" to the class. Be ready to explain: "What must happen for us to say the motion has repeated itself?"

Alternative 1: "The Pendulum Storyboard"
(Visual/Spatial Scaffolding)

- **The Task:** If the learners cannot explain a "cycle" abstractly, the teacher hands the group in a blank 3-frame comic strip template.
- **Instructions for Learners:** "Draw your pendulum or *duyan* across three distinct moments in time. Frame 1 is 'Release'. Frame 2 is the 'Opposite Peak'. Frame 3 is 'Return'. Now, point to where the cycle ends. Why can't Frame 2 be the end of the story?"

solid, observable foundation before they are asked to apply mathematical formulas to these same systems.

	<p>Option 2: "The Shadow Trace Station Rotation"</p> <p>Note for Teachers:</p> <ul style="list-style-type: none"> • Preparation: Dim the room lights to ensure sharp shadows. Set up three distinct stations with clear boundaries. • Safety: Ensure the turntable/fidget spinner is secured, so the "peg" doesn't fly off at high speeds. • Tech Check: Encourage at least one <i>learner</i> per group to have a phone ready for the "Slow-Mo" capture at Station B. <p>Instructions for Learners:</p> <ol style="list-style-type: none"> 1. Rotation: Spend 5 minutes at each station. Focus only on the shadow cast on the wall/paper, not the object itself. <ul style="list-style-type: none"> ○ Station A (The Duyan): Swing the weight gently. Observe the shadow's horizontal path. ○ Station B (The Guitar): Pluck the string. Use your phone's Slow-Motion video to record and observe the "blur" or shadow movement. ○ Station C (The Turntable): Observe the shadow of the peg as the plate rotates at a constant speed. 2. The Trace: On your group whiteboard, draw the path the shadow takes. Mark the "Equilibrium" (the center point where the shadow sits when motion stops). 3. The Discovery: Compare your three drawings. In your journals, answer: <i>"How can a circular movement (Station C) and a straight-line vibration (Station B) produce the exact same shadow pattern?"</i> <p>2. Discussing New Concept</p> <p>Activity: The "Motion Mapping" Discovery Lab</p> <p>For the Teacher: Set up computer stations with the PhET "Masses and Springs" simulation or prepare physical sets with motion sensors (if available). Provide "Graphing Guides" (pre-drawn x and y axes) to save time.</p>	<p>Facilitation Strategy (Option 2)</p> <p>To facilitate this effectively, the teacher should move between stations acting as a "Socratic observer." Instead of explaining physics immediately, ask <i>learners</i>, <i>"Where is the shadow moving the fastest?"</i> or <i>"Where does the shadow stop for a split second?"</i> This guides them to notice that in all three examples, the velocity is zero at the "turning points" (Amplitude) and maximum at the center. Use the "Slow-Mo" footage at the string station to help <i>learners</i> count a single "Cycle," bridging the gap between high-speed vibration and observable SHM.</p> <p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Scaffolding through Analogies: If <i>learners</i> struggle with Phase, use the "Dancing Duo" analogy: "You are both doing the same dance moves (same frequency), but one of you is two steps behind the other."
--	---	--

	<p>The Vocabulary of Vibration</p> <p>Before analyzing complex graphs, use these foundational keys to decode the "DNA" of Simple Harmonic Motion (SHM):</p> <ul style="list-style-type: none"> • Equilibrium ($x = 0$): The "home" or natural resting position of the system where no net force acts on the object. • Cycle: One complete round-trip journey of the motion (starting from a specific point, moving through all positions, and returning to the exact same spot moving in the same direction). • Amplitude (A): The maximum distance or displacement of the object from its equilibrium position. (Measured in meters, m). • Period (T): The total time it takes for an object to complete exactly <i>one</i> full cycle. (Measured in seconds, s). • Frequency (f): The number of complete cycles that happen in exactly <i>one second</i>. (Measured in Hertz, Hz or s^{-1}). • <i>Mathematical Lock:</i> Period and Frequency are inverse twins: $f = \frac{1}{T} \quad \text{and} \quad T = \frac{1}{f}$ • Phase (Φ): The specific starting point or position of an oscillator within its cycle at time $t = 0$ (often compared to an angle on a circle, measured in degrees or radians). <p>Materials Needed:</p> <ul style="list-style-type: none"> • Laptop/Tablet with <u>PhET Simulation: Masses and Springs</u> • Stopwatches and Rulers • Graphing paper and colored pens (Red, Blue, Green) 	<ul style="list-style-type: none"> • Mathematical Solidification: Once <i>learners</i> notice that T and f are "opposites," introduce the formal relationship: $f = 1/T$. • Visualizing the Math: Point to the peak of their drawn wave and label it Amplitude. Show that a full wave cycle on paper represents one "round trip" they observed in Station Rotation. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Defining the DNA: Standardize the definitions based on their findings: Amplitude (max displacement), Period (time for one cycle), Frequency (cycles per second), and Phase (starting position/shift). • Formula Introduction: Briefly show how these variables fit into the SHM equation $x(t) = A \cos(\omega t + \Phi)$, explaining that ω (angular frequency) is just another way to look at f. <p>IDF Application (DepEd SHS Curriculum)</p> <p>By providing a digital or physical "sandbox" (PhET/Springs), the lesson remains Responsive to different learning paces and styles, allowing <i>learners</i> to "see" the math before they calculate it. The structured inquiry ensures Alignment with the DepEd</p>
--	---	--

	<p>Activity Instructions for Learners</p> <p>A. Guided Exploration:</p> <ul style="list-style-type: none"> • Set Up: Open the simulation. Hang a 100g mass on the spring. • Mapping: Pull the mass down and let it vibrate. Using the "Slow Motion" and "Pause" buttons, mark the position of the mass every 0.1 seconds on your graph paper. • The Curve: Connect the dots. Does it form a straight line, a circle, or a wave? <p>B. The "Four Pillar" Variables:</p> <p>Perform the following "What If" tests and record how your graph changes:</p> <ol style="list-style-type: none"> 1. Amplitude (A): Pull the spring down 5cm, then 20cm. <i>Observation: How does the height of your graph's "hill" change?</i> 2. Period (T) and Frequency (f): Use the stopwatch to time 10 full cycles. <ul style="list-style-type: none"> ○ Calculate $T = \text{Total Time} / 10$. ○ Calculate $f = 10 / \text{Total Time}$. ○ <i>Observation: What is the mathematical relationship between T and f?</i> 3. Phase (Φ): Have two members start two different springs. One pulls from the top, one starts from the equilibrium. <ul style="list-style-type: none"> ○ <i>Observation: Do the peaks of your graphs line up? If they are shifted, this is "Phase."</i> <p>C. Peer Interaction:</p> <p>Compare the graphs with the group next to you. If your Amplitude is doubled but your Frequency is the same, how do your "wave" drawings look different?</p>	<p>standards fostering a deep, conceptual understanding of how variables characterize motion in a way that is both purposeful and learner centered.</p>
--	--	---

	<p>3. Developing Mastery</p> <p>Option 1: The "Bottle & Bamboo" Calibration Lab For the Teacher: Prepare "Target Profile Cards" using simple metrics. Since materials are improvised, focus on targets that are easily observable (e.g., "A Period of exactly 1.5 seconds" or "An Amplitude of 15 degrees").</p> <p>Materials Needed (Improvised/Localized):</p> <ul style="list-style-type: none"> • For Pendulums: Plastic bottles (filled with pebbles/sand), kite string, or plastic straw (<i>tali</i>). • For Springs: Strong rubber bands (chained together) or improvised "leaf springs" using flexible bamboo slats/thick plastic rulers. • Measuring Tools: Ruler, stopwatch • Target Cards: Strips of paper with "Target Profiles" (e.g., <i>Target: $T = 2s$, $A = 10cm$</i>). <p>Activity Instructions for Learners</p> <p>A. The "Pinoy" Build Challenge:</p> <ul style="list-style-type: none"> • Pick a Profile: Your group will draw a card. Example: <i>"Create a system with a Frequency of 0.5 Hz (1 swing every 2 seconds)."</i> • Calibrate: *If using a Pendulum, adjust the length of your string. <ul style="list-style-type: none"> ◦ If using a Rubber Band Spring, add or remove "weight" (pebbles) from your bottle. • Test & Adjust: Time 10 cycles. If your total time isn't exactly what the math predicts (e.g., 20 seconds for 10 cycles), shorten or lengthen your setup. <p>B. The "Silent Observer" Peer-Review:</p> <ul style="list-style-type: none"> • Rotation: Move to the next group's station. Observe their moving bottle/system. • Data Collection: Without talking to the owners, use your improvised tools to measure: 	<p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Validating Intuition: If a group's improvised spring (rubber bands) is inconsistent, ask: "How can we make the 'springiness' more constant? Would doubling the bands help?" • Spot-Checking: Use a "Master Stopwatch" to verify groups that claim they've hit their frequency target. • Bridge to Formalism: When <i>learners</i> observe that "longer strings = slower swings," explicitly link this to the relationship between length and Period (T). <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Synthesis: Discuss how "mass" affected the spring but not the pendulum. This solidifies the specific characteristics of different SHM systems. • Error Analysis: Acknowledge that improvised materials have "friction." Explain that in "Ideal SHM," motion doesn't stop, but in the real world, energy is lost.
--	--	--

	<ol style="list-style-type: none"> 1. Amplitude: How far from the center is their bottle swinging? 2. Period (T): Use your timer for 5 cycles and find the average time for one. 3. Frequency (f): Calculate how many times it would swing in 60 seconds. <ul style="list-style-type: none"> • The Reveal: Check the "Target Card" hidden under their table to see if your measurements match their design. <p>C. The "Mental Gym" Drill: On your worksheet, solve these "What-If" scenarios based on your improvised build:</p> <ol style="list-style-type: none"> 1. If you replaced the pebbles with heavy sand (doubling the mass), would your pendulum Period change? Why? 2. If your rubber band "spring" loses its stretch, how will that affect Frequency? <p>Option 2: "The Blind Date Sync" Note for Teachers:</p> <ul style="list-style-type: none"> • Preparation: Use a large cardboard sheet or a movable chalkboard as a "blind" (divider) between the two groups. Ensure the masses are securely attached to the springs to prevent them from flying off during high-frequency oscillations. Remind learners that for the "Sync" to work, they must be extremely precise with their stopwatch timing (average of 3 trials). <p>Instructions for Learners:</p> <ol style="list-style-type: none"> 1. The Partition: Form two teams: Group A (The Pendulum Team) and Group B (The Spring Team). You should not be able to see each other's setups. 2. Group A Task: Build a pendulum. Measure the time it takes for one full swing (Period, T). Once you are satisfied, shout your Period to the other side (e.g., "<i>Our Period is 1.5 seconds!</i>"). 	<p>IDF Application (DepEd SHS Curriculum) This activity applies to the Instructional Design Framework (IDF) by emphasizing Responsiveness and Localization. By substituting specialized lab equipment with common items like plastic bottles and rubber bands, the lesson becomes accessible to all learners regardless of school resources, ensuring Equity in the curriculum. The "Build Challenge" structure maintains strict Alignment with the learning objectives (measuring A, T, and f) while fostering Learner Agency, as <i>learners</i> must troubleshoot and calibrate their own improvised systems to meet scientific standards.</p> <p>Option 2: "The Blind Date Sync" Facilitation Strategy To facilitate this effectively, the teacher must act as the "Master Timekeeper." The success of the "Reveal" depends on a simultaneous release. If the systems are not in sync, guide Group B to troubleshoot their calculation or their measurement of 10 cycles to find a more accurate frequency. When <i>learners</i> notice the "offset" (even with matching frequencies), use that "aha!" moment to introduce Phase. Explain that while T and f dictate the "beat," Phase dictates the "starting line" of the motion.</p>
--	--	--

	<p>3. Group B Task: Upon hearing Group A's Period, use the formula ($f = 1/T$) to find the Frequency. You must now adjust the mass on your spring until its frequency matches Group A's frequency exactly.</p> <p>4. The Reveal: On the teacher's count of "Three," the divider is removed. Both groups release their systems at the exact same moment.</p> <p>5. The Analysis: Observe the motion. Even if the rhythms match, are they moving in the same direction at the same time? Discuss: <i>"If one starts at the peak and the other at the center, what term describes this 'offset'?"</i></p>	<p>(or you may play this video for learners to have a better illustration about Phase) https://www.youtube.com/watch?v=1wVrkhB52LE&t=4s</p> <p>Note for Teachers:</p> <ul style="list-style-type: none"> • The "Magic" Number: Guide learners to see that ($T * f = 1$) is a universal law for all periodic motion. • Consolidation: Use the "Reveal" results to explain that while the <i>hardware</i> (string vs. spring) is different, the <i>software</i> (the SHM principles) is identical. • Phase Formalization: Explicitly define Phase as the fraction of a cycle completed relative to a fixed starting point, often measured in degrees or radians.
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application Activity: The "Ligtas-Pinoy" Engineering Consultant</p> <p>For the Teacher: Prepare "Client Briefs" (short, printed scenarios) that describe a local problem. Provide Manila paper or repurposed cardboard for the design sketches. Encourage the use of local analogies (e.g., comparing a building damper to a duyan or a car suspension to a mountain bike's shocks).</p> <p>Materials Needed:</p> <ul style="list-style-type: none"> • Manila paper or the back of old calendars/posters • Colored markers or crayons • "Client Brief" Cards (Scenario descriptions) 	<p>Facilitation Strategy</p> <ul style="list-style-type: none"> • Promoting Localization: If a group chooses the Jeepney suspension, ask them: "What happens if the Jeepney is overloaded with passengers (more mass)? How does that affect the frequency of the bounce?" • Technical Guidance: Ensure learners not only draw a picture but also identify the <i>mechanisms</i>. For the seismic damper, help them see that

	<p>Activity Instructions for Learners</p> <p>A. Choose Your Client: Pick one "Consultancy Project" that interests your group:</p> <ol style="list-style-type: none"> 1. Project "Matatag" (High-Rise Safety): A new building in Makati needs a Seismic Damper. How can a giant pendulum (SHM) counteract the sway of an earthquake? 2. Project "Lubak" (Jeepney Comfort): A local transport coop wants to improve Jeepney Suspensions. How do the springs use SHM to stop the "bounce" after hitting a pothole? 3. Project "Hataw" (Cultural Music): A local band needs a Mechanical Metronome for their Kulintang practice. How does changing the length of the pendulum adjust the "tick" (Frequency)? <p>B. The Schematic Design: On your Manila paper, draw a large, clear diagram of your chosen system. You must explicitly label the following:</p> <ul style="list-style-type: none"> • The "Home" (Equilibrium): Where the system sits when there is no earthquake or pothole. • The Amplitude Control: Mark where the maximum displacement happens. How do you limit this, so the building doesn't collapse, or the Jeepney doesn't bottom out? • The Frequency Tuner: Label the part that controls the "rhythm." (Is it the length of the cable? The stiffness of the spring?) • The "User Comfort" Zone: Explain in 1–2 sentences how managing these SHM variables makes the system safe or useful for Filipinos. • Phase: Clearly identify and label where Phase is important in your system. Show or explain how the motion is "in phase" or "out of phase" with something (e.g., out-of-phase with the building's sway, or in phase with the desired rhythm of the metronome). 	<p>the building and the pendulum move in opposite phases to cancel each other out.</p> <ul style="list-style-type: none"> • Encouraging Peer Critique: Have "Project Matatag" groups look at "Project Lubak" designs to see how springs and pendulums use the same SHM "DNA" for different purposes. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • The Big Reveal: Explain that the math they learned in the lab (Activity 4 & 5) is exactly what prevents disasters in the real world. • Scaffolding: Remind them that this design pitch is a "rehearsal" for their performance task, showing them how to apply theory to actual Filipino infrastructure. <p>IDF Application (DepEd SHS Curriculum)</p> <p>This activity applies to the Instructional Design Framework (IDF) by emphasizing Contextualization and Purposeful Application. By framing the lesson as an "Engineering Consultancy" for local issues like earthquake safety and Jeepney transport, it ensures Curricular Alignment with the DepEd goal of developing functional scientific literacy. The activity is Responsive to learner needs by allowing choice and encouraging the</p>
--	---	--

C. The Consultant's Pitch: Present your design. Use the "Engineers' Language": "To solve the pothole problem, we adjusted the stiffness of the spring to change the **Frequency** so the passengers don't feel a high **Amplitude** bounce."

Rubric for the "Ligtas-Pinoy" Engineering Consultant Activity

Criteria	3 – Excellent	2 – Satisfactory	1 – Needs Improvement
Scientific Accuracy of SHM Concepts	All SHM concepts (Amplitude, Period, Frequency, and Phase) are correctly identified, explained, and applied to the chosen system. Scientific explanations are accurate and clearly connected to oscillatory motion.	Most SHM concepts are correctly identified and explained, with minor errors or incomplete connections to the system.	SHM concepts are incorrectly explained, missing, or not connected to the system.
Application of Scientific Principles	The design clearly demonstrates how SHM principles help solve real-life engineering or safety problems. The relationship between motion and system behavior is well explained.	The design shows some understanding of SHM application, but explanations are partially developed or unclear.	The design shows little understanding of how SHM principles apply to the real-life problem.
Identification and Labeling of SHM Variables	All required labels (Amplitude, Period, Frequency, Phase, and Equilibrium	Most required labels are present but may contain minor inaccuracies or unclear placements.	Several required labels are missing, inaccurate, or unclear.

use of local analogies, which bridges the gap between abstract physics equations and the tangible safety and comfort of the Filipino community.

		Position) are complete, accurate, and clearly shown in the diagram.			
	Design and Diagram Clarity	Diagrams are neat, organized, detailed, and easy to understand. Visual representations strongly support scientific explanations.	Diagrams are understandable but may lack detail, organization, or clarity in some parts.	Diagrams are incomplete, difficult to understand, or lacks relevant details.	
	Engineering Explanation / Consultant's Pitch	Presentation clearly explains how modifying SHM variables improves safety, comfort, or functionality using appropriate scientific language.	Presentation explains the design but may lack depth, clarity, or proper scientific vocabulary.	Presentation is unclear or lacks scientific explanation of the design.	
	Collaboration and Participation	All group members actively participated and contributed during the activity and presentation.	Most group members participated, but their contributions were uneven.	Minimal participation from group members was observed.	
	2. Making Generalization Activity: The "SHM Triangle" Concept Map For the Teacher: To keep the activity simple, provide a pre-drawn "skeleton" or a large triangle on the Manila paper. This provides a visual anchor, so learners don't get overwhelmed by a "blank page."				Facilitation Strategy <ul style="list-style-type: none"> • Simplicity First: If learners start drawing too many lines, tell them to focus only on the "Big Three": Force, Distance (Amplitude), and Time (Period/Frequency).

	<p>Materials Needed:</p> <ul style="list-style-type: none"> • Manila paper with a large triangle drawn in the center. • Markers (3 different colors). • Tape. <p>Activity Instructions for Learners</p> <p>A. The Three-Point Link: On your paper, place the terms in the designated spots to see how they "talk" to each other:</p> <ol style="list-style-type: none"> 1. The Center (The Cause): Write Restoring Force in the middle. Draw an arrow pointing to Equilibrium. <ul style="list-style-type: none"> ◦ Label the arrow: "Always pulls it back Home." 2. The Top Peak (The Size): Write Amplitude. <ul style="list-style-type: none"> ◦ Label: "How far it goes from Home." 3. The Bottom Base (The Timing): Write Period and Frequency. <ul style="list-style-type: none"> ◦ Label: "How long it takes" vs. "How many in a second." 4. The Starting Line: Write Phase outside the triangle. <ul style="list-style-type: none"> ◦ Label: "Where does the motion start?" <p>B. The "Fast-Talk" Reflection: In your groups, discuss this one question: <i>"If you pull a Duyan (hammock) very high, it has to travel a long way. Why doesn't it take longer to finish the swing?"</i></p> <ul style="list-style-type: none"> • Hint: Look at your center term (Restoring Force). Does a higher pull mean a stronger or weaker pull back? <p>C. Final Check: One member from each group stands up and gives a "10-word summary" of their map. (Example: "SHM is a repeating back-and-forth motion pulled by a force.")</p> <p>D. Individual Reflection: "Which variable changes the size, timing, or synchronization of motion?"</p>	<ul style="list-style-type: none"> • Correcting the Misconception: This is the critical moment to solidify that Amplitude does not change the Period. Use the "Gravity" analogy: "The further you pull it, the harder gravity pulls it back, so it moves faster to cover the extra distance in the same amount of time." • Visual Aid: Draw a simple wave on the board and label the peak as <i>Amplitude</i> and the length of one wave as <i>Period</i> to link the map to the graph they made earlier. <p>IDF Application (DepEd SHS Curriculum)</p> <p>This activity applies the Instructional Design Framework (IDF) by emphasizing Cognitive Clarity and Alignment. By simplifying the concept map into a "Triangle" structure, the lesson remains responsive to learner needs by preventing information overload while still covering all key objectives. It provides a structured way for learners to conclude their inquiry, ensuring that the purpose of the lesson—understanding the characterization of SHM—is generalized into a simple, memorable mental model that they can carry into their final assessment.</p>
--	--	---

V. ASSESSMENT
(Assessing Learnings)

Part 1: Multiple Choice Quiz

Instructions: Choose the best answer for each question.

1. Which of the following best defines "Frequency" in the context of a vibrating guitar string?
 - A. The maximum distance the string moves from its resting position.
 - B. The total time it takes for the string to stop moving.
 - C. The number of complete back-and-forth vibrations the string makes in one second.
 - D. The starting position of the string when it is first plucked.

2. Two learners are swinging on identical playground swings. Learner A starts swinging from 1 meter back, while Learner B starts from 0.5 meters back. If they are in Simple Harmonic Motion, which characteristic will remain the same for both?
 - A. Amplitude
 - B. Period
 - C. Maximum Velocity
 - D. Phase

3. In the design of a car suspension system, what is the primary purpose of understanding "Amplitude"?
 - A. To determine how many minutes the car will bounce after a bump.
 - B. To ensure the car body does not move too far up or down, preventing it from hitting the ground or "bottoming out."
 - C. To calculate the exact time it takes for the car to reach its destination.
 - D. To ensure the tires rotate in a perfect circle.

4. A grandfather's clock is "losing time," meaning its pendulum is swinging too slowly (the Period is too long). To fix the clock and increase the Frequency, an engineer should:
 - A. Increase the Amplitude by pushing the pendulum harder.
 - B. Change the Phase by starting the pendulum from the center.
 - C. Adjust the system to shorten the time it takes for one cycle.
 - D. Increase the mass of the pendulum bob.

5. If two identical pendulums are swinging such that one is at the far left while the other is at the far right at the exact same moment, they are said to have a different:
 - A. Frequency
 - B. Period
 - C. Phase
 - D. Equilibrium

6. Two identical pendulum clocks (Clock X and Clock Y) are mounted side-by-side on a heavy, flexible wooden beam. Over time, due to the subtle vibrations passing through the beam, the two pendulums begin to swing together such that whenever Clock X reaches its maximum displacement to the right, Clock Y reaches its maximum displacement to the left at the exact same millisecond. Which of the following statements perfectly describes their motion?
- The two pendulums are in-phase and running at different frequencies.
 - The two pendulums are 180° (or π radians) out-of-phase and share the same frequency.
 - The two pendulums are 90° (or π radians) out-of-phase and share different periods.
 - The two pendulums are in complete synchronization with a phase shift of 0° .

Scenario: The Baby's Nap Lito is helping his mother put his baby sister to sleep in a duyan (hammock). He notices that if he swings the duyan too fast, the baby wakes up, but if he swings it with a steady, slow rhythm, the baby stays asleep. He decides to use his Physics knowledge to measure the motion. Lito's Observations:

- He pulls the duyan 20 cm from the center, and it takes 30 seconds to complete 10 full swings.
- He then pulls the duyan 40 cm from the center (doubling the distance) and measures the time again.

Question 1: The "Timing" Mystery

Based on the principles of Simple Harmonic Motion, what should Lito expect the Period to be when he pulls the duyan 40 cm away?

- The Period will double (6 seconds) because the distance is twice as long.
- The Period will stay the same (3 seconds) because amplitude does not affect the time of a swing.
- The Period will be cut in half (1.5 seconds) because the duyan moves faster.
- The Period will stop completely because of the extra weight.

Question 2: Tuning the Rhythm

Lito's mother says, "The duyan is swinging too many times per minute! Make it slower." Lito has two choices to decrease the Frequency:

1. Pull the duyan with less force (smaller Amplitude).
2. Lengthen the rope tied to the beam.

Task: Which choice should Lito pick? Explain your answer by describing the relationship between Frequency and the physical setup of a pendulum.

<p>VI. REFLECTION (Feedback and Continuous Improvement)</p>	<p><i>For the teacher:</i></p> <ol style="list-style-type: none"> 1. Were learners able to correctly connect real-life situations to SHM concepts (amplitude, period, frequency, phase)? What evidence supports this? 2. Which activity best supports conceptual understanding, and which needs improvement or simplification? 3. What misconceptions about SHM emerged during the lesson, and how were they addressed? 4. How effectively did the lesson connect physics concepts to real-world Filipino contexts (e.g., jeepney, earthquake, music)? 5. If the lesson were to be repeated, what instructional strategies or materials should be improved or adjusted? <p><i>For the learners:</i></p> <ol style="list-style-type: none"> 1. What concept (amplitude, period, frequency, or phase) was easiest for you to understand? What made it easy? 2. Which concept was most difficult for you to understand, and what part confused you? 3. How did real-life examples (jeepney, earthquake, swing, music) help you understand SHM? 4. How confident are you now in identifying SHM variables in real-life situations? Explain your answer. 5. If you could redo one activity, what would you improve in your group's approach or output?
<p>VII. USE OF GENERATIVE AI</p>	<p>In preparing this Lesson Exemplar (LE), the author(s) used Gemini to assist in structuring, formatting, and refining the ideas of the lesson activities. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.</p>

Learning Area	PHYSICS 1	Lesson Exemplar	21
----------------------	------------------	------------------------	-----------

I. OBJECTIVES	
A. Content Standard	<i>The learners learn that simple harmonic motion can be characterized by periodic motion.</i>
B. Performance Standard	<i>By the end of the quarter, learners properly measure and use pertinent units, compute resultant vectors, and analyze motion graphs. They explain, calculate, and analyze one-dimensional, two-dimensional, and relative motion in practical contexts and solve problems using kinematic equations. They also describe and explain how basic physics principles are applied to describe and make predictions about motion in everyday situations and scenarios.</i>
C. Learning Competencies	<i>The learners use mathematical models to solve for and describe the displacement, velocity, and acceleration of objects in simple harmonic motion</i>
II. REFERENCES and MATERIALS (Selecting Resources and Material)	<ul style="list-style-type: none"> • Bazhenov, S. (2021). <i>The physics of Taipei 101's tuned mass damper</i>. Science in the City. https://www.scienceinthecity.org.nz/features/taipei-101 • Fendt, W. (2024). <i>Simple harmonic motion: Spring pendulum [Interactive applet]</i>. Java Apps for Physics. https://www.walter-fendt.de/html5/phen/springpendulum_en.htm • OpenStax. (2020). <i>University physics volume 1: Oscillations</i>. Rice University. https://openstax.org/details/books/university-physics-volume-1 • Mathematical equations generated using <i>CodeCogs Equation Editor</i>. Accessed May 20, 2026. https://editor.codecogs.com/. • PhET Interactive Simulations. (n.d.). <i>Masses and springs</i>. University of Colorado Boulder. https://phet.colorado.edu/en/simulations/masses-and-springs • YouTube. "Simple Harmonic Motion Explained." Accessed May 20, 2026. https://www.youtube.com/watch?v=DAImSIiETx4. • YouTube. "Simple Harmonic Motion Practice Problems." Accessed May 20, 2026. https://www.youtube.com/watch?v=T33AkTW8K5s&t=3s. • YouTube. "Understanding Oscillations and SHM." Accessed May 20, 2026. https://www.youtube.com/watch?v=GzMuF-LMGaM.

III. CONTENT <i>(Sequencing Content)</i>	Periodic motion 1. Oscillations 2. Simple harmonic motion	
IV. OBJECTIVES <i>(Setting Clear Objectives and Analyzing the Tasks)</i>	At the end of the lesson, the learners will be able to: 1. Solve for displacement, velocity, and acceleration of objects in simple harmonic motion using mathematical models. 2. Interpret the position and motion of an object in SHM (e.g., at equilibrium, at rest, at maximum speed) based on calculated values.	
V. PROCEDURES <i>(Selecting Strategies, Making Meaningful Content, Delivering Lesson and Assessing Learning)</i> This section focuses on selecting learner-centered, evidence-based instructional approaches such as problem-based learning, collaborative tasks, interdisciplinary integration, and technology-enhanced instruction. These strategies are intended to foster active engagement, critical thinking, and adaptability across diverse learning pathways. The chosen approaches and methodologies will be reflected through varied and relevant activities and assessments that emphasize real-world relevance and application, thereby enhancing learner engagement and comprehension. (Each part shall have 2-3 varied activities)		ANNOTATIONS <i>*Instruction to the teacher on how to facilitate the activities.</i> <i>*In the Annotation, explicitly explain how the IDF is applied in each part of the lesson</i>
A. Activating Prior Knowledge	1. Activating Prior Knowledge Option 1: The Oscillation Stations (Recall Edition) Notes for the Teacher: This is a high-speed 15-minute diagnostic. The goal is to verify that learners remember the physical behavior of SHM before they begin calculating displacement, velocity, and acceleration. Materials: * Set up 3 quick stations: A pendulum , a mass-spring , a clamped ruler , meta cards and tape. <ul style="list-style-type: none">Station 1: Pendulum SwingStation 2: Mass-Spring BounceStation 3: Vibrating Ruler	Teachers Facilitation Strategy: <ul style="list-style-type: none">Prompting: Use quick-fire questions like, "Is it faster in the middle or at the end?"Observation: Ensure learners are noticing that "speed" and "position" change predictably. Processing and Wrapping Up: The teacher points to the board and says: "You've confirmed that in SHM, velocity is zero at the ends and maximum at the center. Today, we will use math to

	<p>Activity Instructions for Learners:</p> <ol style="list-style-type: none">1. Observe: Spend 1-2 minutes at each station. Quickly flick the ruler, swing the pendulum, and bounce the spring.2. Analyze: In your groups, pinpoint the following:<ul style="list-style-type: none">▪ Where is the object’s equilibrium?▪ Where does it reach Maximum Speed?▪ Where does it Stop (zero velocity) to change direction?3. Post: Write one observation about Speed or Position on a meta card and stick it on the board. <table><tr><th colspan="2">Teacher Diagnostic Checklist</th></tr><tr><td>Identifies Equilibrium ($x=0$)?</td><td>☐</td></tr><tr><td>Locates Max Speed at Center ($v_{\max}$)?</td><td>☐</td></tr><tr><td>Identifies Zero Velocity at Turn Points ($v=0$)?</td><td>☐</td></tr><tr><td>Infers Acceleration Direction (Pulls toward center)?</td><td>☐</td></tr></table> <p>Option 2: "The Physics Fortune Teller" (Learner-Led Recall & Prediction)</p> <p>Note for Teachers:</p> <ul style="list-style-type: none">• Pre-Class Preparation: Write the four core terms (Amplitude, Period, Frequency, Phase) and Equilibrium on large sticky notes or separate sections of the blackboard.• The Scaffold: This activity puts the cognitive burden entirely on the learners. They must retrieve the physical behaviors they discovered in the previous lessons (the bottles, strings, and dampers) and be the ones to explicitly state why words alone are no longer enough, creating a natural demand for Mathematical Models. <p>Instructions for Learners:</p> <ol style="list-style-type: none">1. The Concept Retrieval: In your groups, look at the five terms on the board. You have 2 minutes to select one specific system from our previous challenges (e.g., the <i>duyan</i>, the leaf spring suspension, or the building	Teacher Diagnostic Checklist		Identifies Equilibrium ($x=0$)?	☐	Locates Max Speed at Center ($v_{\max}$)?	☐	Identifies Zero Velocity at Turn Points ($v=0$)?	☐	Infers Acceleration Direction (Pulls toward center)?	☐	<p><i>calculate exactly how fast it's moving at any given second."</i></p> <p>How the IDF is Applied: The IDF is applied by using a time-efficient recall task that ensures the lesson is responsive to the learners' current understanding of motion patterns. This alignment ensures learners have a solid physical foundation before transitioning into complex mathematical modeling.</p> <p>Teachers Facilitation Strategy:</p> <ul style="list-style-type: none">• Devil's Advocate: If a learner says, "Math makes it accurate," ask them, "Accurate for what? To save money? To save lives? To make a better product?"• Connecting Objectives: Explicitly point to the lesson objectives on the board. Say: "Today we solve for x, v, and a. Look at your car suspension picture—which of those three determines if the passenger's neck gets jerked?" <p>Processing and Wrapping Up: Each group shares their "Complete Sentence" from Part B. The teacher summarizes: <i>"We need mathematical models for SHM because physical</i></p>
Teacher Diagnostic Checklist												
Identifies Equilibrium ($x=0$)?	☐											
Locates Max Speed at Center ($v_{\max}$)?	☐											
Identifies Zero Velocity at Turn Points ($v=0$)?	☐											
Infers Acceleration Direction (Pulls toward center)?	☐											

	<p>damper) and prepare a 1-sentence statement explaining how your chosen term governed that system.</p> <p>2. The Learner-Led Relation: One representative from each group will stand up, point to their term, and explain it to the class.</p> <ul style="list-style-type: none"> ○ <i>Example Learner Response:</i> "We learned that for the Jeepney suspension, if the Amplitude is too high, it bottoms out, so a mechanic must find a way to control that maximum distance." <p>3. The "Fortune Teller" Challenge (The Bridge): Now, look at the new graph projected on the board. It is a perfect, smooth mathematical sine wave.</p> <ul style="list-style-type: none"> ○ As a group, your task is to predict and mathematically relate your physical definitions to this geometric curve. ○ Draw or explain orally: If you had to write an equation to predict exactly where an oscillating object is at any given millisecond, where on this mathematical curve would your physical variables (A, T, f, ϕ) be measured? <p>4. The Learner Conclusion: Conclude the recall by answering as a class: <i>"We can describe these motions with our hands and words, but if we want to program a computer to build a safe earthquake damper, why do we need to translate our definitions into a mathematical equation?"</i></p> <p>2. Establishing the Purpose of the Lesson</p> <p>Activity: Why Predict Motion? (The Precision Challenge)</p> <p>Notes for the Teacher:</p> <p><i>In this 20-minute transition, you are moving learners from "observing" to "valuing" math. The goal is for them to realize that in professional fields, "it moves back and forth" is not enough information—they need the precision of numbers to prevent disaster or improve comfort.</i></p>	<p><i>observation can tell us what is happening, but math tells us exactly where and how fast an object will be at any given time, which allows us to predict and design systems for safety and efficiency."</i></p> <p>How the IDF is Applied:</p> <p>The IDF is applied by establishing a clear, real-world "Why" that aligns the upcoming mathematical rigor with professional engineering and safety standards. This responsiveness to the learner's need for relevance ensures they see the formulas not as abstract hurdles, but as essential tools for solving practical problems.</p>
--	---	---

Materials:

A set of "Impact Cards" or a slide/video presentation featuring the following:

- **The Sky Bridge:** Bridge swings wildly as super typhoon arrives in the Philippines.
<https://www.youtube.com/watch?v=DAImSiETx4>
- **The Safe Ride:** A cutaway of a car's shock absorbers.
<https://www.youtube.com/watch?v=T33AkTW8K5s&t=3s>
- **The Giant Pendulum:** A Tuned Mass Damper inside a skyscraper (like Taipei 101).
<https://www.youtube.com/watch?v=GzMuF-LMGaM>
- Whiteboard markers or "Think-Square" papers for each group.

Activity Instructions for Learners:**Part A: The Failure Analysis (10 minutes)**

Look at the provided scenarios (The bridge, car shock absorber, and mass damper). In your groups, discuss and answer:

1. **The "If-Then" Scenario:** What specific structural catastrophe happens if a civil engineer calculates the **Acceleration (a)** of the structural sway incorrectly when designing a long-span bridge when it is hit by the violent, gusty winds of a Category 5 super typhoon?
2. **The Comfort Factor:** In a car suspension, why isn't it enough to know the car "bounces"? Why must we know the exact **Velocity (v)** as it hits a bump?
3. **Tuned Mass Damper Optimization:** What structural catastrophe happens if the maximum **Displacement (x)** of a 660-tonne Tuned Mass Damper (TMD) suspended inside a skyscraper used in modern high-rises across Metro Manila is calculated incorrectly by just a few centimeters?

Part B: The Mathematical Bridge

Based on your discussion, complete this sentence as a group:

"We need mathematical models for SHM because physical observation can tell us **what** is happening, but math tells us ____ and ____, which allows us to ____."

<p>B. Instituting New Knowledge</p>	<p>1. Presenting Examples Option 1: Motion Snapshot Analysis Notes for the Teacher (Refer to LAS for detailed activity instructions): <i>This activity transitions learners from general observations to precise technical descriptions. You are providing them with "static" data (snapshots) and asking them to reconstruct the "dynamic" behavior of the system. This bridges the gap between seeing motion and modeling it with math.</i></p> <p>Materials:</p> <ul style="list-style-type: none"> ○ Snapshot Cards: A set of 5 images for each group showing a mass-spring system at different intervals ($t=0$, $t=1$, $t=2$, $t=3$, $t=4$ seconds). ○ Marking Pens: Red (for Velocity arrows) and Blue (for Force/Acceleration arrows). ○ Worksheet: A table to record the state of motion at each snapshot. <p>Activity Instructions for Learners: Part A: Mapping the Snapshot <i>Examine the five "snapshots" of the oscillating mass. On each image, do the following:</i></p> <ol style="list-style-type: none"> 1. Identify Zero: Mark the Equilibrium Position with a dashed line across all five snapshots. 2. Assign Signs: Label the regions above equilibrium as (+) Displacement and below as (-) Displacement. 3. Vector Sketch: At each position, draw a small arrow showing the direction the object is moving. If it is stopped, draw an 'X'. 	<p>Teacher Facilitation Strategy</p> <ul style="list-style-type: none"> ● The "Direction Check": Ask learners, "In Snapshot 1, the mass is at zero, so why is the acceleration also zero?" (Answer: Because the spring is neither stretched nor compressed). ● The "Speed Logic": Ask, "Why is the speed zero at Snapshot 2?" (Answer: The object has to stop changing direction from moving 'down' to moving 'up'). <p>Processing and Wrapping Up Review the results in class. Highlight the "Zero-Max-Zero" pattern:</p> <ul style="list-style-type: none"> ● When Displacement is at its maximum (+A or -A), Velocity is always zero. ● When Displacement is at zero (Equilibrium), Velocity is always at its maximum. ● Acceleration always follows the opposite sign of Displacement (if x is positive, a is negative). <p>Application of the IDF The IDF is applied by providing a structured data table that aligns the qualitative observations from the "Snapshots" with the quantitative expectations of the SHS curriculum. It is responsive to learner needs by translating visual "stops and starts" into a logical sequence that prepares them for formal trigonometric modeling.</p>
--	--	---

Part B: Interpretation & Data

Answer the following based on your snapshots:

- **The Speed Peak:** In which snapshot is the mass exactly at equilibrium? Based on your previous station activity, what is the speed here?
- **The Turning Point:** Which snapshot shows the **Maximum Displacement (A)**? What is the velocity at this exact moment?
- **The Direction Flip:** Identify the snapshot where the object is about to change direction. What happens to the "restoring force" at this point?

Part C: The Comparison Table

Fill out this "State of Motion" table for your presentation:

Time Step (t)	Position (x)	Velocity (v)	Acceleration (a)	Physical Interpretation
0	+A (Max)	0 (Zero)	-a max (Max Negative)	The object is momentarily at rest at its highest positive point. The restoring force is pulling it hard back toward the center.
1	0 (Equilibrium)			
2	-A (Max)			
3	0 (Equilibrium)			
4	+A (Max)			

Option 2: "Frame-by-Frame PhET Analysis")

The Activity: Use the PhET "Masses and Springs" Simulation.

Notes for the Teacher: This is a technology-integrated alternative to physical snapshot cards, perfect for blended learning or computer-laboratory setups. By utilizing a real-time physics engine, learners can interactively manipulate time using "Slow Motion" and "Pause" features. This helps them bridge the gap between abstract vector behavior and the continuous, dynamic motion of an oscillating system.

Materials: * Laptops, tablets, or smartphones with internet access.

- Digital worksheet or notebook to log screenshots/sketches.
- **The Task:** Learners use the "Slow Motion" and "Pause" buttons. They must take a screenshot at $x=0$ and $x=A$, then use the digital "Velocity Vector" tool to prove where the arrow is longest.

The Empirical Verification Grid

Using your live virtual observations and screenshots, complete the digital inspection log below:

Target Position	Observed Velocity Arrow (Longest, Shrinking, or Gone/Zero?)	Observed Acceleration Arrow (Longest, Shrinking, or Gone/Zero?)	Vector Direction (Are arrows pointing Up, Down, or None?)
At the Lowest Point ($x = +A$)			Velocity: None Acceleration: _____
Passing the Blue Line			Velocity: _____

	Moving Up ($x = 0$)			Acceleration: None
	At the Highest Point ($x = -A$)			Velocity: None Acceleration: _____
<p>2. Discussing New Concept</p> <p>Option 1: The SHM Formula Workshop</p> <p>Notes for the Teacher: <i>This is the "Deep Dive" phase. You are guiding learners to see that these equations are not just random letters, but "motion sensors" in written form. The key is to keep the link to the physical objects (the spring or pendulum) alive throughout the lesson.</i></p> <p>Common Error to Avoid - Using Degree Mode instead of Radian Mode <i>If the calculator is in DEG mode:</i></p> <ul style="list-style-type: none"> • answers become incorrect, • graphs will not match SHM behavior, • displacement, velocity, and acceleration values become inaccurate. <p>Materials:</p> <ul style="list-style-type: none"> ○ Scientific calculators (Essential: Must be in Radian Mode). ○ Large graph paper or whiteboard. ○ Different colored markers (Blue for x, Red for v, Green for a). ○ A "Formula Decoder" sheet (listing definitions for A, ω, t). <p>Activity Instructions for Learners</p> <p>Part A: Predict the Position</p> <p>1. The Pattern Challenge: Your group is given an object with an Amplitude (A) of 10 cm and a Period (T) of 4 seconds.</p>				
<p>Teachers Facilitation Strategy</p> <ul style="list-style-type: none"> • The "Calculated Guess": Before every calculation, ask: "Do you expect a big number or a small one? Positive or negative?" • The "Radian" Reminder: This is the #1 error. Circulate and ensure calculators aren't in Degrees. • Probing Questions: Ask, "If v is negative, which way is the object traveling?" or "If I double the Amplitude, does the object take longer to finish a cycle, or does it just have to move faster?" • Vector Talk: When discussing, <div style="text-align: center;"> $a = -\omega^2 x$ </div> <i>physically point in the opposite direction of the displacement to emphasize the "Negative" sign means "Restoring."</i> • Correction: If learners are confused by, <div style="text-align: center;"> $v(t) = -A\omega \sin(\omega t)$ </div> <i>remind them that the "Sine" version just means the motion started at the center rather than the edge.</i> 				

	<p>○ Without a formula, guess where the object is at $t = 1\text{s}$, 2s, and 4s.</p> <p>2. The Equation Intro: Use the model</p> $x(t) = A \cos(\omega t)$ <p>○ <i>Step 1:</i> Solve for (Angular Frequency) first using</p> $\omega = \frac{2\pi}{T}$ <p>○ <i>Step 2:</i> Plug in your times (t) to find the exact displacement. (Set calculators for RADIANS!)</p> <p>3. Exploration: Does a negative x value mean the object is "slowing down" or just on the other side of equilibrium? Discuss.</p> <p>Part B: When Is It Fastest? The Velocity Logic: Look at your displacement results. At $t = 0$, x was at its maximum (10cm). Common sense says it's stopped there.</p> <p>1. The Equation Check: Use the model</p> $v(t) = -A\omega \sin(\omega t)$ <p>○ Calculate the velocity at $t = 0$. Does it equal zero? ○ Calculate the velocity at $t = 1\text{s}$ (where $x = 0$). Is this your maximum value?</p> <p>Part C: The Returning Effect</p> <p>1. Inquiry Task: Feel a spring. When you pull it to the right, which way does it pull your hand?</p> <p>2. The Model: The teacher introduces:</p> $a = -\omega^2 x$	<p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • The Trinity: Have groups fill out a final summary: <ul style="list-style-type: none"> ○ At $x = \pm A: v = 0, a = \max$ ○ At $x = 0: v = \max, a = 0$ • Concluding Statement: "The negative sign in the acceleration formula is the most important part of SHM—it is the 'Restoring Force' that keeps the universe oscillating." <p>Application of the IDF The IDF is applied by sequencing mathematical models to follow the logical flow of physical discovery, ensuring that equations for v and a are grounded in the displacement patterns already understood. This alignment responds to the learner's need for conceptual coherence by using the "Returning Effect" activity to explain the negative sign in the acceleration formula before formalizing the math.</p>
--	--	--

	<p>3. Calculation: If $x = +10\text{cm}$, a.</p> <ul style="list-style-type: none"> Is the acceleration positive or negative? <p>4. The "Max" Search: * At what position (x) is the acceleration the strongest?</p> <ul style="list-style-type: none"> At what position (x) is the acceleration zero? <p>5. Graphing Sync: Sketch x, v, and a on one axis. Identify the "Mirror Effect": When x is at its highest peak, where is a?</p> <p>Option 2: "Reverse Engineering the Wave"</p> <p>The Activity: Give learners a pre-drawn Sine wave on graph paper representing displacement.</p> <ul style="list-style-type: none"> The Task: "Work backward." From the graph, find the Amplitude (A) and Period (T). Then, plug those into the general equation $x(t) = A \cos(\omega t)$ <p>3. Developing Mastery</p> <p>Activity: The SHM Investigation Challenge</p> <p>Notes for the Teacher: This part of the lesson transitions learners from guided learning to independent problem-solving. The "Differentiated Challenge" ensures that groups struggling with math can focus on graph interpretation, while advanced groups tackle real-world scenarios. Use a "Timer" on the board to keep the energy high.</p> <p>Materials:</p> <ul style="list-style-type: none"> Problem Card Sets (Color-coded by difficulty: Green = Basic, Blue = Graphing, Red = Real-World). Scientific Calculators. The "Status Board" (A small whiteboard or sheet for groups to record their "Physical Meaning" interpretations). 	<p>Teachers Facilitation Strategy</p> <ul style="list-style-type: none"> The "Why" Prompt: When a group gets the math right, ask: "If the acceleration is positive, does that mean the object is moving to the right, or just that it's being pulled to the right?" Peer Tutoring: If one group finishes Level 1 quickly, assign them as "Consultants" to help groups struggling with Level 2. Error Spotting: Watch for groups using "Degrees" instead of "Radians" in their trig functions; remind them that ωt results in a unitless radian value. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> The "Motion Scan": The teacher calls out a random value (e.g., "$x = +A$"). The class must respond in unison with the velocity and acceleration states ("Velocity zero! Acceleration max negative!"). Summary: Remind the class that x, v, and a are a "package deal", knowing one gives you clues about the others.
--	--	--

	<p>Activity Instructions for Learners</p> <p>1. The Mission Each group picks a "Case File" (Problem Card). You must not only solve math but also describe the "Physical State" of the object at the calculated moment.</p> <p>2. Solving & Interpreting Work through your assigned problems. For every numerical answer, you must answer the "Condition Check":</p> <ul style="list-style-type: none"> • Equilibrium Check: Is the object at $x=0$? • Speed Check: Is it at v_{max} or $v=0$? • Acceleration Check: Is the "restoring force" at its strongest, or is it zero? • Direction Check: Based on the sign (+/-), which way is it headed? <p>3. The Differentiated Challenge:</p> <ul style="list-style-type: none"> • Level 1 (Basic): A mass on a spring has $A = 0.2m$ and $\omega = 4rad/s$. Find x, v, and a at $t = 0.5s$. • Level 2 (Graphing): Look at the provided $v-t$ graph. Identify the time t where the object is at its maximum positive displacement. Explain your logic. 	<p>Answer key:</p> <p>Level 1: $x \approx -0.083\text{ m}$ $v \approx -0.727\text{ m/s}$ $a \approx 1.33\text{ m/s}^2$</p> <p>Level 2: The object is at its maximum positive displacement at approximately: $t = 4\text{ s}$ and $t = 12\text{ s}$</p> <p>Explanation: In a velocity–time ($v-t$) graph, maximum positive displacement occurs when:</p> <ul style="list-style-type: none"> • the velocity becomes zero, and • the object changes direction from moving forward (positive velocity) to backward (negative velocity). <p>On the graph, this happens where the curve crosses the time axis from above to below. From the graph:</p> <ul style="list-style-type: none"> • At $t = 4\text{ s}$, the velocity changes from positive to negative. • At $t = 12\text{ s}$, the same pattern happens again. <p>Therefore, these times represent the object's maximum positive displacement.</p>
--	--	---

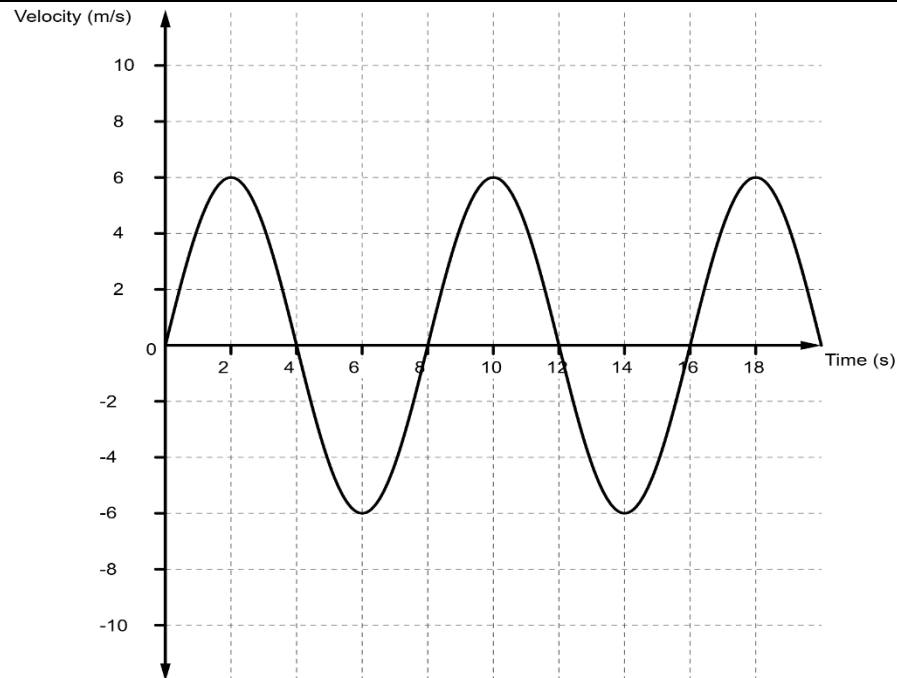


Image is created and download from: <https://ophysics.com/t3.html>

Guiding Questions for Learners

1. At what points does the velocity become zero?
 2. Is the graph crossing upward or downward at those points?
 3. What does zero velocity mean in SHM?
 4. Why does the object reverse direction at maximum displacement?
- **Level 3 (Real-World):** An earthquake shakes a building with a frequency of **0.5Hz**. If the maximum safe acceleration is **2m/s²**, what is the maximum allowable amplitude (A) of the sway?

Level 3: $A \approx 0.203 \text{ m}$

Application of the IDF

The IDF is applied by using differentiated problem sets that align with the diverse readiness levels of the learners while maintaining focus on the core SHS objectives. It responds to learner needs by shifting from rote calculation to physical interpretation, ensuring learners understand the "why" behind the mathematical models they are mastering.

	<p>4. The Defense (20 mins) Be ready to present your "Case File." You must justify why your $v=0$ result means the object is at the amplitude, not the equilibrium.</p> <p>Variation: "The SHM Speed Dating"</p> <ul style="list-style-type: none"> • The Activity: Half the class receives "Scenario Cards" (Physical descriptions), and the other half receives "Data Cards" (Calculated x, v, a values). • The Task: Learners must move around the room and find their "Perfect Match"—the data set that describes their physical scenario. 	
C. Demonstrating Knowledge and Skills	<p>1. Finding Practical Application</p> <p>Activity Title: The SHM Engineering Bureau Notes for the Teacher: This is the "Synthesis" phase. Instead of solving abstract problems, learners apply their mathematical toolkit to a "Design Brief." The focus shifts from finding an answer to setting limits. It is a 40-minute simulation that transforms the classroom into an engineering firm.</p> <ul style="list-style-type: none"> • Materials: <ul style="list-style-type: none"> ◦ Design Brief Cards (Details below). ◦ Large Manila paper or digital presentation slides. ◦ Markers and Calculators. <p>Activity Instructions for Learners</p> <p>1. Pick Your Firm (5 mins): Choose one specialized project:</p> <ul style="list-style-type: none"> • The Thrill Designers: Designing a bungee jump ride where the acceleration must not exceed 3g (approx. 30m/s²) for rider safety. • The Comfort Crew: Designing car suspension for a luxury car where the maximum velocity of the "bounce" shouldn't exceed 0.5 m/s to avoid motion sickness. 	<p>Teachers Facilitation Strategy</p> <ul style="list-style-type: none"> • The "Safety Inspector" Role: Walk around and act as a safety inspector. If a group has a safe velocity but an incredibly high acceleration, ask: "The car isn't moving fast, but will the passengers get whiplash from how fast the speed changes?" • Encourage Trade-offs: If a group's acceleration is too high, suggest they either decrease the Amplitude (A) or increase the Period (T). Let them discover which variable has the biggest impact. <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • Key Reflection: Ask the class, "Which design relied most on controlling Acceleration versus Velocity?"

	<ul style="list-style-type: none"> • The Seismic Guard: Designing a tuned mass damper for a skyscraper where a 2-meter sway ($A=2\text{m}$) must be controlled to prevent the windows from shattering. • The Horologist: Designing a high-precision pendulum clock where the timing depends on a perfect 1.0 meter displacement every 2.0 seconds. <p>2. The Design Calculations: Using the formulas $x(t)$, $v(t)$, and $a(t)$, your group must:</p> <ul style="list-style-type: none"> • Define the "Safe Zone": Calculate the maximum acceleration ($a_{\text{max}} = A\omega^2$) or maximum velocity ($v_{\text{max}} = A\omega$) based on your scenario's needs. • Predict the Worst Case: If the frequency (f) doubles (e.g., a faster earthquake or a rougher road), what happens to your "Safe Zone"? • The "Why" Statement: Draft a 3-sentence explanation of how your math prevents the system from failing. <p>3. The Pitch: Present your "Safety Specifications" to the class. Be prepared to answer: "Why is math more reliable than just testing a physical model?"</p> <p>Option 2: "The Safety Audit"</p> <ul style="list-style-type: none"> • The Activity: Provide learners with "Faulty Designs" (e.g., an amusement park ride where the calculated a_{max} is 10 deadly for humans). • The Task: Learners must act as a Safety Commission. They calculate the error, identify the "Danger Zone," and propose a specific mathematical change to A or ω to make it safe. <p>2. Making Generalization Option 1: The SHM Master Map (Synthesizing the Motion)</p>	<ul style="list-style-type: none"> • Closing: "Engineering is essentially the art of managing SHM. Without the equations you learned today, we couldn't build bridges, cars, or safe rides with any certainty." <p>Application of the IDF The IDF is applied by contextualizing SHM equations into high-stakes engineering scenarios, providing a clear professional purpose for the mathematical rigor. It responds to learner needs by allowing learners to choose a project that interests them, aligning academic objectives with real-world career paths.</p> <p>Teachers Facilitation Strategy</p> <ul style="list-style-type: none"> • The "Connection" Check: If a group connects Acceleration and Velocity, ask: "Does high acceleration always mean high velocity?" (Guide them to realize that at the edges, acceleration is max, but velocity is zero). • The "Force" Link: Ensure every group draws a direct, strong link between Restoring Force and
--	--	---

	<p>Notes for the Teacher: This is the "Closing Argument" of the lesson. The goal is to move from separate formulas to a unified "Big Picture." By forcing learners to connect terms like "restoring force" to "acceleration," you are ensuring they understand the causality (the why) of the motion, not just the math.</p> <p>Materials:</p> <ul style="list-style-type: none"> ○ Large Manila paper or cartolina. ○ Post notes or colored markers. ○ "Connection Cards" (Small slips of paper with the words: Equilibrium, Displacement, Velocity, Acceleration, Restoring Force, Period). <p>Activity Instructions for Learners Part A: Complete the Thought Discuss with your group and finalize one clear, physics-based sentence for each prompt:</p> <ol style="list-style-type: none"> 1. Displacement tells us... (where the object is relative to home). 2. Velocity tells us... (how fast and in what direction it is passing through). 3. Acceleration tells us... (how hard the system is fighting to return to center). 4. An object in SHM moves fastest when... (it passes the equilibrium because no force is pulling back yet). 5. Acceleration is always opposite to displacement because... (the restoring force always pulls toward the center). <p>Part B: The Master Concept Map On your large paper, place the term "OSCILLATION" at the center. Draw arrows to connect the following terms, writing a "linking word" on each arrow (e.g., Oscillation <u>has a center called</u> → Equilibrium):</p>	<p>Acceleration. Ask: "Which one causes the other?"</p> <ul style="list-style-type: none"> • Big Idea Prompt: Circulate and ask: "If I know the time (t), can I find all these other bubbles on your map?" <p>Processing and Wrapping Up</p> <ul style="list-style-type: none"> • The Gallery Walk: Groups spend 2 minutes looking at other maps. • The Final Generalization: The teacher leads the class to the "Big Idea" statement: <p>"Simple Harmonic Motion is a predictable cycle where math models allow us to 'see' the invisible forces and speeds of an object at any fraction of a second." How the IDF is Applied The IDF is applied by using a concept-mapping task that aligns individual mathematical components into a holistic understanding of physical systems. It responds to learner needs by providing a visual and collaborative way to solidify the "Big Idea," ensuring the purpose of the lesson is internalized before moving to the next topic.</p>
--	---	---

	<ul style="list-style-type: none"> • Equilibrium Position • Displacement (x) • Velocity (v) • Acceleration (a) • Restoring Force (F_{net}) <p>Challenge: Draw a small sketch of a v-t and x-t graph next to your map and draw a dotted line connecting the "Peak" of one to the "Zero" of the other.</p> <p>SHM Conceptual Exit Ticket Using what you discovered through your calculations and concept maps, write a concise explanation responding to this question: "In a simple harmonic system (like a swaying bridge or a bouncing spring), why is the Acceleration (a) vector ALWAYS pointing in the exact opposite direction of the Displacement (x) vector?"</p>	
V. ASSESSMENT <i>(Assessing Learnings)</i>	<p>Part A: Problem Solving Instructions: Show all your work. Ensure your calculator is in Radian Mode. Use $\pi \approx 3.14$</p> <p>Scenario: A block attached to a horizontal spring oscillates with an Amplitude (A) of 0.15 m and an Angular Frequency (ω) of 2.0 rad/s. At $t = 0$, the block is at its maximum positive displacement.</p> <ol style="list-style-type: none"> 1. Displacement (x): Calculate the position of the block at $t = 0.8$ s. 2. Velocity (v): Calculate the velocity of the block at $t = 0.8$ s. 3. Acceleration (a): Calculate the acceleration of the block at $t = 0.8$ s. <p>Part B: Motion Interpretation (10 Points) Instructions: Use your calculated values from Part A to answer the following questions. Circle the correct option and justify your answer.</p> <ol style="list-style-type: none"> 4. Direction: At $t = 0.8$ s, is the object moving toward or away from the equilibrium position? <ul style="list-style-type: none"> ○ Justification: _____ 	

5. **Motion State:** Is the object **speeding up** or **slowing down** at this specific moment?

○ *Justification:* _____

6. **Acceleration Behavior:** Is the restoring force currently pulling the object to the **left** or to the **right**?

○ *Justification:* _____

Part C: Conceptual Explanation

Instructions: Provide concise but complete scientific explanations (2–3 sentences each).

7. **The Equilibrium Paradox:** Why is the velocity of the object at its **maximum** when it passes through the equilibrium position (**$x = 0$**)?

8. **The Direction of Acceleration:** Mathematically and physically explain why acceleration is **always directed toward equilibrium**, even when the object is moving away from it.

○
9. **The Turning Point:** Why must the velocity **always become zero** at the moment of maximum displacement?

Answer key:

Part A: Problem Solving

Scenario:

1. **Displacement (x):** ≈ -0.0044 m

2. **Velocity (v):** ≈ -0.30 m/s

3. **Acceleration (a):** $\approx +0.0175$ m/s²

4. **Justification:** The position x is slightly negative (-0.00438 m), so the block is on the left side of equilibrium. The velocity is also negative (-0.30 m/s), meaning it is moving further left, away from $x=0$.

5. **Slowing down; Justification:** Velocity is negative while acceleration is positive. The restoring force acts opposite the velocity, reducing the speed of the block.

6. **To the right; Justification:** Acceleration is positive ($+0.0175$ m/s²). Positive acceleration means the force is directed to the right, toward the equilibrium position.

7. At $x = 0$, the spring is neither stretched nor compressed, so the restoring force and acceleration are zero. All the elastic potential energy has been converted into kinetic energy. With no force opposing the motion, the block achieves its maximum speed ($v_{\max} = A\omega$) at this point.

8. **Mathematically:** $a = -\omega^2 x$. The negative sign guarantees that acceleration is always opposite to displacement. **Physically:** The spring exerts a restoring force ($F = -kx$). When the block moves to the right (positive x), the spring pulls left; when it moves left (negative x), the spring pushes right. This always directs the force (and acceleration) back toward $x = 0$.
9. Velocity must become zero at maximum displacement because the object changes direction there. At the turning point, all motion in that direction stops for an instant before the restoring force pulls it back toward equilibrium.

Rubric for Questions 4–9

Criteria	Excellent (Full Points)	Good (Partial Points)	Needs Improvement	Points
Item 4. Direction (Answer + Justification)	Correct choice (Away) + clear, accurate justification using both x and v values	Correct choice but justification incomplete or weak	Wrong choice or no justification	/3
5. Motion State (Speeding up / Slowing down + Justification)	Correct choice (Slowing down) + strong justification using signs of v and a	Correct choice but justification lacks detail	Wrong choice or incorrect reasoning	/3
6. Acceleration Behavior (Left / Right + Justification)	Correct choice (To the right) + clear justification using sign of a	Correct choice but weak explanation	Wrong direction or no link to acceleration sign	/3
7. Equilibrium Paradox (Conceptual)	Clear, complete 2–3 sentence explanation with correct physics (energy conversion + zero force)	Good explanation but missing one key point	Vague or incorrect explanation	/3
8. Direction of Acceleration (Conceptual)	Excellent answer with both mathematical ($a = -\omega^2 x$) and physical (restoring force) explanations	One part (math or physical) is strong; the other is weak.	Missing math or physical reasoning	/3
9. The Turning Point (Conceptual)	Clear explanation linking maximum potential energy, zero kinetic energy, and $v=0$	Good but incomplete (e.g., misses energy or turning point idea)	Incorrect or very brief explanation	/3
Overall Presentations & Accuracy	All answers use correct values from Part A, neat, and uses scientific language	Minor errors in values or language	Many errors or unclear	/3

VI. REFLECTION <i>(Feedback and Continuous Improvement)</i>	<p><i>For the Teacher:</i></p> <ol style="list-style-type: none"> 1. Which instructional strategy triggered the most immediate learner breakthroughs today ("what went well"), and which step in the process stalled the lesson's momentum ("what needs improvement")? 2. Did the group discussion phase successfully scaffold learner confidence for the independent practice problem, or did some learners hide behind their peers' explanations? 3. Based on today's learner performance data and responses, what specific part of this lesson will you modify before teaching it to the next class? <p><i>For the Learners:</i></p> <ol style="list-style-type: none"> 1. What part of today's lesson felt like a major win ("what went well"), and at what exact moment did you feel the most confused or frustrated ("what needs improvement")? 2. How did arguing or collaborating with your group during the conduct of the activities help you understand the physics better than working completely alone? 3. If we were to redo one of the activities tomorrow, what changes would you make to how you study, calculate, or manage your time to improve your score?
VII. USE OF GENERATIVE AI	<p>In preparing this Learning Exemplar (LE), the author(s) used Gemini in order to assist in structuring, formatting, and refining the ideas of the lesson activities. The author reviewed and finalized the writing of the content. The author takes full responsibility for the content of this LE.</p>