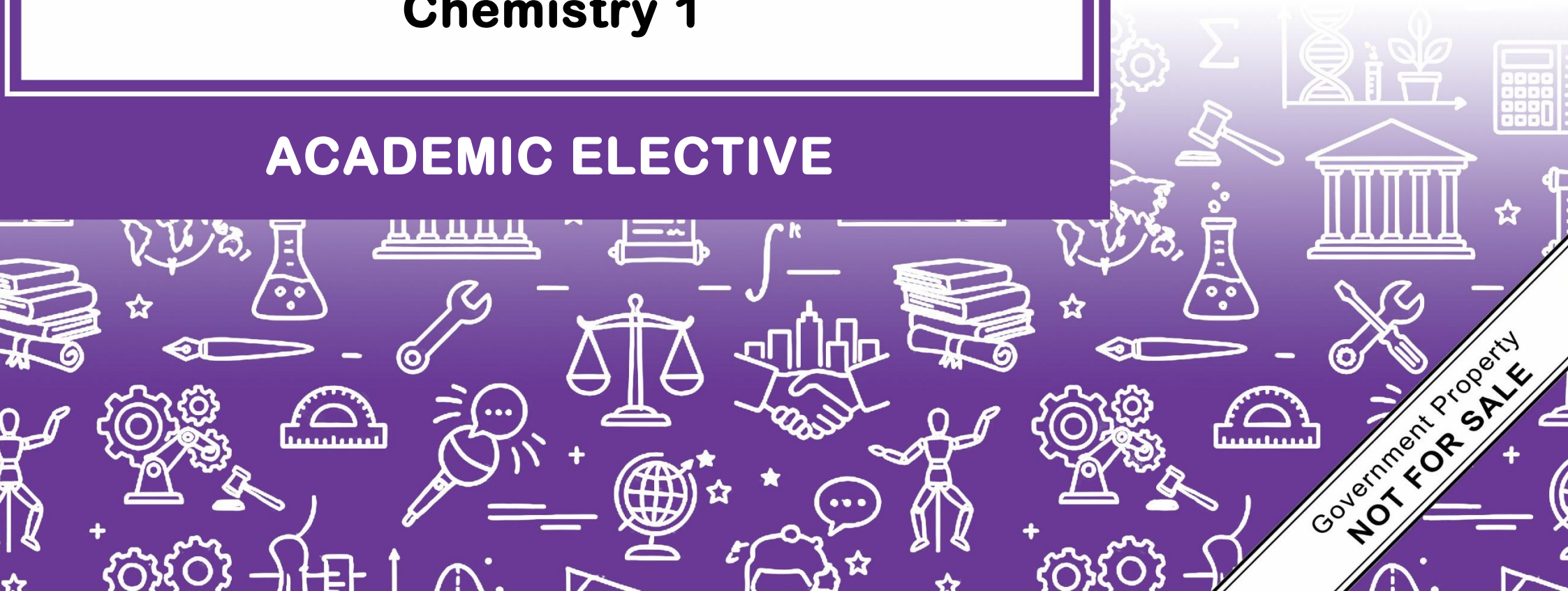
Strengthened Senior High School

DepED
DEPARTMENT OF EDUCATION

Lesson Exemplars for Chemistry 1

ACADEMIC ELECTIVE



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Lesson Exemplars for Chemistry 1

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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**.

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Learning Title/Topic:	Chemistry in Daily Life	Lesson Exemplar:	1

I. OBJECTIVES	
A. Content Standard	The learners learn that chemistry plays an essential role in solving real-world problems and contributes to various industries and career pathways.
B. Performance Standard	By the end of the quarter, learners apply science process skills to obtain accurate and reliable measurements and recognize sources of error. They also apply significant figures and scientific notation in calculations. They explain the development of quantum mechanical models and write electron configurations. They determine periodic trends to predict the properties of elements and describe their applications. Learners explain what isotopes are and how they may be useful and possibly harmful.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	1. Recall fundamental chemistry concepts such as matter, elements, compounds, and reactions.
	The learners describe how chemistry contributes to solving real-world problems in health, environment, and industry as well as career opportunities in chemistry-related fields.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	Binogi International. "Importance of Chemistry in Life, Everyday Uses (Chemistry)." YouTube video, 3:03. February 11, 2014. https://www.youtube.com/watch?v=L2Q2q20KaEk. Ladha, Divya. "1.1 Development and Importance of Chemistry." CK-12 Foundation. Accessed May 7, 2026. https://flexbooks.ck12.org/cbook/ck-12-cbse-chemistry-class-11/section/1.1/primary/lesson/development-and-importance-of-chemistry/. "Scientists Turn Plastic Waste into Clean Hydrogen Fuel Using Sunlight." ScienceDaily, May 4, 2026. https://www.sciencedaily.com/releases/2026/05/260504023841.htm. "This New Carbon Material Could Make Carbon Capture Far More Affordable." ScienceDaily, March 28, 2026. https://www.sciencedaily.com/releases/2026/03/260328043549.htm. "Why Is Chemistry Called 'the Central Science'?" Brainscape Academy, October 10, 2024. https://www.brainscape.com/academy/why-chemistry-central-science/. Materials: modified bingo cards, activity sheets, articles, videos, assessment criteria Annexes: https://tinyurl.com/CHEM1AnnexQ1LE1
III. CONTENT *(Sequencing Content)*	Chemistry in Daily Life

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Give examples of chemistry applications in health, environment, and industry.
2. Explain how chemistry provides solutions to everyday problems in these fields.
3. Explain one way chemistry contributes to addressing a health, environmental, or industrial challenge using a clear real-world example.
4. Recognize career opportunities in chemistry-related fields.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="4">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1: Everyday Chemistry</td></tr>
<tr><td>Ask students to complete the table with daily-life examples of chemistry in health, environment, and industry. They should use short phrases showing how chemistry is applied, then briefly explain why each example fits its category. Let them share their answers with the class to compare and discuss how chemistry connects to real life.
<table><tr><th>Category</th><th>Example</th><th>Explanation</th></tr><tr><td>Health</td><td></td><td></td></tr><tr><td>Environment</td><td></td><td></td></tr><tr><td>Industry</td><td></td><td></td></tr></table></td><td>This option targets Objective 1, is Relevant and Reflective, and applies to a Constructivist and Integrative approach. The pedagogy emphasizes real-world application and peer sharing through table completion and class discussion. Teachers should highlight clear links and guide reflection, using annexes with examples and general questions to check understanding.</td></tr>
<tr><td colspan="2">Option 2: Chemistry Bingo</td></tr>
<tr><td>Ask students to listen as examples of chemistry in everyday life are drawn from the box. When an example matches one on their bingo card, they mark the square. The first student to complete a row, column, or diagonal should briefly explain how chemistry is involved in those examples.</td><td>This option targets Objective 1, is Relevant and Responsive, and combines Constructivist and Integrative approaches. The pedagogy uses bingo engagement, everyday examples, peer explanation, and feedback to connect chemistry to daily life. Teachers should prepare varied bingo cards across health, environment, and industry, supported by annexes with examples and guiding questions for comprehension.</td></tr>
</table>

	Option 3: Admission Ticket	
	Ask students to write a short response about one way they encounter chemistry in daily life, such as medicine, fertilizers, or cleaning agents. They should explain how chemistry is involved and why it matters. Prompt: I encounter chemistry when I use _____. Chemistry is involved because _____. This matters because _____.	This option targets Objective 1, is Relevant and Reflective, and follows a Constructivist and Inquiry-based approach. The pedagogy centers on short written responses, real-world application, and guided prompts to elicit personal connections to chemistry. Teachers should encourage specific, clear examples to ensure meaningful reflections on everyday encounters with chemistry.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Reading for Solutions	
	Ask students to read "Development and Importance of Chemistry" by Divya Ladha. After reading, have them answer the guide questions provided to check their understanding of chemistry development, importance, and applications in daily life. 1. What problems are being addressed? 2. How does chemistry provide a solution to these problems? 3. Why are these important in daily life or society?	This option targets Objective 2, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes reading comprehension and partner discussion to connect chemistry with modern living. Teachers should download materials ahead for offline use and may select other accessible articles, preferably local.
	Option 2: Chemistry in Daily Life	
	Ask students to watch "Importance of Chemistry in Life, Everyday Uses (Chemistry)" by Binogi International on YouTube. After watching, have them answer the guide questions to explain how chemistry is used in everyday life and why it is important. 1. What problems are being addressed? 2. How does chemistry provide a solution to these problems? 3. Why are these important in daily life or society?	This option targets Objective 2, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes video analysis and small group discussion to explore chemistry's role in daily life. Teachers should download videos ahead for offline use and may choose other accessible options, preferably local.
	Option 3: The Central Science	
	Ask students to read "Why is Chemistry Called 'the Central Science'?" by Brainscape Academy and explore how chemistry connects with biology, physics, and earth science. After reading,	This option targets Objective 2, is Relevant and Reflective, and applies to a Constructivist and Integrative approach. The pedagogy emphasizes

	have them answer the guide questions to explain why chemistry is considered central to understanding other sciences. 1. What scientific fields are being supported? 2. What specific examples show chemistry's role? 3. How does chemistry act as the central science in these cases?	reading comprehension and class discussion to show chemistry's role in supporting other sciences. Teachers should download materials ahead for offline use and may select other accessible articles.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1: Chemistry in the News	
	Ask students to analyze the ScienceDaily articles "Scientists Turn Plastic Waste Into Clean Hydrogen Fuel Using Sunlight" and "This New Carbon Material Could Make Carbon Capture Far More Affordable." After reading, have them answer the guide questions to explain how chemistry helps address environmental problems through innovation and sustainable technology. 1. What innovation is shown in the article? 2. Why is the real-world problem being addressed?	This option targets Objective 3, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes article analysis and partner discussion to connect chemistry innovations with global challenges. Teachers should download materials ahead for offline use, select accessible news articles, and guide clear connections.
	Option 2: Trivia for Global Impact	
	Ask students to analyze the trivia presented about innovations in health, environment, and industry. As each item is discussed, have them reflect on the guide questions to explain how chemistry contributes to real-world problem-solving and technological advancement. 1. What specific innovation is being highlighted? 2. Why does this matter on a global scale?	This option targets Objective 3, is Relevant and Reflective, and applies to a Constructivist and Collaborative approach. The pedagogy emphasizes trivia analysis and class discussion to highlight chemistry's global impact. Teachers should use accessible trivia, refer to annexes, and guide links to global contexts.
	Option 3: Product Chemistry Showcase	
	Ask students to observe the everyday products shown and identify their chemical basis using the table provided. Have them record their observations and answer the guide questions to explain how chemistry is involved in each product. 1. What product is being observed? 2. How does this improve the quality of life?	This option targets Objective 3, is Relevant and Reflective, and applies to a Constructivist and Integrative approach. The pedagogy emphasizes product observation and class discussion to show chemistry's contribution to everyday living. Teachers should use accessible products such as beverages, medicines, textiles, electronics, and personal care items, and guide to clear links.

<table>
<tr><td></td><td colspan="2">B.2. Discussing New Concept</td></tr>
<tr><td></td><td colspan="2">Option 1: Career Word Hunt</td></tr>
<tr><td></td><td>Ask students to complete the word puzzle on chemistry-related careers. Afterward, present each profession’s roles, tasks, and related chemical processes.
Have students record each profession and its role in the table, then share notes with a seatmate to explain how these careers contribute to health, environment, and industry.
<table><tr><th>Profession</th><th>Roles or Task</th><th>Chemistry Connection</th></tr><tr><td></td><td></td><td></td></tr></table></td><td>This option targets Objective 4, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes word puzzle solving and peer discussion to connect chemistry-related careers with health, environment, and industry. Teachers should review annexes for brief explanations of each profession and their chemistry connections.</td></tr>
<tr><td></td><td colspan="2">Option 2: Career Gallery Walk</td></tr>
<tr><td></td><td>Ask students to rotate through stations with career descriptions. At each station, have them read about the profession, note its main responsibilities, and discuss with their group the roles and skills needed to succeed, including technical and soft skills.
Let them share ideas, compare perspectives, and explain how these careers connect to science and society.</td><td>This option targets Objective 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes station rotation, career description analysis, and group discussion to highlight responsibilities and skills in science-related professions. Teachers should ensure diverse career stations, prepare posters, encourage both technical and soft skills, and guide connections to science and society.</td></tr>
<tr><td></td><td colspan="2">Option 3: Career Talk</td></tr>
<tr><td></td><td>Ask students to listen attentively to invited professionals sharing experiences in chemistry-related careers. Have them use the table to record the roles and skills discussed, and prepare thoughtful questions about motivation, useful chemistry skills, career paths, and emerging trends.
Afterward, let students write reflections connecting the professionals’ insights to class learning and possible career choices, then share these with classmates.</td><td>This option targets Objective 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes professional talks, table completion, question preparation, reflection writing, and class sharing to connect real-world career experiences with student learning. Teachers should invite diverse</td></tr>
</table>

	<table><tr><th>Career</th><th>Motivations</th><th>Roles/ Tasks</th><th>Chemistry Skills</th><th>Professional Development</th></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td colspan="5">Reflection:</td></tr></table>	professionals or use recorded interviews or printed profiles, guide students in preparing thoughtful questions, and provide summaries to bridge speaker insights with key concepts.
	B.3. Developing Mastery	
	Option 1: Match the Career	
	Ask students to match each product, service, or task with the chemistry-related profession most directly responsible for it. After making their matches, instruct them to explain the chemistry involved in each correct pair. A 1. drug formulation 2. fuel processing 3. nutrient analysis 4. ceramics and polymers 5. pesticide management B a. chemical engineer b. material scientist c. agricultural chemist d. pharmaceutical scientist e. food scientist	This option targets Objectives 1 to 4, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes matching activities, reasoning explanations, and class discussion to link products and services with chemistry-related professions. Teachers should ensure diverse examples and guide clear connections to careers, chemistry, and professional skills.
	Option 2: True or False	
	Ask students to evaluate statements on chemistry applications and careers, mark each as true or false, and justify their reasoning to peers. 1. Forensic scientists use chemical tests to identify crime scene substances, as done in the PNP Crime Lab and the NBI. 2. Chemical engineers only work in labs, not in industries like oil, cement, or food production. 3. Pharmaceutical scientists need knowledge of chemical-biological interactions to create medicines for diseases like dengue and TB. 4. Materials scientists only study natural materials like bamboo or stone, ignoring synthetics. 5. Environmental chemists test air, water, and soil to track pollution in rivers and lakes, then design cleanup methods.	This option targets Objectives 1 to 4, is Relevant and Reflective, and applies to a Constructivist and Collaborative approach. The pedagogy emphasizes true/false evaluation, peer justification, and class discussion to deepen understanding of chemistry applications and careers. Teachers should prepare clear statements, guide reasoning beyond yes/no responses, and embed Philippine-based examples, local industry linkages, or community-based scenarios for contextual relevance. Answers are provided in the annexes.

	Option 3: Role Play	
	Ask students to act out scenarios showing how chemistry helps solve real-world problems, such as a pharmacist explaining medicine or an engineer discussing construction materials. They should communicate clearly and present from the professional's perspective. Evaluate their performance using the provided criteria. **Reflection:** What real-world problem did your scenario show, and how did chemistry help solve it?	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes role-play scenarios and professional perspectives to show chemistry solving real-world problems. Teachers should apply assessment criteria from annexes, encourage focus on communication, and highlight professional perspectives during evaluation.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1: Career Show and Tell	
	Ask students to describe a career they want to pursue and explain how chemistry connects to that path, such as in medicine, engineering, environmental science, or another field. They should identify one relevant chemistry contribution and explain how professionals use it, or how it connects to a class activity, case, or observed example. After the presentation, classmates may give feedback or ask questions. Evaluate the work using the provided assessment criteria.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes career description, chemistry connection analysis, and reflection writing to link personal career goals with chemistry applications. Teachers should encourage diverse career choices, apply assessment criteria from annexes, and provide feedback and support after each presentation.
	Option 2: Field Immersion	
	Ask students, during visits to local government units or private organizations, to use the table provided to record observations on the issue being addressed, the chemical principle or material applied, the measurable impact of chemistry, and the professionals using chemistry knowledge. Afterward, have them connect their observations to classroom learning and reflect on how chemistry may influence their future career choices.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes field visits or case file analysis, reflection writing, and class sharing to connect chemistry principles with societal roles. Teachers should coordinate with LGUs or private organizations, guide notetaking and reflection, secure consent, avoid public posting without permission, and provide

	<table><tr><th>Field</th><th>Issue/Need</th><th>Chemistry Connection</th><th>Outcome</th><th>In-charge</th></tr><tr><td></td><td></td><td></td><td></td><td></td></tr><tr><td colspan="5">Insights/Reflection:</td></tr></table>	alternatives such as case files or virtual field trips when needed.
	Option 3: Resume of the Future	
	Ask students to create a resume highlighting their chemistry-related strengths. It should include their name, contact details, education, experiences, achievements, and skills. Have them draw from class activities, projects, or internships and connect these to future career goals. In describing skills and experiences, they should emphasize chemistry-related contributions such as analysis, synthesis, formulation, materials design, reaction control, or environmental testing, and explain how these were applied. Evaluate the resume using the provided assessment criteria.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes resume drafting, chemistry contribution analysis, and reflection writing to highlight chemistry-related strengths and career aspirations. Teachers should encourage diverse career goals, guide students to emphasize chemistry contributions, apply assessment criteria from annexes, and share the example template provided.
	C.2. Making Generalization	
	Option 1: 3-2-1 Reflection	
	Ask students to analyze the lesson by completing the form provided. Remind them to be specific, so their responses clearly connect to the key ideas discussed. Afterward, let them share answers with the class to compare insights, clarify concepts, and deepen understanding through different perspectives. <table><tr><th>Question</th><th>Answer</th></tr><tr><td>3 things I learned about how chemistry provides solutions to everyday problems</td><td></td></tr><tr><td>2 interesting details I learned about career opportunities in chemistry-related fields</td><td></td></tr><tr><td>1 lingering question I still have for today’s lesson</td><td></td></tr></table>	This option targets Objectives 1 to 4, is Relevant and Reflective, and applies to a Constructivist and Collaborative approach. The pedagogy emphasizes lesson analysis forms, peer sharing, and class discussion to connect chemistry concepts with everyday problems and careers. Teachers should guide learners to be specific in their responses and encourage comparison of perspectives to deepen understanding.

<table>
<tr><td></td><td colspan="2">Option 2: Changing Perspectives</td></tr>
<tr><td></td><td>Ask students to write a reflection on a one-whole sheet of paper about how their view of chemistry changed after the lesson. Guide them to organize their thoughts by recording new insights and explaining how their understanding has grown.
Guide Questions:
1. What new ideas did you learn about chemistry in health, environment, or industry?
2. How did this change or deepen your perspective on chemistry?
3. How might chemistry play a role in your future career or daily life?
Afterward, let students share their reflections with peers and listen to different perspectives to broaden their understanding.</td><td>This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes individual reflection writing, guided questions, and peer discussion to show how views of chemistry evolve. Teachers should encourage honest reflection and lead peer sharing to broaden understanding.</td></tr>
<tr><td></td><td colspan="2">Option 3: Absent Friend Summary</td></tr>
<tr><td></td><td>Ask students to summarize five key points from the lesson using the table provided. They should focus on how chemistry helps solve problems in health, environment, and industry, and how it connects to career opportunities.
1. For each point, have them answer:
2. Why is this one of the most important ideas?
3. How can this help someone who missed class understand the lesson?
After completing the table, let students share their summary with peers and explain their choices during discussion.
<table><tr><th>Most Essential Points</th><th>Significance</th><th>How does it help your friend?</th></tr><tr><td></td><td></td><td></td></tr></table></td><td>This option targets Objectives 1 to 4, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes peer sharing and guided discussion to summarize key points and explain chemistry’s role in health, environment, industry, and careers. Teachers should guide learners to select five essential points and encourage peer explanation to strengthen comprehension.</td></tr>
</table>

	C.3. Evaluating Learning	
	Option 1: Exit Ticket Checkpoint	
	Ask students to write a short response on a one-fourth sheet of paper explaining what they learned today. They should describe how chemistry connects to everyday life in health, environment, or industry, and how it relates to possible careers.	This option targets Objectives 1 to 4, is Relevant and Reflective, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes short written reflections, everyday life connections, career relevance, and peer sharing to consolidate learning. Teachers should facilitate peer discussion to broaden perspectives.
	Option 2: Expert Interview	
	Ask students to interview a professional in a chemistry-related field, either in person or through a live oral format. Have them write a report describing the professional's role, the impact of their work, and the relevance of the career to health, environment, or industry. They should also connect interview insights to their own interests and future goals. Require submission of the written report, recorded audio or video interview, and signed consent form.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes professional interviews, report writing, and career connections to link chemistry with real-world professions. Teachers should guide learners in preparing interview questions, ensure consent forms are signed, and provide in-class alternatives such as vetted career profiles if interviews are not possible. A copy of the consent form is available in the annexes.
	Option 3: Fishbowl Chemistry	
	Ask students to draw an example of chemistry's role in health, environment, or industry from the bowl. Have them present the related career paths, explain how chemistry is applied, and allow peers to listen, observe, and give constructive feedback.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes random draw activities, career connection presentations, and peer feedback to show chemistry's role in health, environment, and industry. Teachers should prepare slips with examples and remind peers to listen actively and provide constructive feedback.

	C.4. Additional Activities	
	Option 1: Career Infographic	
	Ask students to design a poster or paper infographic highlighting chemistry-related careers. They should use visuals, text, and creative design to show how chemistry connects to different professions. Completed outputs will be displayed for peer learning. Before submission, students should ask a peer to review their work. Evaluate the final output using the provided assessment criteria.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes poster or infographic design, career connection, and visual knowledge sharing to highlight chemistry-related professions. Teachers should allow students to choose between digital or paper formats and apply assessment criteria from annexes for evaluation.
	Option 2: A Day in the Life	
	Ask students to create a one-minute video portraying the daily work of a chemistry professional, such as a pharmacist, food scientist, or environmental chemist. They should plan, record, and edit the video to show realistic tasks and responsibilities. Evaluate the output using the assessment criteria provided by the teacher.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes video production or storyboard creation, career portrayal, and realistic task demonstration to show chemistry in professional practice. Teachers should apply assessment criteria from annexes and allow storyboard alternatives if video production is not possible.
	Option 3: Job Interview	
	Ask students to prepare for a mock interview on a chemistry-related career of their choice. Have them review the required skills and practice clear answers to questions such as: 1. Why are you interested in this career? 2. How have you applied chemistry to solve a problem? 3. How does chemistry contribute to this career path? During the interview, students should highlight how chemistry connects to the role. Evaluate using the assessment criteria provided.	This option targets Objectives 1 to 4, is Relevant, Reflective, and Responsive, and applies to a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes mock interview practice, career connection, and oral communication skills to prepare learners for chemistry-related careers. Teachers should guide students in preparing for interviews, remind them to practice clear and confident answers, and apply assessment criteria for evaluation.

VI. ASSESSMENT *(Assessing Learnings)*	**Capstone Project** – Ask students to complete a capstone project that demonstrates their ability to connect chemistry concepts to real-world applications, global challenges, and career opportunities by gathering reliable evidence (such as articles, videos, case studies, or reflections), organizing it logically, and presenting it creatively to show comprehension. Their portfolio must highlight how chemistry helps solve problems in health, environment, and industry, while also exploring a career pathway and reflecting on a global challenge, with clarity, creativity, and evidence-based reasoning emphasized throughout. **Note to Teacher:** Refer to the annex for detailed project requirements and assessment criteria.
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot in order to structure concepts, ensure grammatical accuracy, and design curated learning 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.

Learning Title/Topic:	Physical and Chemical Properties of Matter	Lesson Exemplar:	2

I. OBJECTIVES	
A. Content Standard	The learners learn that matter has observable and measurable properties that can be used to classify, describe, and explain changes in substances.
B. Performance Standard	By the end of the quarter, learners apply science process skills to obtain accurate and reliable measurements and recognize sources of error. They also apply significant figures and scientific notation in calculations. They explain the development of quantum mechanical model and write electron configurations. They determine periodic trends to predict the properties of elements and describe their applications. Learners explain what isotopes are and how they may be useful and possibly harmful.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	1. Differentiate between physical and chemical changes by recalling their definitions and providing everyday examples. 2. Distinguish observable signs of chemical change from those of physical change.
	The learners describe the physical and chemical properties of matter, and explain how these properties are used in real-life applications and in identifying substances.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	Brown, Theodore E., H. Eugene LeMay, Jr., Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew E. Stoltzfus. *Chemistry: The Central Science*. 13th ed. Upper Saddle River, NJ: Pearson, 2015. "DIY Tests to Check Gold at Home." Luxury Brand Jewellery, January 16, 2023. https://www.luxurybrandjewellery.com.au/blogs/news/diy-tests-to-check-gold-at-home?srsltid=AfmBOoqh_vzn4X3vZhDpJFqX1B0WEHvUlKBZwxa0rt7GQ0L_GLsrZ19J. "Mystery Powders." Let's Talk Science. Accessed May 8, 2026. https://letstalkscience.ca/educational-resources/lessons/mystery-powders. "Physical and Chemical Properties in Chemistry: Definitions & Examples." The Physics Classroom. Accessed May 7, 2026. https://www.physicsclassroom.com/Chemistry-Tutorial/Matter/Physical-Chemical-Properties. Materials: activity sheets, assessment criteria, laboratory manual, different household items Annexes: https://tinyurl.com/CHEM1AnnexQ1LE2
III. CONTENT *(Sequencing Content)*	Physical and Chemical Properties of Matter

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Distinguish between physical and chemical properties of matter and give examples.
2. Explain how physical and chemical properties are applied in real-world contexts.
3. Discuss how physical and chemical properties are used to identify unknown substances.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="4">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1: Know-What-How Chart</td></tr>
<tr><td>Ask students to complete the table by providing 2–3 entries per column. They may express their ideas in phrases or sentences, but they should briefly explain each entry. Afterward, let them share their work with two peers, compare ideas to identify gaps, and discuss how observable traits differ from changes in composition.<table><tr><th>What do I know about physical and chemical properties?</th><th>What do I want to know about physical and chemical properties?</th><th>How do I find out?</th></tr><tr><td></td><td></td><td></td></tr></table></td><td>This option targets Objective 1, is Relevant, Reflective, and Responsive, and applies a Constructivist, and Integrative approach. The pedagogy emphasizes peer sharing and concept clarification to distinguish observable traits from changes in composition. Teachers should clarify that physical properties can be observed without altering identity, while chemical properties require composition change through a reaction.</td></tr>
<tr><td colspan="2">Option 2: Bring Me</td></tr>
<tr><td>Ask students to listen to the teacher’s prompt, quickly present an item that matches the property described, and explain whether it shows a physical or chemical property with justification.</td><td>This option targets Objective 1, is Relevant and Responsive, and applies a Constructivist and Integrative approach. The pedagogy emphasizes quick response activities, property classification, and peer justification to identify physical versus chemical properties. Teachers should prompt learners with examples like “bring me something hard” or “bring me something flammable” and guide discussion on differences between physical and chemical properties.</td></tr>
</table>

	Option 3: Quick Response Ticket	
	Ask students to answer the questions in complete sentences on a one-fourth sheet of paper. 1. What happens when ice melts? Does the substance remain the same or change into something new? 2. What happens when paper burns? Does the substance remain the same or change into something new? 3. Which example shows a physical change? Which shows a chemical change? 4. Which property helps explain each case?	This option targets Objective 1, is Relevant, Reflective, and Responsive, and applies a Constructivist, and Integrative approach. The pedagogy emphasizes short written responses, property classification, and peer sharing to analyze physical and chemical changes. Teachers should emphasize the distinction between properties and changes, clarifying that a property is a characteristic of matter while a change is the process of transformation.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Mystery Situations	
	Ask students to answer the questions in complete sentences, share their ideas openly, compare perspectives with classmates, and support their answers with observations and reasoning. 1. Why does a metal spoon get hot in boiling water while a plastic spoon does not? 2. Why does iron rust over time, but gold does not? 3. How do physical and chemical properties explain everyday situations?	This option targets Objective 2, is Relevant, Reflective, and Responsive, and applies a Constructivist, Integrative, and Collaborative approach. The pedagogy emphasizes written explanations, everyday examples, peer comparison, and reasoning practice to connect physical and chemical properties with real-world situations. Teachers should highlight how these properties are applied in manufacturing, engineering, medicine, and daily life.
	Option 2: Choose the Best	
	Ask students to select the most suitable material for each scenario based on its physical and chemical properties. They should explain their choices using relevant properties as evidence. Afterward, let them compare answers with classmates and justify their decisions through discussion. Example questions: 1. Which material would you choose to build a bridge: wood, steel, or plastic?	This option targets Objective 2, is Relevant, Reflective, and Responsive, and applies to a Constructivist, and Integrative approach. The pedagogy emphasizes scenario-based applications, material selection, and peer justification to show how properties guide safe and efficient choices. Teachers should emphasize that physical and chemical properties determine material behavior, ensuring safety, efficiency, and durability.

<table>
<tr><td></td><td>2. Which fibrous material would you choose to make a barong tagalog: piña, abaca, cocoon, or jusi?</td><td></td></tr>
<tr><td></td><td colspan="2">Option 3: Chemistry in the Market</td></tr>
<tr><td></td><td>Ask students to recall experiences with everyday produce such as leafy greens, fruits, meat, eggs, or fish. Guide them to describe how physical properties such as texture, firmness, moisture, color, and odor, and chemical properties such as acidity, spoilage reactions, or changes in smell help determine freshness, ripeness, or spoilage.
Let them share observations with classmates, compare ideas, and reflect on how these properties guide daily food choices.
Example: Dagupan bangus is known for its tender flesh, buttery richness, and lack of muddy aftertaste. It may be identified by its shorter lower tail fin, small head, and round belly.</td><td>This option targets Objective 2, is Relevant, Reflective, and Responsive, and applies a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes observation, comparison, discussion, and reflection to connect food choices with physical and chemical properties. Teachers should guide learners to rely on multiple consistent observations for reliable identification, stressing the value of combined evidence over single traits.</td></tr>
<tr><td rowspan="3">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: 4 Pictures and 1 Word</td></tr>
<tr><td>Ask students to look at each set of four pictures and identify the common word they suggest. Then, have them decide whether the word represents a physical or chemical property and explain their reasoning to the class. Example:
<table>
<tr><th>Scrambled Words</th><th>Image Descriptions</th><th>Classification</th></tr>
<tr><td>ITDSYEN
[DENSITY]</td><td>Wooden block floating on water
Oil layer resting above water
Balloon rising in air
Rock sinking in a lake</td><td>[physical]</td></tr>
</table>
</td><td>This option targets Objective 1, is Relevant, Responsive, and Reflective, and applies a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes visual prompts, word association, classification, and explanation to connect properties with everyday phenomena. Teachers should explain how physical and chemical properties account for real-life events and review annexes for sample image-based questions.</td></tr>
</table>

<table>
<tr><td></td><td colspan="2">Option 2: Sorting Challenge</td></tr>
<tr><td></td><td>Ask students to use flashcards to sort phrases into physical or chemical properties. Have them read each card carefully, decide where it belongs, and justify their classification by explaining the evidence to peers. Example:
<table>
<tr><th>Physical Properties</th><th>Chemical Properties</th></tr>
<tr><td>o easily cuts with knife
o solid at room temperature
o conducts electricity</td><td>o oxidize in air
o reacts violently with water
o produces a green solution</td></tr>
</table></td><td>This option targets Objective 1, is Relevant, Responsive, and Reflective, and applies to a Constructivist and Inquiry-based approach. The pedagogy emphasizes flashcard sorting and peer justification to classify properties with evidence. Teachers should clarify that physical properties describe a substance’s current state, while chemical properties describe its potential to change, and review annexes for additional phrases.</td></tr>
<tr><td></td><td colspan="2">Option 3: Mini Demonstration</td></tr>
<tr><td></td><td>Ask students to observe simple changes, such as breaking chalk, melting a crayon, bending copper wire, fizzing an antacid tablet, or burning paper. Have them classify each as a physical or chemical change, then identify the property involved, such as flammability, malleability, or melting point.
Let them compare answers with classmates and justify their classifications using observable evidence.</td><td>This option targets Objective 1, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Integrative approach. The pedagogy emphasizes hands-on demonstrations, observation, classification, and peer comparison to distinguish physical and chemical changes. Teachers should refer to annexes for complete procedures and stress that reliable classification comes from consistent evidence across observations.</td></tr>
<tr><td></td><td colspan="2">B.2. Discussing New Concept</td></tr>
<tr><td></td><td colspan="2">Option 1: Property Stations</td></tr>
<tr><td></td><td>Ask students to observe changes such as breaking chalk, melting crayons, bending copper wire, fizzing antacid, or burning paper. Have them classify each as a physical or chemical change and identify the related property, such as flammability, malleability, or melting point.
Let them compare answers and justify classifications using observable evidence.</td><td>This option targets Objective 3, is a Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes learning stations, observation, recording, peer discussion, real-life application, and evidence-based reflection to show how properties identify materials. Teachers should prepare varied stations with posters, videos, or demonstrations,</td></tr>
</table>

<table>
<tr><td></td><td></td><td>review annexes for instructions, and stress that identification is strongest when several consistent observations converge.</td></tr>
<tr><td></td><td colspan="2">Option 2: Substance Evidence Comparison</td></tr>
<tr><td></td><td>Ask students to work with four samples: candle wax, milk, sugar, and vinegar. Have them observe and record each material's physical properties, then perform simple tests that reveal chemical properties, such as burning wax, curdling milk, caramelizing sugar, or reacting vinegar with baking soda.
Let them create a comparison table with observations and brief explanations to support their reasoning.</td><td>This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist and Inquiry-based approach. The pedagogy emphasizes observation, testing, comparison, and evidence-based reasoning to classify physical and chemical properties. Teachers should refer to annexes for the complete guide, emphasize that appearance alone is insufficient, and highlight that testing both physical and chemical properties ensures accuracy.</td></tr>
<tr><td></td><td colspan="2">Option 3: Scavenger Hunt</td></tr>
<tr><td></td><td>Ask students to conduct a classroom scavenger hunt using the teacher's checklist of predetermined properties. For each property, have them find a matching object, observe it carefully, record it, and explain how it demonstrates the property.
Let them compare findings with classmates and justify how these properties relate to the object's use. For example:
<table>
<tr><th>Property</th><th>Object Found</th><th>Reason</th></tr>
<tr><td>hardness</td><td>[glass]</td><td>[resists scratching]</td></tr>
<tr><td>flammability</td><td>[paper]</td><td>[turns into ash when burned]</td></tr>
</table></td><td>This option targets Objective 3, is a Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes scavenger hunts, observation, and peer comparison to connect properties with material use. Teachers should ensure varied properties in the checklist, review annexes for examples, and remind learners that reliable identification comes from multiple consistent observations, not appearance alone.</td></tr>
<tr><td></td><td colspan="2">B.3. Developing Mastery</td></tr>
<tr><td></td><td colspan="2">Option 1: Physical or Chemical?</td></tr>
<tr><td></td><td>Ask students to read each scenario, identify whether it shows a physical or chemical change, and state the property or evidence that supports their answer.</td><td>This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes</td></tr>
</table>

<table>
<tr><td></td><td>For example:<table><tr><th>Scenario</th><th>Classification</th><th>Evidence</th></tr><tr><td>A student removes a loaf of bread from the oven. The student cuts a slice off the loaf and spreads butter on it.</td><td>[physical]</td><td>[no change in substance]</td></tr></table></td><td>scenario analysis, classification, and evidence-based explanation to distinguish physical and chemical changes. Teachers should guide learners to justify classifications with clear evidence and review annexes for additional scenarios and structured activity guides.</td></tr>
<tr><td></td><td colspan="2">Option 2: Blind Item</td></tr>
<tr><td></td><td>Ask students to listen as you list property clues, guess the material, write their answer, and explain their reasoning. Let them work with classmates to connect the properties to real-world uses and reflect on how properties help identify materials. Example:
Clues: Extremely hard, transparent, thermally conductive, chemically inert pure carbon lattice
Answer: Diamond
Reason: Hardness makes it useful for cutting tools, transparency for jewelry, and conductivity for electronics.</td><td>This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes property clues, reasoning, and peer reflection to connect material properties with real-world uses. Teachers should provide varied property sets, encourage reasoning beyond guesses, and review annexes for prepared property lists and sample materials to support activity flow.</td></tr>
<tr><td></td><td colspan="2">Option 3: Checkpoint Toss</td></tr>
<tr><td></td><td>Ask students to answer the short questions below in a lively way by catching a ball before responding.
1. Which two properties make aluminum useful for airplane construction? (lightweight and strong)
2. Why is density useful for identifying unknown liquids? (different liquids have distinct densities)
3. Which property of glass explains its use in windows and lenses? (transparency)</td><td>This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, and Inquiry-based approach. The pedagogy emphasizes short question prompts, active participation, and peer justification to reinforce understanding of material properties. Teachers should use engaging formats like ball toss and ensure answers are supported by reasoning.</td></tr>
<tr><td rowspan="3">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: Real or Fake?</td></tr>
<tr><td>Ask students to explore how to distinguish real gold from pyrite or fake samples using property-based tests such as vinegar, float, magnet, and teacher-supervised heat testing. Guide them</td><td>This option targets Objectives 1 and 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Integrative, Collaborative, and Inquiry-based approach. The pedagogy emphasizes</td></tr>
</table>

	in connecting these observations to practical consumer knowledge, deception prevention, and everyday relevance. To strengthen reasoning, ask: 1. How would your conclusion change if one test gave a different result? 2. Why is using several observations better than relying on one clue? **Safety note:** Handle all tests carefully and allow only the teacher to manage heat-related procedures.	property-based testing, observation, comparison, peer reflection, and real-world application to distinguish genuine materials from imitations. Teachers should use photos, sample data tables, or short case cards when physical samples are limited, and review annexes for prepared guides to ensure consistency.
	Option 2: Chemistry in the Household	
	Ask students to choose a household item and demonstrate one useful property. Have them explain why property is important in daily life. Example response: I chose a rubber band. Its useful property is elasticity. This matters because it can hold objects together and stretch without breaking.	This option targets Objectives 1 and 2, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Integrative, Collaborative, and Evidence-based approach. The pedagogy emphasizes demonstrations, real-world connections, evidence-based explanations, and peer sharing to highlight useful properties of everyday items. Teachers should approve only low-hazard items and emphasize safety precautions.
	Option 3: Design Challenge	
	Ask students to design a product, such as a water bottle or smartphone case, by selecting materials based on their physical and chemical properties. Have them present the design and explain how each property guided their choices. Evaluate their work using the provided criteria. Example: "AquaLite" is lightweight, transparent, durable, UV-resistant, and recyclable, making it useful, safe, and environmentally responsible.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Integrative, and Inquiry-based approach. The pedagogy emphasizes design activities, peer presentations, and real-world applications to connect material properties with product innovation. Teachers should emphasize practical function and sustainability, provide assessment criteria in the annexes, and guide learners to connect explanations to both performance and environmental impact.

	C.2. Making Generalization	
	Option 1: Big Idea Statement	
	Ask students to write one sentence summarizing how physical and chemical properties help explain the behavior and usefulness of substances. Have them share, receive feedback, and refine their statement. Example: Physical and chemical properties help us understand how substances behave and why they are useful in daily life.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes synthesis, peer feedback, refinement, and real-world connection to capture the central lesson in one statement. Teachers should reinforce the big idea that physical and chemical properties define how materials are understood and used.
	Option 2: Think–Pair–Share	
	Ask students to reflect individually, share with a partner, and present to the class how physical and chemical properties apply in real situations. Example: One property useful in construction is density because denser materials can provide strength and stability for buildings.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes individual reflection, partner sharing, class presentation, and real-world application to connect properties with practical contexts. Teachers should remind students to link chosen properties to real situations and explain why they matter.
	Option 3: New Clothes	
	Ask students to think of new and creative applications of the properties learned. Have them share their ideas with classmates, listen to suggestions, and refine their work. Example: Because lightweight alloys have low density but high strength, they may be explored as spacecraft materials to help save fuel.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes creative application, peer sharing, feedback refinement, and real-world connection to encourage innovative uses of properties. Teachers should guide learners to think of novel applications and link science to practical possibilities.

<table>
<tr><td></td><td colspan="2">C.3. Evaluating Learning</td></tr>
<tr><td></td><td colspan="2">Option 1: Learning–Application–Questions Chart</td></tr>
<tr><td></td><td>Ask students to complete the table with 2–3 entries per column. Tell them to express their ideas in phrases or sentences and explain each entry clearly. Afterward, have them share their work with their peers. Instruct them to compare ideas to identify gaps in knowledge and guide them to give feedback on lingering questions to strengthen understanding.
<table>
<tr><th>What have I learned about physical and chemical properties?</th><th>How will I apply physical and chemical properties?</th><th>What further questions do I still have?</th></tr>
<tr><td></td><td></td><td></td></tr>
</table></td><td>This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Integrative approach. The pedagogy emphasizes reflection, peer comparison, feedback exchange, and real-world application to consolidate learning. Teachers should guide learners to complete the chart with clear, concise entries that connect properties to practical uses.</td></tr>
<tr><td></td><td colspan="2">Option 2: Exit Ticket</td></tr>
<tr><td></td><td>Ask students to answer the questions below. After responding, have them share their answers with classmates. Instruct them to compare ideas to strengthen understanding and refine explanations together.
1. Name one physical property and its everyday use.
2. Name one chemical property and its effect in real life.
3. Give one example of a property guiding material choice.
4. How can a property help identify an unknown object?</td><td>This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes question-answer consolidation, peer comparison, feedback refinement, and real-world application to strengthen understanding. Teachers should use this activity to consolidate learning with short, clear responses.</td></tr>
<tr><td></td><td colspan="2">Option 3: True or False</td></tr>
<tr><td></td><td>Ask students to read each statement about physical and chemical properties of matter, decide whether it is correct or incorrect, and briefly explain their answer.
1. Physical properties such as density and melting points can be observed without changing the substance’s identity. [True]
2. Solubility in water is a chemical property because dissolving creates a new substance. [False]
3. Food scientists use odors and textures, which are chemical properties, to detect spoilage. [False]</td><td>This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes scenario evaluation, evidence-based reasoning, peer comparison, and real-world application to clarify misconceptions about properties. Teachers should stress that physical properties describe matter without changing</td></tr>
</table>

	4. Appearance alone is always enough to identify an unknown substance. [False] 5. Both physical and chemical properties can be combined to identify an unknown substance more accurately. [True]	identity, while chemical properties involve forming new substances.
	C.4. Additional Activities	
	Option 1: Product Brochure	
	Ask students to create a pamphlet that showcases one innovative product by highlighting its physical and chemical properties and explaining its real-world applications. Instruct them to work individually or in a group to design and present their pamphlet, blending science with communication skills to demonstrate how material properties connect to practical innovation.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Integrative approach. The pedagogy emphasizes pamphlet creation, and real-world application to blend science with communication skills. Teachers should encourage clarity and evidence-based reasoning in the brochure, guiding learners to highlight both physical and chemical properties of the chosen product. Annexes provide the assessment criteria for evaluating the brochure outputs.
	Option 2: Advanced Applications of Properties	
	Ask students to research one physical property and one chemical property of materials, then identify an advanced application of each in modern technology or industry. Have them write a short explanation showing why each property is essential, then share with a classmate to compare and refine ideas. Example: Conductivity supports graphene-based flexible electronics because it allows efficient electricity flow. Corrosion resistance supports titanium implants because it prevents chemical degradation inside the body.	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes research, explanation, and evidence-based reasoning to connect properties with modern technology or industry. Teachers should guide learners to select one physical and one chemical property, explain advanced applications, and highlight why each property is essential.
	Option 3: Daily Reflection	
	Ask students to write a short reflection (up to 150 words) on how they encounter physical and chemical properties in daily life. Instruct them to give simple examples such as bike rusting, food changing when cooked, or other everyday	This option targets Objectives 1 to 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, Integrative, and Reflective approach. The pedagogy emphasizes short

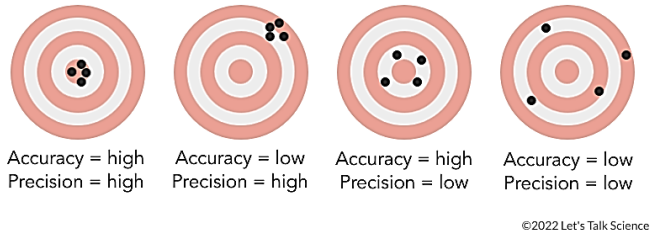
	situations. Tell them to explain briefly how these examples show science at work and why they matter personally.	reflection writing, everyday examples, and real-world connection to show how properties are encountered daily. Teachers should encourage learners to provide specific examples and explain how these illustrate science at work.
VI. ASSESSMENT *(Assessing Learnings)*	**Mystery Powder Lab** – In this activity, you will investigate several everyday powders to figure out the identity of an unknown sample. Your teacher will provide the materials and guide you in testing properties such as how the powders look, whether they dissolve in water, and how they react with vinegar. You will record your observations and compare them with the known substances. By combining these property tests, you will learn how scientists use evidence to accurately identify materials and understand the difference between physical and chemical properties. **Note to Teacher:** An overview is provided in the annex. See the Mystery Powder resource at Let's Talk Science for detailed instructions on carrying out the lab activity.	
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?	
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot in order to structure concepts, ensure grammatical accuracy, and design curated learning 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.	

Learning Title/Topic:	Accuracy and Precision	Lesson Exemplar:	3

I. OBJECTIVES	
A. Content Standard	The learners learn that accurate measurement, precision, and proper use of scientific notation and significant figures are essential for reliable experimental results.
B. Performance Standard	By the end of the quarter, learners apply science process skills to obtain accurate and reliable measurements and recognize sources of error. They also apply significant figures and scientific notation in calculations. They explain the development of quantum mechanical models and write electron configurations. They determine periodic trends to predict the properties of elements and describe their applications. Learners explain what isotopes are and how they may be useful and possibly harmful.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	1. Recognize the importance of measurement in scientific investigations. 2. Use basic laboratory instruments correctly and safely. 3. Interpret simple numerical data by identifying patterns and drawing conclusions.
	The learners explain that accuracy and precision are important to assess the quality of experimental results.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	"Accuracy and Precision." UCalgary Chemistry Textbook, June 4, 2024. https://chem-textbook.ucalgary.ca/version2/review-of-background-topics/measurements-and-data/uncertainty-accuracy-and-precision/accuracy-and-precision/. Brown, Theodore E., H. Eugene LeMay, Jr., Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew E. Stoltzfus. *Chemistry: The Central Science*. 13th ed. Upper Saddle River, NJ: Pearson, 2015. *Bullseyes showing various levels of precision and accuracy*. *Let's Talk Science*. Let's Talk Science. Accessed May 11, 2026. https://letstalkscience.ca/educational-resources/backgrounders/precision-and-accuracy. Cheung, Helier, and Stephen Mulvey. "Great Miscalculations: The French Railway Error and 10 Others." BBC News, May 22, 2014. https://www.bbc.com/news/magazine-27509559. Geyh, Mebus A. *Visual comparison of accuracy and precision using bell curves*. *Research Gate*. Accessed May 11, 2026. https://www.researchgate.net/figure/The-meanings-of-accuracy-and-precision-Accuracy-describes-the-approximation-of-a-mean-to_fig1_285257629. Materials: suction cup darts, ruler, beaker, triple beam balance, paper, volleyball, bean bags, water, rock Annexes: https://tinyurl.com/CHEM1AnnexQ1LE3
III. CONTENT *(Sequencing Content)*	Accuracy and Precision

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Identify the role of measurement in scientific experiments.
2. Use simple laboratory instruments safely to obtain repeated measurements.
3. Differentiate accuracy and precision.
4. Explain why both accuracy and precision are essential in evaluating experimental data and laboratory outcomes.
5. Analyze repeated measurements to determine whether results are accurate, precise, both, or neither.</td></tr>
<tr><td colspan="2">IV. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="6">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1: Measurement Word Cloud</td></tr>
<tr><td>Brainstorm words related to measurement and created a collective word cloud with your classmates. Afterwards, answer these guide questions:
1. Why is measurement important in everyday life?
2. What are common tools for measurement?
3. Why is measurement essential for experiments and investigations?</td><td>This option targets Objective 1, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, and Integrative approach. The pedagogy emphasizes brainstorming to activate prior knowledge. Teachers should provide corrective feedback on misconceptions learners may have.</td></tr>
<tr><td colspan="2">Option 2: Vocabulary Builder</td></tr>
<tr><td>Allow students to create their own definitions for the following measurement-related vocabulary: instrument, observation, magnitude, unit, scale, variable, accuracy, precision, range, standard, calibration, quantity, dimension, interval, and error. Ask them to provide everyday examples that show their understanding of each term.</td><td>This option targets Objective 1, is Relevant and Reflective, and applies to a Constructivist and Inquiry-based approach. The pedagogy emphasizes vocabulary building and contextual examples. Teachers should review annexes for definitions and ideal examples and clarify common misconceptions such as confusing accuracy with precision.</td></tr>
<tr><td colspan="2">Option 3: Hands-On Measuring</td></tr>
<tr><td>Allow students to measure assigned items using tools such as rulers, beakers, or balances. They should use each tool to measure the assigned item, explain how they performed the measurement, and justify why the tool was appropriate for the task. Afterwards, let them compare their methods with classmates and discuss the accuracy and precision of their results.</td><td>This option targets Objectives 1 and 2, is Responsive, Relevant, and Reflective, and applies to a Constructivist and Collaborative approach. The pedagogy emphasizes hands-on measurement and peer discussion. Teachers should ensure learners understand why specific tools are used, explain the difference between</td></tr>
</table>

		accuracy and precision, and review annexes for complete procedures and guide questions.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Admission Ticket	
	Allow students to respond to the question, "Why do we need to measure correctly?" By sharing their ideas with the class. Ask them to consider how accurate and precise measurements affect experiments, everyday tasks, and decision-making. Example response: Correct measurement is important because it promotes consistency, safety, and reliability. When we measure accurately and precisely, we increase the chance that our actions will produce the intended results.	This option targets Objective 4, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, and Inquiry-based approach. The pedagogy emphasizes question-driven discussion, real-life application, and peer sharing. Teachers should reinforce that correct measurement ensures safety, consistency, and reliability, eliminating guesswork, and minimizing waste of time and resources.
	Option 2: What If Scenarios?	
	Allow students to work with classmates to analyze everyday situations by predicting possible outcomes and relating them to accuracy and precision. As they reflect, ask them to consider how measurement of errors can affect results, sometimes subtly and sometimes with serious consequences. Example scenarios to explore: 1. How will a 2 cm difference at the waist affect Maria's Baro't Saya during the ceremony and photos? 2. What practical problems may arise from a few-centimeter error in the layout of a nipa hut post? 3. What chemical and safety consequences may result from adding slightly too much acid in the classroom setting?	This option targets Objective 4, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, and Reflective approach. The pedagogy emphasizes scenario analysis, predictive reasoning, group discussion, and real-life application to connect measurement accuracy and precision with everyday consequences. Teachers should guide learners to analyze outcomes of small measurement errors and review annexes for additional example scenarios to extend discussion.
	Option 3: Measurements Gone Wrong	
	Allow students to work in groups to analyze one assigned case from the article "Great Miscalculations: The French Railway Error and 10 Others" by Helier Cheung and Stephen Mulvey. Ask them to reflect on how measurement or calculation of errors affect science and everyday life and discuss how attention to detail and	This option targets Objective 4, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes case study analysis, group discussion, and real-

	reliable measurement practices can help prevent serious consequences.	world application. Teachers should emphasize that careful attention to detail and reliable measurement practices prevent serious consequences.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1: Target Practice	
	Allow students to simulate hitting a target and then describe the accuracy and precision of their results. Ask them to compare different outcomes with classmates and discuss what the results reveal.  	This option targets Objectives 3 and 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Integrative, approach. The pedagogy emphasizes simulation activity, experiential learning, peer comparison, and reflective discussion to illustrate accuracy and precision. Teachers should ensure learner safety by using suction cup darts instead of real darts and clarify that accuracy means closeness to the accepted value while precision means closeness of repeated measurements to one another.
	Option 2: Paper Airplane Test	
	Allow students to fold paper airplanes of the same design and launch them from a fixed point toward a target distance or "true value." They should throw each airplane several times using similar force and angle, mark where the nose lands, and measure the distance from the target using a tape measure. Ask them to record results in a table, analyze whether the throws show accuracy, precision, or both, and compare findings with classmates to discuss consistency versus closeness in measurement quality.	This option targets Objectives 3 and 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes hands-on experimentation and reflective discussion. Teachers should clear the activity area, ensure consistent airplane design and launch method, and explain how the target activity models closeness and consistency, contrasting laboratory accepted values with game targets.
	Option 3: Sports Connection	
	Allow students to serve volleyball several times from the end line and mark where each ball lands. Ask them to record the results,	This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a

	then evaluate accuracy based on how close the serves are to the designated "true value" area inside the court, and precision based on how consistent the serves are across attempts. Afterward, let them compare results with classmates and discuss the difference between being consistent and being close to the goal, and how both contribute to effective serving.	Constructivist, Collaborative, Inquiry-based, and Integrative approach. The pedagogy emphasizes experiential learning to connect sports performance with measurement concepts. Teachers should facilitate volleyball activity safely and explain how accuracy and precision in sports parallel laboratory measurement practices.
	B.2. Discussing New Concept	
	Option 1: Calculating Accuracy & Precision	
	You measure the time it takes for a pendulum to complete 10 swings. The recorded times are: 12.1 s, 12.0 s, 12.2 s, 11.9 s, 12.3 s, 12.0 s, 12.2 s, 12.1 s, 11.8 s, and 12.4 s. a. Find the average time. b. Calculate the percent error compared to the known value of 11.8 s. c. Determine the standard deviation. d. Interpret the accuracy and precision of measurements.	This option targets Objectives 2 to 5, is Relevant, and Responsive, and applies to a Constructivist, Inquiry-based and Integrative approach. The pedagogy emphasizes data analysis. Teachers should review the annexes to reinforce how accuracy can be determined using percentage error and how precision can be assessed through standard deviation, with additional practice problems provided to strengthen understanding.
	Option 2: Visualizing Accuracy & Precision	
	Examine the bell curves shown for various scenarios of accuracy and precision. For each case, provide a description of how the curve reflects the condition being illustrated. Answer the guide questions: 1. Does the curve center closely on the target value, or is it shifting away? 2. Are the results tightly clustered together, or widely spread out? 3. How does this curve differ from the others in terms of shape and position?	This option targets Objectives 3 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Reflective approach. The pedagogy emphasizes guided analysis, visual interpretation, and question-driven learning. Teachers should show a picture of the bell curve in the annexes, explaining how it illustrates accuracy and precision through the dataset center, spread, and shape. The annexes also provide answers to the questions.
	Option 3: Measure It (Part 1)	
	Measure the mass of a wooden block five times using a triple beam balance. Record each value in the grams in the table below. Use	This option targets Objectives 2 to 5, is Relevant, and Responsive, and applies to a Constructivist and Inquiry-based approach. The pedagogy

	the digital balance reading from a calibrated instrument as the accepted reference value. Calculate the average mass, percentage error, and standard deviation. Interpret your results based on these calculations. **Trial** | **Mass (g)** | $x_i - \bar{x}$ | $(x_i - \bar{x})^2$ 1 | | | | … | | | | 5 | | | | Σ | | | |	emphasizes hands-on measurement and data analysis, and statistical interpretation. Teachers should review the annexes to reinforce how accuracy can be determined using percentage error and how precision can be assessed through standard deviation, with assessment criteria also provided in the annexes.
	B.3. Developing Mastery	
	Option 1: Accurate or Precise	
	Read each scenario, decide if the instrument is accurate, precise, both, or neither, explain your answer. For example: 1. A thermometer sometimes reads 1.5 °C higher, sometimes 1.5 °C lower, but the average matches the true temperature. 2. A graduated cylinder has uneven markings, so readings vary randomly and are usually 5 mL above the true volume. 3. A stopwatch mechanism is slightly slow, so it consistently records times 0.2 seconds longer than the actual duration. 4. A digital scale sensor is stable and always reads exactly the true weight.	This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Collaborative approach. The pedagogy emphasizes scenario analysis, critical reasoning, and peer justification. Teachers should use comparisons across cases to strengthen conceptual clarity.
	Option 2: Blank Targets	
	Ask students to plot points on a blank target to show different patterns of accuracy and precision. Let them compare diagrams with classmates and justify their reasoning. Evaluate their work using the provided assessment criteria.	This option targets Objective 3, is Relevant and Responsive, and applies to a Constructivist, Collaborative, and Inquiry-based approach. The pedagogy emphasizes diagram plotting and peer comparison. Teachers should provide clear target templates and assessment criteria in the annexes.

<table>
<tr><td></td><td colspan="2">Option 3: Data Set Analysis (Part 1)</td></tr>
<tr><td></td><td>Work in groups to analyze the data in the table below. Each set will be assigned to a group. For each set, calculate the average percentage error, and standard deviation. Compare your work with other groups to determine which set shows higher accuracy and precision.
<table>
<tr><th></th><th colspan="3">Volume of Water, True Value = 50 mL</th></tr>
<tr><th>Trial</th><th>Set A (mL)</th><th>Set B (mL)</th><th>Set C (mL)</th></tr>
<tr><td>1</td><td>49.8</td><td>47.5</td><td>52.0</td></tr>
<tr><td>2</td><td>50.2</td><td>47.8</td><td>51.5</td></tr>
<tr><td>3</td><td>49.9</td><td>48.0</td><td>52.5</td></tr>
<tr><td>4</td><td>50.1</td><td>47.6</td><td>51.8</td></tr>
<tr><td>5</td><td>50.0</td><td>47.7</td><td>52.2</td></tr>
</table></td><td>This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Collaborative approach. The pedagogy emphasizes data analysis, statistical comparison, and evidence-based justification. Teachers should review the annexes to reinforce how accuracy can be determined using percentage error and how precision can be assessed through standard deviation, with assessment criteria also provided in the annexes.</td></tr>
<tr><td rowspan="5">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: Beanbag Toss</td></tr>
<tr><td>Ask students to toss beanbags toward a target and record where they land. Have them analyze their results in terms of accuracy and precision, then reflect on whether their throws show consistency, closeness, both, or neither. Let them compare findings with classmates.</td><td>This option targets Objectives 3 and 5, is Relevant, and Responsive, and applies to a Constructivist, Collaborative, and Inquiry-based approach. The pedagogy emphasizes hands-on activity and comparative analysis. Teachers should clear the activity area, use only soft or non-breakable materials for target tasks, and provide seated or paper-based alternatives when needed.</td></tr>
<tr><td colspan="2">Option 2: Accurate or Precise</td></tr>
<tr><td>Analyze the distance a ball rolls five times for each scenario. Classify each data set as accurate, precise, both, or neither. Justify your choice in one sentence using evidence from the values. Finally compare your reasoning with a peer to discuss which evidence best supports your classification.</td><td>This option targets Objectives 2 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Collaborative approach. The pedagogy emphasizes data analysis. Teachers should compare the values to decide whether each set is accurate and precise, precise, but not accurate, accurate, but not</td></tr>
</table>

	Distance, True Value = 10 m			
Trial	**Set A (m)**	**Set B (m)**	**Set C (m)**	**Set D (m)**
1	8.0	15.0	9.9	12.0
2	12.0	6.0	10.1	12.1
3	10.0	13.0	10.0	11.9
4	11.0	5.0	10.0	12.0
5	9.0	14.0	10.1	12.1

precise, or neither accurate nor precise, with no computation required.

Option 3: Measure It (Part 2)

Imagine you are a materials engineer testing a rock for construction. Measure its volume five times using water displacement and express the final volume in cm^3. Record your data, then calculate the average percentage error, and standard deviation. As in industry, accuracy and consistency decide approval. Afterward, answer these process questions:

1. How does repeating trials improve reliability?
2. Why is error analysis critical in industry?
3. What would high variability mean for industry decisions?

Trial	**Initial Volume of Water (mL)**	**Final Volume of Water (mL)**	**Volume of the rock (cm^3)**	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
1					
…					
5					
Σ					

This option targets Objectives 2 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Collaborative approach. The pedagogy emphasizes hands-on measurement, data analysis, and statistical interpretation. Teachers should dispose of water properly, dry wet floors immediately, and store measurement tools safely after use. Annexes provide assessment criteria. Explain accuracy as closeness to the accepted value often described using percent of error, and precision as consistency among repeated measurements commonly described through spread measures such as range or standard deviation.

C.2. Making Generalization

Option 1: Accuracy vs. Precision

Ask students to draw a Venn diagram with two overlapping circles labeled Accuracy and Precision. In each circle, list unique characteristics and examples; in the overlap, show how results can be both accurate and precise.

This option targets Objective 3, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, and Integrative approach. The pedagogy emphasizes concept

	Guide them with these questions: What makes measurements accurate? What makes them precise? Require at least one real-life example and ask them to explain their diagram to a peer using evidence.	mapping and peer sharing. Teachers should highlight that accuracy and precision are both essential metrics for evaluating measurement quality yet address different aspects of data reliability—accuracy reflects closeness to the true target value, while precision describes consistency and reproducibility of repeated measurements.
	Option 2: Takeaways	
	Ask students to summarize the lesson in five key points about accuracy and precision. For each point, they should clearly explain the concept and state why it is important. After writing, let them share with a classmate, compare ideas, and discuss how the points connect to real-world examples.	This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Collaborative, and Reflective approach. The pedagogy emphasizes summarization, evidence-based explanation, and peer comparison. Teachers should refer to the annexes for responses to look out for.
	Option 3: Word Splash	
	Ask students to write a 2–3 sentence summary of the lesson using the given words. Their summary should explain how accuracy relates to closeness to true value and how precision relates to consistency, repeatability, and clustering of measurements. Words to use true value, closeness, correctness, consistency, repeatability, clustering, error, variation, reliability, range, deviation.	This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, and Integrative approach. The pedagogy emphasizes concept consolidation and peer sharing. Teachers should remind learners that accuracy refers to the closeness of results to the true value, minimizing error, range, and deviation, while precision highlights consistency, repeatability, and tight clustering of values despite some variation, ensuring reliability of results.
	C.3. Evaluating Learning	
	Option 1: Exit Ticket	
	Ask students to answer the questions below to consolidate learning, then share and compare responses with classmates. 1. How do you determine accuracy and precision?	This option targets Objectives 2 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist and Inquiry-based approach. The

	2. When is accuracy more important? When is precision more important? 3. How are accuracy and precision different, and why do both matter in experiments?	pedagogy emphasizes question-driven consolidation and peer discussion. Teachers should stress that both accuracy and precision are essential in experiments. Make clear that experiments are not reliable if either is missing, since both must work together for valid findings.
	Option 2: Multiple Choice	
	Ask students to read each question carefully, choose the best answer, and justify it in one sentence using measurement concepts. Then, let them compare answers with a classmate and discuss why accuracy or precision matters in each scenario.	This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist and Inquiry-based approach. The pedagogy emphasizes multiple choice questions. Teachers should review the annexes for complete questions and answers.
	Option 3: True or False Check	
	Ask students to evaluate the statements about accuracy and precision, identify whether each is true or false, and justify their answers to peers by explaining their reasoning.	This option targets Objectives 1 to 5, is Relevant and Reflective, and applies to a Constructivist and Collaborative approach. The pedagogy emphasizes true/false evaluation and peer discussion. Teachers should require learners to justify each answer briefly, with questions and explanations in the annexes.
	C.4. Additional Activities	
	Option 1: Reflection	
	Ask students to write a short essay explaining why accuracy and precision matter in experiments and everyday life. They may use personal examples such as cooking, sports, or household measurements. Then, ask them to connect these ideas to local occupations and community enterprises, such as farming, food businesses, market selling, healthcare, and construction, where accurate and precise measurements are important.	This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist and Integrative approach. The pedagogy emphasizes essay writing, real-life application, and peer sharing. Teachers should remind students that accuracy shows closeness to true value, while precision shows consistency and repeatability.

<table>
<tr><td rowspan="4"></td><td colspan="2">Option 2: Accurate or Precise with Error Investigation</td></tr>
<tr><td>Ask students to read each scenario and classify the results as accurate and precise, precise but not accurate, accurate, but not precise, or neither accurate nor precise. They should also identify possible causes of error.
1. A 100.0 g block is measured as 100.1 g, 100.0 g, 100.2 g, 100.1 g, and 100.0 g.
2. A thermometer consistently reads 5°C higher than the actual temperature.
3. Students measure a table and get 150.0 cm, 149.0 cm, 151.5 cm, 150.5 cm, and 149.5 cm.
4. Water volume is recorded as 45 mL, 60 mL, 52 mL, 70 mL, and 40 mL when the true value is 50 mL.</td><td>This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Constructivist, Inquiry-based, and Reflective approach. The pedagogy emphasizes scenario analysis, error identification, and evidence-based reasoning. Teachers should remind learners that accuracy relates to closeness to true value, while precision relates to consistency of repeated measurements. Experimental error can be systematic, such as instrument bias or calibration issues, or random, such as human inconsistency or environmental factors. Answers are provided in the annexes.</td></tr>
<tr><td colspan="2">Option 3: Accuracy vs Precision Debate</td></tr>
<tr><td>Ask students to engage in a structured debate on whether accuracy or precision is more important. They should prepare clear arguments using examples from experiments or everyday situations, present their points respectfully, and listen carefully to opposing views.</td><td>This option targets Objectives 1 to 5, is Relevant, Responsive, and Reflective, and applies to a Collaborative, Inquiry-based, and Reflective approach. The pedagogy emphasizes evidence-based discussion. Teachers should conclude by emphasizing that both accuracy and precision are essential, guiding reflection on balanced understanding.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Data Analysis (Part 2): Imagine you are part of a quality control team in a manufacturing plant. Three different sensors (Sensor X, Sensor Y, Sensor Z) recorded water temperatures during a process where the true value should be 75.0 °C. Calculate the average, percentage error, and standard deviation for each set. After completing your calculations, answer the following process questions:
1. Which sensor shows higher accuracy, and which shows higher precision? Why does industry need both?
2. What risks could arise if a sensor consistently reports values with high errors?
3. If you were the plant manager, which sensor would you approve for continued use?</td></tr>
</table>

<table>
<tr><td></td><td></td><td colspan="4"><table>
<tr><th></th><th colspan="3">Temperature of Water, True Value = 75.0 °C</th></tr>
<tr><th>Trial</th><th>Sensor X (°C)</th><th>Sensor Y (°C)</th><th>Sensor Z (°C)</th></tr>
<tr><td>1</td><td>77.0</td><td>74.8</td><td>72.5</td></tr>
<tr><td>2</td><td>76.5</td><td>75.2</td><td>72.8</td></tr>
<tr><td>3</td><td>77.5</td><td>75.0</td><td>73.0</td></tr>
<tr><td>4</td><td>76.8</td><td>74.9</td><td>72.6</td></tr>
<tr><td>5</td><td>77.2</td><td>75.1</td><td>72.7</td></tr>
</table></td></tr>
<tr><td>VII. REFLECTION
(Feedback and Continuous Improvement)</td><td colspan="5">Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery.
1. How many learners successfully demonstrated the learning objectives based on the assessment results?
2. Which activity helped learners understand the lesson the most? Which activity helped the least?
3. Which part of the lesson was easiest for learners? Which part was the most difficult?
4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support?
5. What did the assessment results show about learners' understanding of the lesson?
6. What improvement would you make if you taught this lesson again?</td></tr>
<tr><td>VIII. USE OF GENERATIVE AI</td><td colspan="5">In preparing this Learning Exemplar (LE), the author(s) used Copilot in order to structure concepts, ensure grammatical accuracy, and design curated learning 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.</td></tr>
</table>

Learning Title/Topic:	Sources and Types of Experimental Error	Lesson Exemplar:	4

I. OBJECTIVES	
A. Content Standard	The learners learn that experimental results are affected by sources of error, which can be minimized.
B. Performance Standard	The learners will be able to critically identify sources of experimental error, propose practical strategies to minimize them, and apply accurate measurement, precision, and proper use of scientific notation and significant figures to ensure reliable and valid experimental results.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	The learners must already know how to measure accurately, record data properly, and apply concepts of accuracy and precision. They must also have the skill to observe critically and follow lab protocols.
	Identify sources of experimental error and suggest ways to improve the reliability of experimental results.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	**References:** Taylor, John R. An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements. 2nd ed. University Science Books, 1997. International Organization for Standardization. ISO/IEC Guide 98-3:2008. Uncertainty of Measurement—Part 3: Guide to the Expression of Uncertainty in Measurement (GUM:1995). Geneva: ISO, 2008. **Materials:** measuring tools (ruler, balance, graduated cylinder, thermometer image), scenario cards, chart paper, markers, projector or printed visuals, learner worksheets.
III. CONTENT *(Sequencing Content)*	Sources and Types of Experimental Error

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Define experimental error and distinguish systematic and random error patterns.
2. Identify common sources of error in a laboratory set-up or procedure.
3. Propose one corrective measure to reduce a detected error.
4. Redesign a simple laboratory procedure to minimize a specific source of error.</td></tr>
<tr><td colspan="2">IV. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1: Think-Pair-Share</td></tr>
<tr><td>Activity Flow:
Ask: “Have you ever measured something twice and got different results? What happened?”
Students jot down an example (e.g., measuring their height, weighing rice, timing a run).
1. Pair up and share experiences.
2. Teacher highlights: These differences connect to accuracy (closeness to true value) and precision (consistency of repeated results).</td><td>This activity targets Objectives 1 and 2. It elicits prior knowledge and supports relevance and responsiveness by linking measurement errors to daily-life situations. The activity uses constructivist and inquiry-based approaches through guided questioning and peer discussion. The specific pedagogy is think-pair-share.
Note to the teachers: Listen for confusion between accuracy, precision, error type, and error source, then address these before moving to the new lesson.</td></tr>
<tr><td colspan="2">Option 2: Everyday Object Estimation</td></tr>
<tr><td>Activity Flow:
1. Show a familiar object (e.g., a pencil, a coin, a glass of water).
2. Ask students to estimate its length, weight, or volume.
3. Compare estimates with actual measurements.
4. Discuss: Were the results accurate? Were they precise?</td><td>This activity targets Objectives 1-4. Its guiding principle is experiential learning, shown by using familiar contexts to make error detection authentic. The 2C–2I–1R framework is evident in focused content and contextual links to everyday practice. Guided inquiry is appropriate as students discover and analyze errors through structured tasks, while</td></tr>
</table>

	Purpose: Activates prior knowledge by linking measurement errors to daily life.	constructivism fits because learners connect prior experiences with laboratory practices to build meaningful understanding. **Teacher diagnostic follow-up:** If learners treat precise measurements as automatically accurate, clarify that precision means consistency, while accuracy means closeness to the accepted value. If learners treat every mistake as the same type of error, explain that error type and error source are related but not identical ideas.
	Option 3: Mini Warm-Up Quiz	
	Activity Flow: Present three short scenarios: - A student measures a 10.0 cm object three times and gets 9.9 cm, 9.9 cm, and 9.9 cm. Are the results precise? Are they accurate? Explain using the accepted value. - A scale always reads 2 kg too high. What type of error pattern does this show? - A stopwatch gives slightly different times in each trial. What type of error pattern does this show? Collect answers and connect to lesson objectives.	This mini warm-up quiz supports all four objectives through contextual learning, applying the 2C–2I–1R approach with guided discussion and a constructivist pedagogy that engages students in interpreting relatable scenarios, classifying errors, and linking everyday experiences to laboratory practice for improved accuracy and precision**.** **Note to the teachers**: The teacher should validate student answers, clarify misconceptions, and scaffold the redesign step to ensure practical solutions.

	A.2. Establishing the Purpose of the Lesson	
	Option 1: Mystery Scenario	
	Activity Flow: The teacher presents three quick everyday situations: 1. A scale shows 2 kg heavier than the actual weight. 2. Two classmates time a race and get slightly different results. 3. A student misreads a thermometer by looking at it from the side. **Prompt:** "These are all examples of errors. Can you guess what type of error each one is?" **Sample student response:** Scenario 3 Thermometer misread: Systematic error, parallax error from an incorrect viewing angle. **Meniscus Reading: http://tiny.cc/CHEMLE4LAS**	This mystery scenario activity meets all four objectives through contextual learning, applying the 2C–2I–1R approach with guided inquiry and a constructivist pedagogy that engages students in classifying, analyzing, and redesigning procedures to strengthen accuracy and precision**.** **Note to the teachers:** The teacher should validate student answers, clarify misconceptions, and scaffold the redesign step to ensure practical and feasible solutions.
	Option 2: Group Sorting Game	
	Activity Flow: Students form small groups (3-4 groups). Each group receives cards with the scenarios written on them. Their task is to sort the cards into Types and Sources of experimental error. For discussion, groups explain their sorting choices in sentence form. Each group proposes one corrective measure for a chosen scenario and redesigns the procedure to minimize that error. **Class Debrief:** Teacher reviews group answers, clarifies misconceptions, and connects the activity to laboratory error analysis.	This card sorting activity aligns with all four objectives through active learning, applying the 2C–2I–1R approach with collaborative problem solving and a constructivist pedagogy that engages students in classifying errors, justifying choices, and correcting misconceptions to strengthen accuracy and precision**.** **Note to the teachers:** The teacher should ensure scenarios are clear, guide to classification discussions, and scaffold corrective/redesign steps to connect everyday examples with laboratory practice.

	Option 3: Concept Mapping	
	Instructions: Students create a concept map with *Experimental Error* at the center, branching into *Systematic* and *Random* errors. From each type, they add sources such as *Instrumental, Environmental, Observational,* and *Personal*. Each source is linked to corrective measures like *calibration, repeated trials, careful observation,* and *proper meniscus reading*. Groups then complete their maps and present, explaining how classification and solutions improve accuracy and precision. **Experimental Error Concept Mapping:http://tiny.cc/CHEMLE4LAS**	This concept mapping activity enables students to meet all four objectives through conceptual integration, applying the 2C–2I–1R approach with guided discovery and a constructivist pedagogy that builds accuracy and precision via visual connections among error types, sources, and solutions. **Note to the teachers:** The teacher should ensure students provide concrete examples, guide them to propose corrections, and highlight redesign strategies during synthesis.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1: Error Gallery Walk	
	Activity Flow: Arrange stations around the classroom with scenario cards and posters. Divide students into small groups. Rotate groups through stations (3–5 minutes each). At each station, students classify the error type, identify the source, and propose one corrective measure. **Generalization step**: "What do these examples collectively show us about measurement errors? **Error Gallery Walk Activity: http://tiny.cc/CHEMLE4LAS**	The activity aligns with all four objectives, its guiding principle of experiential and collaborative learning is shown through station-based error simulations, where learners actively observe and discuss mistakes, the 2C–2I–1R approach is applied through clear content, contextualized scenarios, and the pedagogy of constructivism is appropriate because learners build understanding by connecting prior knowledge with laboratory practice and collaboratively analyzing error patterns.

	Option 2: Error Mystery Box	
	Activity Flow: Teacher Setup: Prepare three boxes with items (miscalibrated scale, stopwatch with varied times, ruler with unclear markings). **Student Task:** Learners rotate through stations, test each item, and record observations. **Synthesis**: Teacher leads a class discussion, asking "What type of error did you detect? What caused it?" and connects findings to lesson objectives. **Lab Safety Measures: http://tiny.cc/CHEMLE4LAS**	The activity aligns with the given objectives, its guiding principle of experiential learning is shown through props that simulate authentic error situations, the 2C–2I–1R approach is applied through clear content, contextualized tasks, and the pedagogy of constructivism is appropriate because learners discover error types through hands-on testing and build understanding by connecting prior knowledge with practice. **Note to the teachers:** The teacher should guide students to classify each error correctly, highlight the cause, and scaffold discussions toward corrective actions and redesign strategies that connect classroom simulations to real laboratory practice.
	Option 3: Detective Puzzle	
	Activity Flow: In this *Detective Puzzle* activity, students analyze mystery scenarios of measurement mistakes, classify each error type and source, propose corrective measures, and share findings with the class to reinforce how proper error classification improves accuracy and precision. **Wrap-up with**: *"Errors are everywhere — today we learned how to classify them and reduce their impact on experiments. By practicing skills like reading the meniscus correctly, we can minimize human error and improve precision."* **Detective Puzzle Activity: http://tiny.cc/CHEMLE4LAS**	The activity aligns with all four objectives, its guiding principle of contextual learning is shown through mystery scenarios that connect laboratory errors to everyday experiences and stimulate analytical thinking, the 2C–2I–1R approach is applied through clear content, contextual problem-solving, values integration, interactive group inquiry, and the pedagogy of constructivism is appropriate because guided inquiry enables learners to collaboratively investigate, classify, and justify error types by linking prior knowledge with experimental practice. **Note to the teachers**: Include guiding students to connect error types to practical lab solutions.

	B.2. Discussing New Concept	
	Option 1: Case Study Analysis	
	Activity Flow: The teacher divides the class into small groups and posts the three case study station cards around the room. Students rotate through each station, analyze the case study, and record their answers on the worksheet. **Reflection Questions:** 1. Which type of error do you think has the greatest impact on scientific research? Why? 2. How do errors influence accuracy and precision in experiments? 3. What strategies can scientists use to minimize these errors? **Case Study Analysis: http://tiny.cc/CHEMLE4LAS**	The activity aligns with the given objectives, its guiding principle of contextualized experiential learning is shown through case examples that connect laboratory errors to authentic situations, the 2C–2I–1R approach is applied through clear content, contextual problem-solving, and the pedagogy of constructivism is appropriate because case-based inquiry enables learners to actively analyze, justify, and build understanding by linking prior knowledge with experimental practice. **Note to the teachers:** Demonstrate correct meniscus reading at Station 3 before the students' practice.
	Option 2: Error Simulation	
	Activity Flow: The teacher posts the three station cards around the room, and students rotate in groups to complete the worksheet at each station. At every station, they define the error type, identify its source, propose a corrective measure, and redesign the procedure. Finally, each group shares one redesign with the class to reinforce how error classification improves accuracy and precision. **Reflection Questions:** 1. Which type of error do you think has the greatest impact on scientific research? Why? 2. What strategies can scientists use to minimize these errors?	The activity aligns with the given objectives, its guiding principle of hands-on experiential learning is shown through station-based error simulations that let learners directly observe and test mistakes, the 2C–2I–1R approach is applied through clear content, contextualized scenarios, and the pedagogy of constructivism is appropriate because station-based inquiry enables learners to actively analyze, justify, and build understanding by linking prior knowledge with experimental practice. **Note to the teachers:** Include guiding students to connect each simulation to everyday contexts and practicing **meniscus reading** to minimize human error.

	Option 3: Face-to-Face (Debate)	
	Debate Process: Each group presents everyday-life examples, explains why their error type is significant, and proposes corrective measures. Groups fill in the debate table during discussion. **Sample Response (Human Error Group)** **Example:** Misreading the thermometer when checking water temperature for cooking. **Source:** Observer error due to parallax. **Corrective Measure:** Always read at eye level **Why It Matters:** Proper meniscus reading ensures accurate temperature measurement, a skill essential in both everyday life and laboratory experiments. **Debate Scoring Rubric: http://tiny.cc/CHEMLE4LAS**	This debate activity supports all four objectives through contextual learning, the application of the 2C–2I–1R approach, collaborative discussion, and a constructivist pedagogy that engages students in analyzing everyday examples, proposing corrective measures, and reflecting on the significance of errors. **Note to the teacher:** Include assigning groups, encouraging rebuttals, and integrating meniscus-reading practice to highlight the reduction in human error.
	B.3. Developing Mastery	
	Option 1: Lab Set-up Detective	
	Instructions: The teacher arranges a mock lab station with intentional flaws—an uncalibrated balance, a beaker of water on an uneven surface, and a thermometer placed at an angle—while students, working in groups, carefully inspect the setup to classify errors as systematic or random and by source (instrumental, environmental, observational, or personal), propose corrective measures such as recalibration, leveling surfaces, or reading at eye level with the meniscus, then present findings, with the teacher emphasizing that errors are everywhere and can be reduced through proper classification and correction, all while observing attached lab safety measures. **Lab Set-Up Detective Activity: http://tiny.cc/CHEMLE4LAS**	This detective-style lab setup activity meets all four objectives through contextual learning, applying the 2C–2I–1R approach with guided inquiry and a constructivist pedagogy that engages students in inspecting flawed equipment, classifying errors, and proposing corrective measures to strengthen accuracy and precision. **Note to the teachers:** Include guiding students to spot intentional flaws, connect them to everyday contexts, and follow **lab safety protocols** such as careful handling of equipment, cleaning spills, and safe thermometer use with proper **meniscus reading.**

	Option 2: Simulation Challenge	
	Activity Flow: Students measure the same object several times using different instruments (ruler, tape measure, caliper). Write all measurements in a results table.Compare variations and identify them as types of errors (random/systematic or sources of error (instrumental, environmental, observational, or personal). Propose strategies such as calibration, repeated trials, and careful observation (including proper **meniscus** reading for thermometers/cylinders). **Lab Safety Measures: http://tiny.cc/CHEMLE4LAS**	This aligns with objectives by engaging students to define experimental error, types of errors (random/systematic or sources of error (instrumental, environmental, observational, or personal) propose corrective measures, and redesign procedures. Its design principle is hands-on experiential learning; the teaching approach is guided inquiry with repetition, pedagogy emphasizes constructivism. **Note to the teachers:** Include ensuring safety protocols, guiding classification, and integrating meniscus reading practices to reduce human error.
	Option 3: Relay Game	
	Activity Flow: Present quick scenarios (e.g., misreading thermometer, faulty ruler, and inconsistent timing). Teams race to classify each scenario as random/systematic or sources of error (instrumental, environmental, observational, or personal). Points awarded for correct classifications; fastest accurate group wins. **Wrap-Up:** *Teacher connects error types to practical solutions (calibration, repeated trials, careful observation, proper meniscus reading).*	The activity aligns with all the given objectives, its guiding principle of experiential and collaborative learning is shown through movement-based stations where learners classify errors under time pressure, the 2C–2I–1R approach is applied through clear content, contextualized tasks, interactive peer competition, innovative corrective strategies, and reflective review, and the pedagogy of constructivism is appropriate because students construct knowledge by engaging in collaborative, inquiry-driven practice.

<table>
<tr><td rowspan="5">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: Master Chemist Chef</td></tr>
<tr><td>Teacher Setup: Provide a simple recipe-style lab task (mixing, measuring, heating). Learners act as “chemist chefs,” follow steps carefully, and record measurements. Identify and classify mistakes as random or systematic, noting sources (instrumental, environmental, observational, personal). Propose solutions such as calibration, repeated trials, careful observation, and proper meniscus reading.

Lab Safety Measures: http://tiny.cc/CHEMLE4LAS</td><td>The activity aligns with the given objectives, its guiding principle of experiential and collaborative learning is shown through role-play tasks where learners simulate precise lab handling, the 2C–2I–1R approach is applied through clear content, contextualized scenarios, values integration, interactive teamwork, innovative procedure redesign, and reflective evaluation, and the pedagogy of constructivism is appropriate because students actively build understanding by connecting prior knowledge with practical laboratory simulation.
Note to the teachers: Include reinforcing safety and accuracy in measurement.</td></tr>
<tr><td colspan="2">Option 2: Aba! Nakakabasa na pala ako!</td></tr>
<tr><td>Instructions of Family Task: Different members read the same thermometer at varying angles.
Identify Error: Learners classify the mistake as a human/parallax error.
Apply Correction: Instruct readers to check the thermometer at eye level. Skill Development: Students practice reading the meniscus correctly when measuring liquid temperature, ensuring accuracy. Practical Application: Discuss how careful observation and proper procedure improve reliability in health monitoring (e.g., fever checks).
Meniscus Reading: http://tiny.cc/CHEMLE4LAS</td><td>An objective-centered practical activity that helps learners identify human/parallax errors, apply corrective measures, and develop the skill of using the meniscus in thermometer reading. Its design principle is applied learning; the teaching approach is hands-on demonstration; pedagogy emphasizes constructivism.
Note to the teachers: Include reinforcing safe thermometer handling and accurate eye-level observation.</td></tr>
</table>

	Option 3: A Chemist went to the Market	
	Market Observation: Students imagine a chemist buying items like salt, vinegar, or baking soda. Identify everyday items with chemical properties and note their common uses at home or in cooking. **Classify Errors:** Learners analyze how errors may occur in measuring or using these items. Distinguish random vs. systematic errors and identify sources: instrumental, environmental, observational, and personal **Apply Corrective Measures:** Students propose solutions to improve accuracy and reliability. • Calibrate measuring tools • Repeat trials for consistency • Observe at eye level (meniscus reading for liquids) **Lab Safety Measures: http://tiny.cc/CHEMLE4LAS**	This activity is an objective-centered practical application that helps learners classify errors as random or systematic, identify sources (instrumental, environmental, observational, personal), and apply corrective measures. Its design principle is experiential learning through real-life context; the teaching approach is scenario-based inquiry; pedagogy emphasizes constructivism. **Note to the teachers:** Include reinforcing accurate measurement skills like **meniscus reading** and safe handling of household chemicals. Prepare a **ready-made household items list** that students can use as examples during this activity.
	C.2. Making Generalization	
	Option 1: Exit Poll	
	Instructions: Learners summarize their understanding of error types (random/systematic) and sources (instrumental, environmental, observational, and personal). For readiness, classify: *"A scale shows slightly different weights each time" → Random.* Identify source: *"A thermometer consistently reads 1°C higher than actual" → Instrumental.* Suggest a corrective measure: *"A student reads liquid volume from above the meniscus." → Read at eye level with the meniscus.* For reflection, students may record a short video/audio or create a slide;	This is an objective-centered activity that engages learners in reflection, summary, and readiness checks. It generalizes the lesson objectives by reinforcing classification of errors and sources, applying corrective measures, and connecting careful observation to reliable practice. Its design principle is reflective learning; the teaching approach is exiting poll with multimedia or written alternatives; pedagogy emphasizes constructivism.

	alternatively, they may write a brief paragraph or draw a simple diagram showing error types and corrective measures.	**Note to the teacher:** Include ensuring accessibility for all learners. The teacher also highlights how careful observation and proper procedures improve accuracy and reliability in both lab and health monitoring.
	Option 2: Error Pattern Hunt	
	Instructions Learners examine simple lab or daily-life measurement examples (weighing, timing, thermometer reading), classify recurring mistakes as random or systematic errors, and note sources (instrumental, environmental, observational, personal), then summarize how error patterns affect reliability. For readiness: *"A stopwatch gives slightly different times each trial" → Random; "A balance consistently reads 2 g heavier" → Instrumental; "A student reads liquid volume from above the meniscus" → Corrective measure: read at eye level with the meniscus.* **Lab Safety Measures: http://tiny.cc/CHEMLE4LAS**	This is an objective-centered activity that engages learners in identifying recurring error types and sources, reflecting their impact, and checking readiness through an exit poll. Its design principle is pattern recognition through inquiry, the teaching approach is reflective analysis, and pedagogy emphasizes constructivism. **Note to the teacher:** Include guiding students to generalize error awareness to practical applications in science and health monitoring.
	Option 3: PhET Simulation – Measurement Errors	
	Instructions: Learners use the PhET simulation to measure length, mass, and temperature, observe how errors occur when instruments are misused or readings are taken incorrectly, classify mistakes as random or systematic and identify sources as instrumental, environmental, observational, or personal, then write a short reflection summarizing error patterns and explain how corrective measures such as calibration, repeated trials, eye-level reading, and proper meniscus use improve accuracy.	This is an objective-centered activity that engages learners in identifying error types and sources, reflecting their impact, and checking readiness through an exit poll. Its design principle is applied inquiry, the teaching approach is simulation or hands-on practice, and pedagogy emphasizes constructivism.

	Readiness Check: Exit poll — "I can now identify error types and sources confidently: Yes / No / Unsure."	**Note to the teacher:** Alternative Task (Non-Multimedia): Learners perform a hands-on measurement activity (e.g., reading a ruler, thermometer, or weighing scale) and note possible errors. Also, prepare a **ready-made reflection template** so students can systematically record their observations, error type, source, and corrective measures.
	C.3. Evaluating Learning	
	Option 1: Peer Teaching Presentation	
	Instructions: Each learner (or small group) prepares a short teaching demo on a specific topic (e.g., identifying random vs. systematic errors and their sources). Learners explain the concept clearly to peers, using simple examples or demonstrations. Peers provide quick feedback on clarity, accuracy, and practical application. **Reflection & Summary:** Presenters reflect on what they taught and summarize how peer feedback helps improve understanding. **Generalization:** Teacher highlights how teaching others reinforces mastery and connects error awareness to reliable lab and health practices. **Peer feedback rubric: http://tiny.cc/CHEMLE4LAS**	This is an objective-centered readiness check that evaluates learners' confidence in explaining error types, applying corrective measures, reflecting peer teaching impact, and readiness for practical application. Its design principle is reflective evaluation; the teaching approach is an exciting poll with self-assessment, and pedagogy emphasizes constructivism. **Note to the teacher:** Include using results to guide reinforcement or remediation. Prepare a **peer feedback rubric,** so students have clear criteria when evaluating each other's presentations.
	Option 2: Kahoot Quiz: Types and Sources of Error	
	Instructions: (Multimedia Option): Learners join a Kahoot quiz with multiple-choice questions on random vs. systematic errors and sources of error (instrumental, environmental, observational, personal). Responses are checked immediately to reinforce accuracy. Learners briefly reflect on which error types	This is an objective-centered evaluation activity that assesses learners' ability to classify error types and sources, apply corrective measures, and reflect on their understanding. Its design principle is interactive assessment; the teaching approach is

	they found easiest or hardest to identify, then summarize how corrective measures improve reliability. Alternative Task (Non-Multimedia): Teacher provides the same quiz questions in printed or verbal format.	quiz-based evaluation with multimedia or paper alternatives, and pedagogy emphasizes constructivism.
	Option 3: Scenario-Based Written Quiz	
	Instructions: Learners are given short, real-life or lab-based situations (e.g., misreading a thermometer, an uncalibrated balance, or fluctuating room temperature). For each scenario, learners identify the type of error and specify the source of error (instrumental, environmental, observational, or personal). Suggest a corrective measure. Reflection & Summary: Learners write a brief reflection on how recognizing error patterns improves reliability in both laboratory and health monitoring.	The Scenario-Based Written Quiz is an objective-centered evaluation activity that assesses learners' ability to classify error types, identify sources, and propose corrective measures. Its design principle is applied for assessment through scenarios, the teaching approach is written analysis with reflection, and pedagogy emphasizes constructivism.
	C.4. Additional Activities	
	Option 1: Error Investigation Project (Remediation)	
	Instructions: Students measure a basic object (e.g., pencil length or water volume) using one instrument. Write down 2–3 repeated measurements. The teacher guides students to spot differences and classify them as random or systematic, with support, students connect errors to sources: instrumental, environmental, observational, or personal, and suggest one simple solution (e.g., recalibrate instrument, repeat trials, careful observation). **Lab Safety Measures: http://tiny.cc/CHEMLE4LAS**	This activity is designed for learners who need extra support. It simplifies tasks to focus on identifying random vs. systematic errors and recognizing sources (instrumental, environmental, observational, personal) with teacher guidance. Its design principle is scaffolding experiential learning, the teaching approach is guided practice, and pedagogy emphasizes constructivism with support. **Teacher note: Include** reinforcing safety and building confidence in error classification.

<table>
<tr><td rowspan="4"></td><td colspan="2">Option 2: Error Case Study Clinic (Enrichment)</td></tr>
<tr><td>Instructions: Present 2–3 short case studies with intentional errors (e.g., faulty balance, inconsistent timing, misread thermometer). Students read each case, identify it as a type of error, or a source of error. Groups propose practical solutions such as calibration, repeated trials, or careful observation.
Lab Safety Measures: http://tiny.cc/CHEMLE4LAS</td><td>This is an objective-centered activity; its design principle is case-based inquiry, the teaching approach is collaborative analysis, and pedagogy emphasizes constructivism.</td></tr>
<tr><td colspan="2">Option 3: Professional Error Interview Project (Extension Activity)</td></tr>
<tr><td>Instructions
Identify a Professional: Students choose a science teacher, lab technician, or other professional who regularly performs measurements.
Conduct a Brief Interview: Ask 3 guiding questions:
1. What common errors occur in your work?
2. How do you classify them (systematic, random, human)?
3. What strategies do you use to reduce or correct them?
Summarize Findings: Write a short report highlighting one example of each error type and the corrective measure used.</td><td>This serves as an extension activity because it builds prior knowledge of error classification, encourages authentic application through interviews, and connects classroom learning to professional practice. Its design principle is authentic learning; the teaching approach is case-based inquiry; pedagogy emphasizes constructivism.
Teacher note: Include guiding students to keep interviews brief, respectful, and focused on error classification and solutions. Encourage students to present key insights to classmates, connecting professional practices to laboratory accuracy and precision.</td></tr>
<tr><td>V. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Instructions: Read each task carefully and perform the required activity.
Error Analysis and Correction Task (rubric: http://tiny.cc/CHEMLE4LAS)
Task: Students will determine the mass of a sample of salt using a laboratory balance. While completing the task, they must first define experimental error and classify the type of error observed as either systematic or random. Next, they will identify the source of the error, such as instrumental (e.g., miscalibrated balance), environmental (e.g., air currents), observational (e.g., misreading the display), or personal (e.g., inconsistent handling). Students will then propose one corrective measure to reduce the error, such as recalibrating the balance, shielding the balance from drafts, or practicing careful observation. Finally, they will redesign the procedure by rewriting one step to minimize the detected error, ensuring more accurate and reliable mass measurements.</td></tr>
</table>

VI. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot to structure concepts, ensure grammatical accuracy, and design curated learning activities. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.

Learning Title/Topic:	Measurement and Laboratory Skills: Scientific Notation and Significant Figures	Lesson Exemplar:	5

I. OBJECTIVES	
A. Content Standard	The learners learn that experimental results are affected by sources of error, which can be minimized.
B. Performance Standard	The learners will be able to critically identify sources of experimental error, propose practical strategies to minimize them, and apply accurate measurement, precision, and proper use of scientific notation and significant figures to ensure reliable and valid experimental results.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	The learners are expected to have prior knowledge of basic measurement concepts, including familiarity with SI units and common laboratory units, and the proper use of basic laboratory instruments such as the graduated cylinder, balance, ruler, and thermometer. They should also possess foundational skills in arithmetic operations, rounding rules, identifying significant figures, and expressing values in scientific notation, as well as the ability to perform basic unit conversions and recognize sources of measurement error (instrumental, environmental, observational, personal). These prerequisite skills ensure learners can accurately record, interpret, and analyze measurements in scientific contexts.
	Apply significant figures and scientific notation in calculations and unit conversions using accurate measurements from basic laboratory equipment (e.g., graduated cylinder, balance, ruler, thermometer);
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	**References:** ▪ American Chemical Society. *General Chemistry Laboratory Manual*. Washington, DC: ACS Publications, 2020. ▪ BIPM (Bureau International des Poids et Mesures). *The International System of Units (SI Brochure)*, 9th edition. Sèvres: BIPM, 2019. ▪ Chang, Raymond, and Kenneth A. Goldsby. *Chemistry*. 13th ed. New York: McGraw-Hill Education, 2019. ▪ Tro, Nivaldo J. *Chemistry: A Molecular Approach*. 6th ed. New York: Pearson, 2020. ▪ Zumdahl, Steven S., and Susan A. Zumdahl. *Chemistry*. 10th ed. Boston: Cengage Learning, 2020. **Materials:** ▪ Laboratory Instruments: Graduated cylinders, balances, pipettes, burettes. ▪ Reference Standards: SI Brochure (ISO-correct reference: BIPM, The International System of Units, 9th ed., 2019). ▪ Worksheets & Test Papers: Sig Fig Survival Guide (MCQ, True/False, Written Response).

	▪ Assessment Tools: Authentic Assessment tasks (Numbers that Matter Challenge, Everyday Precision Challenge). ▪ Physical Material Alternative**:** Provide printed worksheets, reference charts, and simple lab props (e.g., measuring cylinders, balances, rulers, thermometers)	
III. CONTENT *(Sequencing Content)*	Measurement and Laboratory Skills: Scientific Notation and Significant Figures	
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Explain scientific notation and significant figures in the context of laboratory measurements. 2. Apply the rules of significant figures correctly when performing laboratory calculations. 3. Express laboratory data in scientific notation accurately. 4. Perform unit conversions using accurate measurements from laboratory instruments	
IV. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1: Review: "Do you remember?" (3 minutes)	
	Instruction: For each item, write the numerical figure, determine the number of significant figures, and explain briefly why. **(Time duration: 3 minutes)** 1. One millionth o Figures: 0.000001 o Significant Figures: 1 (digit 1; leading zeros are not significant) 2. Eighty-seven ten-thousandths o Figures: 0.0087 o Significant Figures: 2 (digits 8 and 7; leading zeros are not significant) 3. Five hundred forty-five thousand o Figures: 545,000 o Significant Figures: 3 (digits 5, 4, 5; trailing zeros without a decimal are not significant) **Review tool: Significant Figures ladder: https://l1nk.dev/sgkdfhb**	This activity addresses objectives 1 and 2 through conceptual integration, using the 2C–2I–1R approach with guided discovery and a constructivist pedagogy. The constructivist approach is appropriate as it allows students to actively build understanding by analyzing, comparing, and explaining how each rule affects numerical precision. **Note to the teachers:** Option 1: Short Review," for 545,000; it identifies 3 significant figures. While correct by general rules, it is a "vague" number. Suggestion: Use this as a teaching moment. Explain that without a decimal point, trailing zeros are usually placeholders, but in scientific notation (5.450 \times 10^5), the precision becomes unambiguous.

Option 2: Perfect Match (3 minutes)

Instruction: Identify the correct metric unit and explain why that unit is appropriate for the given measurement. Then interpret the value's precision by stating how many significant figures it contains and what that indicates its accuracy.

Quantities	Appropriate unit of measurement
Student height	A. 0.250 mL
Body temperature	B. 36.5 ^{0}C
Graduated cylinder reading	C. 1.65 m

Sample response:

Student height

- Measured Value: 1.65 m
- Unit: Meter (m)
- Why appropriate: Height is a linear dimension; meters are the standard SI unit for length.
- Significant Figures: 3 (digits 1, 6, and 5; the zero is not present, so all digits shown are significant).
- Scientific Notation: 1.65×10^0m

This activity targets the objective of applying metric units with precision through contextual learning, using the 2C–2I–1R approach, guided practice, and a constructivist pedagogy. The guiding principle is shown by presenting realistic, measured values that connect abstract unit rules to everyday contexts. The constructivist approach is appropriate because learners actively interpret units, analyze significant figures, and convert values into scientific notation, thereby constructing a deeper understanding of accuracy and measurement standards.

Note to the teacher: Address common errors (e.g., confusion on counting significant figures and writing scientific notation form) immediately after the activity.

Option 3: Mini-Lecture / Rule Sheet (2 minutes):

Instruction: Briefly present the four rules of significant figures with one quick example each:

1. Non-zero digits are always significant (e.g., 725 → 3 sig figs).
2. Zeros between digits are significant (e.g., 1002 → 4 sig figs).
3. Leading zeros are not significant (e.g., 0.0043 → 2 sig figs).

This activity targets the objective 1 and 2 through scaffolded prior knowledge activation, using the 2C–2I–1R approach with a constructivist mini-lecture plus guided practice pedagogy. The guiding principle is shown by presenting a short "Rule Sheet" before the task, ensuring learners understand why certain digits count as significant. The pedagogy is

	4. Trailing zeros are significant only if a decimal is present (e.g., 150.0 → 4 sig figs). **Review tool: Significant Figures ladder: https://l1nk.dev/sgkdfhb**	appropriate because the mini-lecture provides immediate scaffolding, allows students to actively interpret units, precision, and scientific notation.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Lab Report (2 minutes)	
	Scenario: A student assistant submitted a lab report from a chemistry experiment: a. 0.00000045 L of solution was measured b. 450,000,000 g of material was recorded However, the lab supervisor rejected the report, saying: "These values are technically correct but scientifically unclear and risky to interpret." **Guide Questions** 1. Why do you think the supervisor found these numbers problematic? Imagine you are a scientist reading this report—what difficulties might you face? 2. How could writing these values differently make them easier and safer to use in scientific communication? **Wrap-Up**: "In real laboratory work, scientists must communicate very large and very small measurements clearly and precisely. Today, we will learn how scientific notation and significant figures help us do exactly that."	This activity targets the objective of recognizing the importance of clarity and precision in reporting very large and very small measurements through scientific communication awareness, using the 2C–2I–1R approach with a contextual and inquiry-based pedagogy. The guiding principle is shown by presenting ambiguous values that highlight the risks of unclear reporting. The pedagogy is appropriate because inquiry prompts students to reflect on difficulties scientists face when interpreting such data, and contextual discussion leads them to discover how scientific notation and significant figures provide safer, clearer communication in laboratory work.
	Option 2: Technician Data (2 minutes)	
	Scenario: A laboratory technician recorded these measurements during an experiment: a. 25.0 °C (temperature of a reaction b. 1500 mL (volume of solution used) Another scientist reviewing the data asked: "Before we use these values in calculations, how confident are we about their precision?"	This activity targets the objective of interpreting the precision of laboratory measurements through scientific accuracy awareness, using the 2C–2I–1R approach with an inquiry-based pedagogy. The guiding principle is shown by presenting realistic values that differ in the number of significant figures, prompting learners to question reliability and certainty. The pedagogy is appropriate because inquiry

	Guide Questions 1. If you were using this data in a real experiment, would all values be equally reliable? Why or why not? 2. What might happen if scientists misinterpret the precision of these measurements? 3. Why is it important in science to know exactly how precise a number is? **Wrap-Up:** "In laboratory science, not all numbers carry the same level of certainty. Scientists must understand which digits are meaningful before performing calculations. This is where significant figures become essential."	encourages students to analyze why not all values are equally reliable, reflect on the risks of misinterpretation, and recognize how significant figures communicate confidence in scientific data.
	Option 3: Multi-Group Comparison	
	Scenario: Two groups conducted the same experiment measuring the same substance, but their reported results were: Group A: 1500 mL Group B: 3.2×10^3 g (converted from mass data) Group C: 0.00045 L When the teacher compared results, a problem was discovered: "Although the groups followed the same procedure, their results cannot be fairly compared because they were reported in different formats and levels of precision." **Guide Questions:** 1. Why might different ways of writing numbers create confusion in scientific comparison? 2. How could scientists ensure fair comparison of results from different groups? 3. What do you think is needed so that data from different experiments can be reliably combined? Wrap-Up: "In real scientific work, data from different experiments must be comparable and precise. Scientific notation and significant figures provide a standard way to express and compare measurements accurately. Today, we will learn how to apply them in calculations and conversions."	This activity targets the objective of applying scientific notation and significant figures to ensure comparability of experimental data through standardization in scientific communication, using the 2C–2I–1R approach with an inquiry-based pedagogy. The guiding principle is shown by presenting results in different formats, which highlights the confusion caused by inconsistent reporting. The pedagogy is appropriate because inquiry prompts learners to analyze why differing formats hinder fair comparison, reflect on the need for precision, and recognize how scientific notation and significant figures provide a reliable standard for combining and interpreting data across experiments. **Note to the teacher**: Address common errors/confusion immediately after the activity

<table>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: Conversion Relay Game</td></tr>
<tr><td>Instructions: Each team receives a Standard Operating Procedure (SOP) card showing a worked conversion example.
• Example: Measure 0.050 L using a burette
• Convert to milliliters → 5.0 × 10¹ mL
• SOP explains why the trailing zero is retained to reflect instrument precision
Observe the Demonstration: Teams study the SOP card and the teacher's explanation before starting the relay.
• Review how significant figures are identified
• Note how scientific notation is applied
• Discuss why precision matters in lab measurements
Practice in Relay Teams: Teams solve posted conversion tasks in relay format, applying the SOP rules.
Relay Game Activity: https://l1nk.dev/sgkdfhb</td><td>This activity aligns with applying unit conversions and significant figures through the guiding principle of experiential learning, shown by the SOP card that models authentic lab-based measurement and emphasizes instrument precision. It applies the 2C–2I–1R approach by presenting clear content, contextualized tasks, interactive relay inquiry, innovative teamwork, and reflective evaluation. The selected collaborative practice of pedagogy is appropriate because it allows learners to actively engage in solving conversions, reinforce accuracy through peer support, and internalize scientific conventions in a dynamic, team-based environment.</td></tr>
<tr><td colspan="2">Option 2: Sig Fig Showdown</td></tr>
<tr><td>Instructions: Before the game starts, the teacher presents real laboratory measurement examples using common laboratory tools such as a thermometer, graduated cylinder, and digital balance.
The teacher models how to identify significant figures from actual measurements and explains how the precision of the instrument affects the recorded value.
Examples:
a. 25.0 °C from a thermometer → 3 significant figures
b. 0.0042 L from a graduated cylinder → 2 significant figures
c. 100.0 g from a digital balance → 4 significant figures
The teacher briefly explains why some zeros are significant while others are not. Students then play the "Sig Fig Showdown" game</td><td>This activity strengthens learners' ability to monitor and evaluate measurement accuracy through significant figures. The guiding principle of experiential learning is shown as students actively engage in rapid, authentic problem-solving that mirrors laboratory reporting. Using the 2C–2I–1R approach, the activity presents clear content (sig fig rules), contextualized examples (lab-based values). The chosen game-based collaborative pedagogy is appropriate because it motivates learners to apply conventions quickly and accurately, while</td></tr>
</table>

	by identifying the number of significant figures and explaining their answers using the examples presented earlier as their guide. **Sig Fig Showdown Activity: https://l1nk.dev/sgkdfhb**	reinforcing responsibility and precision in scientific practice.
	Option 3: Number Mystery Challenge	
	Instructions: Before the challenge begins, the teacher presents examples of very large and very small laboratory measurements to show why scientists use scientific notation and significant figures in reporting data. The teacher models how long numbers can be rewritten into scientific notation while preserving the correct number of significant figures. **Examples:** a. 0.00000045 L → 4.5×10^{-7} L (2 significant figures) b. 450,000,000 g → 4.5×10^{8} g (2 significant figures) c. 25.0 °C → 2.50×10^{1} °C (3 significant figures) The teacher briefly explains how scientific notation makes measurements easier to read and how significant figures preserve the precision of the data. Students then participate in the "Number Mystery Challenge" by converting measurements into scientific notation and identifying the correct number of significant figures using the examples as their guide. **Number Mystery Challenge Activity: https://l1nk.dev/sgkdfhb**	This activity aligns with all four objectives. The guiding principle of experiential learning is shown as students transform unwieldy numbers into scientific notation and justify significant figures, mirroring authentic laboratory reporting. Using the 2C–2I–1R approach, the activity presents clear content (notation and sig fig rules), contextualized lab-based examples, values integration (honesty and precision), interactive team competition, innovative reasoning, and reflective prompts. The chosen game-based collaborative pedagogy is appropriate because it motivates learners to apply conventions quickly, fosters peer dialogue, and strengthens accuracy and responsibility in scientific communication.
	B.2. Discussing New Concept	
	Option 1: Digital Quiz Burst!	
	Instructions: Students answer the quiz questions individually or by team, then explain their reasoning during class discussion. **For students with gadgets (online mode):** 1. The teacher sets up a short quiz using Kahoot/Google Forms. 2. Sample questions:	This activity addresses objectives on explaining, applying, and expressing laboratory data with significant figures and scientific notation through the guiding principle of explicit teaching with modeling, shown in think-aloud explanations and guided questioning; using the 2C–2I–1R approach with clear content,

	○ Rewrite 0.00000045 L in scientific notation. ○ How many significant figures are at 25.0 °C? ○ Convert 1500 mL to liters with correct sig figs. 3. Students answer in real time using their phones or laptops. 4. Results are displayed instantly, and the teacher explains the correct answers. **For students without gadgets (offline mode):** 1. The teacher writes the same questions on the board or prepares printed slips. 2. Students answer individually on paper or in a quick-fire oral round. 3. Teacher reviews answers, explains reasoning, and compares responses across the class. **Wrap-Up:** For each question, the teacher asks: "Which digits are actually measured?" "What does the instrument tell us about precision?" "Why is this exponent positive or negative?" Students discuss answers briefly before submitting responses.	contextualized lab examples, interactive discussion, innovative reasoning, and reflection; and employing guided practice pedagogy that scaffolds understanding, ensures accuracy, and builds learner independence in handling laboratory measurements. **Note to the teachers:** Before students answer each question, the teacher explicitly discusses the concept behind the item using guided explanations and think-aloud modeling. The teacher explains how to identify significant figures, why leading zeros are not significant, why trailing zeros may indicate precision, and how scientific notation preserves significant figures
	Option 2: Hands-On-Lab Numbers	
	Instructions: For students with gadgets (digital mode): The teacher provides digital lab data via Google Classroom, Padlet, or a shared document: ○ Mass = 3.20×10^3 g ○ Volume = 13.2 mL Students calculate density = mass ÷ volume using calculators or apps. They submit answers in scientific notation with correct significant figures through the platform.	This activity addresses objectives 1-4, the guiding principle of explicit teaching with modeling, shown in the teacher's think-aloud demonstration of how measurement precision limits final answers; using the 2C–2I–1R approach with clear content, contextualized lab data, values integration (honesty and precision), interactive guided discussion, innovative reasoning, and reflection; and employing guided practice pedagogy that scaffolds learner understanding, ensures accuracy, and builds

	For students without gadgets (offline mode): The teacher writes the same lab data on the board. Students calculate density manually on paper. Volunteers share answers aloud. **Discussion:** "Which measurement limits the precision of the final answer?" Students help identify the correct number of significant figures before solving, calculate the remaining examples, and explain how they determined the correct precision of their answers. Using the sample laboratory data, the teacher explains how significant figures are determined from measurements, why calculated answers must follow sig fig rules, and how scientific notation communicates precision clearly.	independence in handling laboratory measurements. **Note to the teacher:** Before solving the calculations, the teacher demonstrates how measurement precision affects the final reported answer.
	Option 3: Lab Dash: Measure and Master Relay	
	Activity Flow: Set up stations with different instruments: o Station 1: Graduated cylinder — measure 1500 mL of water. o Station 2: Digital balance — weigh a sample of 3.2×10^3 g. o Station 3: Micropipette — dispense 0.00045 L of solution. Divide the class into teams. Each team then rotates through the stations, applying the reasoning and procedures discussed during the teacher demonstration. At each station, students must: o Record the measurement. o Perform the unit conversion (e.g., mL → L, g → kg). o Express the results in scientific notation with correct significant figures.	This activity addresses objectives 1-4, through explicit teaching with modeling shown in the teacher's step-by-step demonstration that connects measurement precision, conversions, and notation before station practice; using the 2C–2I–1R approach with clear content, contextualized lab tasks, values integration, interactive questioning, innovative station work, and reflection; and employing guided practice pedagogy appropriate for scaffolding reasoning, ensuring accuracy, and building learner independence in handling laboratory data. **Note to the teacher**: Before the relay begins, the teacher demonstrates one complete station and explains how measurements, unit conversions, scientific notation, and significant figures are connected. The teacher models how to read measurements correctly from laboratory instruments, how instrument precision affects

	2. Teams pass a "relay baton" (marker or card) to the next group member after completing a station. 3. The first team to finish all stations accurately wins. **Safety Note:** This activity involves moving between stations with glassware and instruments. No running during the relay; ensure all spills are cleaned immediately to prevent slipping.	significant figures, how unit conversions preserve measurement precision, and how scientific notation simplifies very large or small values
	B.3. Developing Mastery	
	Option 1: Precision Lab Drill	
	Instructions: Provide each group with a digital balance and a graduated cylinder. Prepare Instruments. Ensure that all lab instruments are ready for accurate measurement. Calibrate the digital balance. Clean and dry the graduated cylinder. Gather sample material 1. Students measure the mass of a sample (e.g., ~3.20 × 10^3 g) and its volume (~13.2 mL). 2. Calculate density = mass ÷ volume. 3. Apply significant figure rules to report the final answer. 4. Express the results in scientific notation. **Safety Note:** This activity involves moving between stations with glassware and instruments. No running during the activity; ensure all spills are cleaned immediately to prevent slipping.	This activity aligns with all objectives by requiring students to manipulate instruments, record data, apply sig fig rules, express results in scientific notation, and perform unit conversions. The design principle is contextual learning with authentic lab practice. The teaching approach is experiential learning, while pedagogy emphasizes constructivism — students build mastery through direct measurement and calculation. **Note to the teacher:** Monitor instrument use for accuracy, highlight common sig fig errors, and connect results to real lab reporting standards.
	Option 2: Notation and Conversion Circuit	
	Instructions: Set up lab stations with different instruments: Station 1: Graduated cylinder — measure 1500 mL of water. Station 2: Micropipette — dispense 0.00045 L solution. Station 3: Digital balance — weigh a sample of 3.2 × 10^3 g.	This activity aligns with all objectives by requiring students to manipulate instruments, perform conversions, apply sig fig rules, and express results in scientific notation. The design principle is collaborative competition, motivating students through teamwork and

	Divide the class into teams. Each team rotates through the stations in a circuit format. At each station, students must: ○ Record the measurement. ○ Perform the unit conversion (e.g., mL → L, g → kg, L → mL). ○ Express the results in scientific notation with correct significant figures. Teams complete a circuit worksheet where they log all answers. At the end, teams submit their completed sheet. The teacher reviews accuracy and reasoning. **Example Conversions** • 1500 mL → 1.5×10^0 L (2 sig figs)	structured rotation. The teaching approach is active learning, while pedagogy emphasizes reinforcement through practice and peer collaboration. **Note to the teacher:** Keep rotations timed and organized, stress accuracy over speed, and connect each conversion to real laboratory reporting standards.
	Option 3:	
	Instructions: Prepare instruments: digital balance, graduated cylinder, micropipette, and thermometer. Assign tasks to each group: - Measure liquid volume with the graduated cylinder. - weigh a solid sample using the balance. - Record temperature using the thermometer. - Dispense a small volume using the micropipette. Record all measurements with the correct number of significant figures based on instrument precision. Perform one calculation (e.g., density = mass ÷ volume, or molarity = moles ÷ volume). Express all results in scientific notation and ensure sig fig rules are applied consistently. Convert units (e.g., mL → L, g → kg, °C → K) while maintaining accuracy. Groups present their results and reasoning to the class for peer review. **Example Outputs** • Mass = 3.20×10^3 g (3 sig figs)	This activity aligns with all objectives by integrating measurement, calculation, notation, and conversion into one cohesive lab exercise. The design principle is mastery through practice, ensuring students apply concepts in authentic contexts. The teaching approach is experiential and inquiry-based learning, while pedagogy emphasizes concept application and reinforcement. **Note to the teachers:** Monitor instrument use for safety and accuracy, encourage peer checking of sig figs, and highlight how proper notation and conversions are essential for professional lab reporting.

<table>
<tr><td rowspan="5">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: Food Chemistry Lab</td></tr>
<tr><td>Instruction: Provide students with a sugar solution sample, measure the sugar mass using a digital balance and the water volume with a graduated cylinder, calculate concentration as mass ÷ volume, apply significant figure rules, express the result in scientific notation, perform a unit conversion (e.g., g/mL → kg/L), and discuss how accurate measurements support product safety and nutritional labeling.

Food Chem Activity: https://l1nk.dev/sgkdfhb</td><td>This activity aligns with all objectives by requiring students to measure, calculate, apply sig fig rules, express results in scientific notation, and perform conversions. The design principle is mastery through practice with real-world relevance. The teaching approach is experiential and applied to learning, while pedagogy emphasizes reinforcement through authentic contexts.

Note to the teachers: Connect results to food labels and nutrition facts, highlight why precision matters in food chemistry, and encourage students to reflect on how lab skills translate to consumer safety and product quality.</td></tr>
<tr><td colspan="2">Option 2: Environmental Sampling Conversion</td></tr>
<tr><td>Context: You are a scientist testing the turbidity and lead levels of the Marikina River after a typhoon. Convert the parts per billion (ppb) measurements into scientific notation to determine if it meets the Philippine National Standards for Drinking Water."
Safety note: Treat all water samples as potentially contaminated, wear gloves, goggles, and a lab coat, handle instruments carefully to avoid spills, dispose of samples in designated waste containers rather than sinks, wash hands after the activity, and record data honestly and precisely to ensure reliable results for public health.

Environment Sampling: https://l1nk.dev/sgkdfhb</td><td>This activity addresses the 4 objectives. The guiding principle of explicit teaching with modeling is shown as the teacher demonstrates conversions and sig fig rules before students apply them to real water quality data. Using the 2C–2I–1R approach, the activity presents clear content, contextualized environmental examples, interactive problem-solving, innovative application, and reflection. The chosen guided practice of pedagogy is appropriate because it scaffolds reasoning, ensures accuracy, and builds independence in applying conventions to authentic public health contexts.</td></tr>
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	Option 3: Eco Math Drive	
	Task Prompt: Choose one track based on your local environment. Collect or simulate data using laboratory instruments, apply significant figure rules, convert values into scientific notation, and explain the practical relevance. **Community Tracks:** The Agricultural Track: Analyzing the nitrogen/phosphorus levels of local farm soil (Relevance: Food security/Farmers). The Consumer Protection Track: - Auditing the precision of "timbangan" (scales) in the local public market to ensure consumers aren't being cheated (Relevance: Social justice/Economics). The Health Track: Converting dosage measurements for a "Barangay Health Center" medical mission (Relevance: Public health). **Safety note:** Treat all water samples as potentially contaminated, wear gloves, goggles, and a lab coat, handle instruments carefully to avoid spills, dispose of samples in designated waste containers rather than sinks, and wash hands after the activity. **Eco Math Drive: https://l1nk.dev/sgkdfhb**	This activity addresses objectives 1-4. The guiding principle of explicit teaching with modeling is shown as the teacher demonstrates one track with instrument readings before students apply the same reasoning. Using the 2C–2I–1R approach, the activity presents clear content, contextualized community examples, values of integration (honesty, responsibility, public welfare), interactive discussion, innovative local application, and reflection. The chosen guided practice of pedagogy is appropriate because it scaffolds reasoning, ensures accuracy, and builds independence in applying conventions to authentic community contexts.
	C.2. Making Generalization	
	Option 1: Precision in Every Peso:	
	Task Prompt: Students measure ingredients for a bottled iced tea product, apply significant figures and scientific notation to compute concentration and cost per unit, and explain how precision ensures fair pricing and accurate nutritional labeling. **Safety Note:** Students must handle all ingredients and lab instruments responsibly. Wear protective gear such as gloves and goggles when measuring liquids or powders, ensure balances and cylinders are used on stable surfaces to avoid spills, and clean instruments after use. Wash hands thoroughly after the activity and practice honesty and precision in recording data to ensure reliable results.	This activity highlights the practical application of significant figures and scientific notation in entrepreneurship. By measuring ingredients for a bottled iced tea product, students learn how precision in laboratory instruments directly affects product costing and nutritional labeling. The integration of values such as honesty and responsibility ensures that learners connect scientific accuracy with consumer trust and fair business practices. This generalization task supports SHS exits by bridging classroom

		science with entrepreneurial ventures and TESDA-aligned middle-level skills.
	Option 2: Lab Accuracy in Action	
	Task Prompt: You are a TESDA trainee in a laboratory setting. Follow the standard operating procedures (SOPs) to measure the mass of a solute and the volume of a solvent using laboratory instruments. Apply the rules of significant figures in your calculations, convert units as required, and express your final concentration values in scientific notation. Finally, explain how precision in measurement and notation ensures compliance with industry standards and supports workplace safety and reliability. **Safety Note:** Students must strictly follow laboratory SOPs: wear gloves, goggles, and lab coats, handle balances and cylinders carefully to avoid spills, and ensure instruments are calibrated before use. Dispose of solutions properly in designated waste containers, never in sinks, and wash hands thoroughly after the activity. Accuracy and honesty in recording data are essential for both safety and compliance with industry standards.	This activity emphasizes the practical application of significant figures and scientific notation in laboratory work, aligned with TESDA middle-level skills. By following SOPs to measure solution mass and volume, students practice accuracy, compliance, and discipline—skills essential for employability in technical fields. Values such as honesty and responsibility are integrated, showing how precision in science supports industry standards and workplace safety.
	Option 3: From Lab to Life	
	Task Prompt: You are a community health worker preparing a simulated oral rehydration solution (ORS) for a barangay health mission. Using laboratory instruments, measure the mass of solute (salt and sugar) and the volume of solvent (water). Apply the rules of significant figures in recording and calculating values, convert units as required, and express the final concentrations in scientific notation. Finally, explain how precision in measurement supports safe health practices for patients and ensures accurate product labeling for community distribution. **Safety Note:** Treat all solutions as potentially sensitive; avoid direct contact with powders and liquids. Always wear protective gear, handle instruments carefully to prevent spills, and dispose of test samples properly. Wash hands thoroughly after the activity,	This activity targets applying sig figs and scientific notation in laboratory measurements and conversions through contextual and experiential learning shown in preparing a simulated oral rehydration solution that connects precision to community health and labeling; using the 2C–2I–1R approach with clear content, contextualized scenarios, interactive inquiry, innovative unit conversions, and reflection; and employing constructivist pedagogy appropriate because students build understanding by linking prior measurement knowledge to authentic health applications and collaboratively analyzing accuracy for safe practices and reliable labeling.

	and practice honesty and precision in recording data to ensure safe health practices. **Lab to Life: https://l1nk.dev/sgkdfhb**	
	C.3. Evaluating Learning	
	Option 1: Conversion Challenge Exam	
	Instructions: This is a timed written exam (30–45 minutes). Students must show all steps in their calculations. Each problem requires: Unit conversion, Application of significant figure rules, and a final answer expressed in scientific notation. Include a short reflection question at the end. **Sample Exam Items:** Convert 3.20×10^3 g into kilograms. 1. Express 0.00045 L in milliliters and scientific notation. 2. A car travels 120 km using 2.50 L of fuel. Calculate its fuel efficiency (km/L) with sig figs and express it in scientific notation. 3. Convert 1500 mL of water into liters and express in scientific notation. **Rubric: https://l1nk.dev/sgkdfhb**	The Conversion Challenge Exam is designed as a summative assessment that directly evaluates all four objectives in a structured exam format. The design principle behind this exam is summative assessment, which evaluates mastery under exam conditions. The teaching approach is formal testing with a problem-solving focus, while the pedagogy emphasizes reinforcement and evaluation to ensure students can apply skills independently. **Note to the teacher**: Wrap-up with this question: "Why *is precision important in science and everyday life? Provide one example from your own experience.*
	Option 2: Lab Measurement Quiz	
	Instructions: Answer all questions carefully. Show all steps in your calculations. Apply significant figure rules correctly. Express all final answers in scientific notation. **Quiz Items** 1. A beaker contains **0.00456 L** solution. Convert this into milliliters and express it in scientific notation. o Calculation: _____ o Final Answer: _____	The Lab Measurement Quiz is a formative assessment that directly evaluates all four objectives. Its design principle is formative assessment, which checks understanding during the learning process. The teaching approach is performance-based evaluation, while the pedagogy emphasizes constructivism, allowing students to demonstrate applied understanding of lab concepts.

	2. A sample weighs **12500 g**. Convert this into kilograms and express in scientific notation with correct sig figs. o Calculation: _____ o Final Answer: _____ 3. A thermometer reads **3.20 m** of liquid column height. Convert this into centimeters and express it in scientific notation. o Calculation: _____ o Final Answer: _____	**Note to the teacher:** Teachers should provide varied data sets, use the rubric for structured feedback, and encourage students to explain their reasoning rather than simply provide answers. Check the general rubric on the link provided.
	Option 3: Keep It Real	
	Instructions: Solve the following real-world conversion problems: - A phone has **128,000 MB** storage. Convert to GB and express in scientific notation. - A household uses 200 kWh of electricity. Convert to joules and express in scientific notation. - A water bottle contains 1500 mL. Convert to liters and expressions in scientific notation. Show all steps in your calculations and apply significant figure rules correctly. Write a short reflection (3–5 sentences) on why precision matters in everyday contexts like technology, energy, or health.	The task evaluates all four objectives by requiring students to perform unit conversions, apply significant figures, and express data in scientific notation using everyday scenarios. Its design principle is an authentic application, connecting science to real-life contexts. The teaching approach is an inquiry-based assessment, while the pedagogy emphasizes concept generalization, helping students transfer lab skills to technology, energy, and health.
	C.4. Additional Activities	
	Option 1: Lab Math Mastery (Enrichment)	
	Instructions: Provide students with a set of laboratory-style measurements (e.g., 0.00456 L, 12500 g, 3.20 m). Ask them to: - Convert each measurement into another unit (L → mL, g → kg, m → cm). - Apply significant figure rules to report results correctly. - Express each answer in scientific notation.	This activity enriches student learning by directly addressing all four objectives through varied laboratory-style data. Its design principle is authentic lab-based enrichment, encouraging deeper practice. The teaching approach is performance-based problem solving, while the pedagogy emphasizes constructivism, allowing

	After completing, students compare their answers with peers and discuss why differences in rounding may occur. End with a short reflection: *Why does precision matter in laboratory work* **Rubric: https://l1nk.dev/sgkdfhb**	learners to build understanding through application.
	Option 2: Survival Guide (Reinforcement/Remediation)	
	Instructions: Distribute a worksheet with step-by-step prompts to guide students through conversions and sig fig applications. Step 1: Convert the given measurement into another unit (e.g., 0.00456 L → mL). Step 2: Identify the number of significant figures in the original value. Step 3: Apply rounding rules to maintain correct sig figs. Step 4: Express the final answer in scientific notation. Provide worked examples at the top of the worksheet for reference. Students complete the worksheet individually, then compare answers in pairs or small groups. **End with a short reflection:** *How do sig figs and scientific notation help ensure accuracy in laboratory work?*	This activity reinforces learning by directly addressing all four objectives through scaffolded practice. Its design principle is structured for remediation, ensuring clarity for learners who need extra support. The teaching approach is guided practice, while the pedagogy emphasizes mastery learning, allowing students to progress step by step. Facilitation should focus on providing hints, immediate feedback, and peer review to strengthen confidence and accuracy.
	Option 3: Numbers that Matter	
	Instructions: Present students with real-world scenarios that require conversions and precision: - A laptop has 512,000 MB of storage. Convert to GB and express in scientific notation. - A household consumes 420 kWh of electricity. Convert to joules and express in scientific notation.	This activity applies to all four objectives. Its design principle is an authentic application, making science relevant beyond the laboratory. The teaching approach is inquiry-based problem solving, while the pedagogy emphasizes concept generalization, helping learners

	- A sports drink bottle contains 600 mL. Convert to liters and express in scientific notation. Students must perform each conversion step by step, apply significant figure rules correctly, and express all answers in scientific notation. **End with a short reflection:** *Why do these numbers matter in everyday life? How does precision affect technology, energy, or health decisions*	transfer lab skills to real-world decision-making. Facilitation should encourage reflection on how precision supports accuracy in technology, energy use, and health outcomes.
V. ASSESSMENT *(Assessing Learnings)*	**Authentic Assessment (rubric: https://l1nk.dev/sgkdfhb)** **Instructions:** Students will complete a performance-based task that integrates scientific notation, significant figures, and unit conversions into real-world laboratory scenarios. **Task outline:** 1. You are a laboratory technician preparing a report. Convert the following measurements into appropriate units, apply sig fig rules, and express results in scientific notation. ▪ A solution volume of 0.00456 L → mL ▪ A mass of 12,500 g → kg ▪ A distance of 3.20 m → cm 2. Write a short explanation in sentence form for each conversion, describing why sig figs and scientific notation are important for accuracy. **Conclude with a reflection paragraph:** *How does precision in laboratory math affect real-world science, technology, or health outcomes?*	

VI. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot to structure concepts, ensure grammatical accuracy, and design curated learning 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.

Learning Title/Topic:	**1. Planck's quantum hypothesis** **2. Bohr's model of the atom and quantized energy levels** **3. Schrödinger's wave mechanical model** **4. Orbitals and probability-based electron distribution** **5. Comparison of Bohr's model and the quantum mechanical model** **6. Simple applications of quantized energy in spectra and technology**	**Lesson Exemplar:**	6

I. OBJECTIVES	
A. Content Standard	The learners understand how the contributions of Planck, Bohr, and Schrödinger led to the development of the quantum mechanical model, which explains the behavior of electrons and other subatomic particles.
B. Performance Standard	By the end of the quarter, learners make reliable measurements and record data using appropriate laboratory and/or measuring tools. They also apply significant figures, scientific notation, and unit conversion. Using the Quantum Mechanical Model, they describe electrons in levels and write electron configurations for elements. Learners explain what isotopes are and how they may be useful and possibly harmful.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners can describe the structure of the atom in terms of protons, neutrons, and electrons; recall the major features of Dalton's, Thomson's, and Rutherford's models; and interpret simple ideas about light, energy, and electron arrangement.
	The learners describe the development of the quantum mechanical model.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	Materials: projector, printed task cards, timeline cards, formative check sheets, orbital model materials, and teacher-prepared visuals or videos. References: Chemistry Learner. 2022. "Bohr Model: Definition, Features, and Limitations." Chemistry Learner. January 3, 2022. https://www.chemistrylearner.com/bohr-model.html. English, Trevor. 2020. "Planck's Quantum Theory Is One of the Most Pivotal Physics Discoveries of All Time." Interestingengineering.com. June 21, 2020. https://interestingengineering.com/science/an-in-depth-look-at-max-plancks-quantum-theory. 2021. Stsci-Opo.org. 2021. https://stsci-opo.org/STScI-01FFJCDM48WWMYHXWEJC7W9SX2.jpg.

	2026. Quizlet.com. 2026. https://o.quizlet.com/AI4tz2Vjk8HghzuKoVkBgw.png. 2026. Ftcdn.net. 2026. https://as1.ftcdn.net/v2/jpg/04/89/60/02/1000_F_489600235_JIIJNVybX34ELtEHwueKiR1RyqwMEncO.jpg.
III. CONTENT *(Sequencing Content)*	1. Planck's quantum hypothesis 2. Bohr's model of the atom and quantized energy levels 3. Schrödinger's wave mechanical model 4. Orbitals and probability-based electron distribution 5. Comparison of Bohr's model and the quantum mechanical model 6. Simple applications of quantized energy in spectra and technology
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Describe how Planck, Bohr, and Schrödinger contributed to the development of quantum theory. 2. Compare Bohr's model and the quantum mechanical model in explaining electron behavior. 3. Use the idea of orbitals as probability regions to explain why the quantum mechanical model improved earlier atomic models.

IV. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge (ELICIT)	***A.1. Activating Prior Knowledge***	
	Think–Pair–Share Activity	
	Students reflect quietly for 2–3 minutes on the guiding questions: • What is an atom? • What are the different subatomic particles? • How are electrons arranged in atoms? • How do electrons move around the nucleus? Students share their ideas with a partner. Some of the pairs will share the highlights to the class. **Diagnostic Check:** Ask learners to mark each statement as True or False: 1. Electrons move in fixed circular paths in all atoms.	The activity targets Learning Objective 1. It shows Relevance by linking learners' prior ideas about atomic models to accurate explanations, and Responsiveness as misconceptions are surfaced and clarified through peer discussion. The Constructivist–Interactive approach is evident because students actively share and refine ideas. The Think–Pair–Share strategy fits the objective by encouraging reflection and collaboration before teacher explanation. *Note to the teachers:* List common misconceptions (e.g., electrons orbiting like planets), let learners sketch or describe, then clarify Bohr's fixed paths versus Schrödinger's orbital probabilities, reinforcing Planck–Bohr–Schrödinger connections.

	2. Energy can be emitted in discrete packets. 3. Orbitals describe regions where electrons are most likely to be found. 4. Each electron in an atom occupies a specific energy level.	
	Atomic Model Storyboard	
	Students will complete an atomic model storyboard using the provided activity sheets. They will arrange Dalton, Thomson, and Rutherford chronologically, match each scientist with the correct model and contribution, add a sketch or illustration with a short caption, and discuss how each model improved on the previous one. See **Annex A** for the complete activity sheets. (https://tinyurl.com/mtkmwupv)	Targets Objective 1. Shows Relevance by linking each scientist's contribution to atomic theory, and Responsiveness as misconceptions are clarified during sequencing. Reflects Respect by acknowledging and refining learner ideas. The Collaborative–Interactive storyboard strategy makes abstract concepts visible and shows how each model corrected earlier ones. **Note to the teacher:** Prepare clear atomic model cards to avoid confusion. Emphasize how each model improved on the previous one, then highlight the shift from Bohr's fixed orbits to Schrödinger's orbitals.
	Atomic Theory Timeline – (Oral Review)	
	The students will be given set of atomic theory timeline questions for review. Here are the sample Atomic Theory Timeline Oral Review questions that can be used (multiple choice or identification question will do) 1. Who created the "plum pudding model" of atom? 2. James Chadwick discovered _____. a.proton c. electron b. neutron d. atom	Targets Objectives 1–2 by linking scientists' contributions to atomic models and clarifying misconceptions through guided questioning. Students recall, explain, and receive quick feedback through a Constructivist–Interactive approach. *Note to Teacher:* Use identification and multiple-choice items, ask for brief explanations, correct common errors, and give immediate feedback to reinforce Objective 2.

	A.2. Establishing the Purpose of the Lesson	
	Connect-the-Dots Atomic Journey	
	Description: The teacher presents a simple diagram with four numbered dots labeled Planck, Bohr, Schrödinger, and Quantum Mechanical Model. Students connect the dots in sequence and predict "What changes in our understanding of electrons occur as we move from dot 1 to dot 4?" After sharing ideas, the teacher explains that just as connecting dots forms a complete picture, connecting these scientists' contributions builds the quantum mechanical model. **Resource Link:** (https://tinyurl.com/mtkmwupv)	Targets Objectives 1–3 by linking scientists' contributions and clarifying misconceptions through sequencing and guided prediction. *Note to Teacher:* Use this to introduce the lesson, not to assess mastery. Accept initial predictions, clarify with model answers, and revisit learners' ideas during generalization.
	"What's Different?"	
	The teacher shows a collage of two images. Students observe closely and point out the differences they notice. *See Annex C for detailed activity sheets and materials.* (https://tinyurl.com/mtkmwupv) **Sample Guide Questions:** **Picture A:** What difference do you notice between the way light is shown in Picture 1 and Picture 2? **Picture B:** What is the main difference in how the electrons are shown around the nucleus?"	This activity targets Objectives 2–3 by guiding students to compare atomic models and clarify misconceptions through discussion. **Note to Teacher:** Help students connect visual differences to meaning, such as Bohr's fixed orbits and Schrödinger's probability regions. Clarify that electrons do not disappear in the quantum model and that the quantum mechanical model better explains electron behavior.

	Scenario Presentation	
	The teacher posts and reads the scenario: **Scenario:** Last April 2026, the Philippines hosted an international PyroOlympics with colorful pyrotechnic displays. Imagine your team is designing the opening sequence for the next competition. Before launching your fireworks, your team must pass a safety and technical board interview. **Interview Questions:** 1. Why do flame tests and element emissions produce specific colors, such as bright green or vivid red, instead of a continuous rainbow? 2. What do these colors show about how atoms absorb and release energy? 3. If energy in atoms were not quantized, what would the firework flame look like in the sky?	Targets Objectives 2–3 by linking quantized energy and electron behavior to fireworks colors through scenario-based questions. **Note to Teacher:** Guide students to explain why emissions produce specific colors, how atoms absorb and release energy, and how fireworks would appear if energy were not quantized. Emphasize that quantum theory explains these observable colors.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Learning Station: Contributions to the Quantum Theory	
	This activity is designed to understand the contributions of Max Planck, Niels Bohr, and Erwin Schrödinger to the development of quantum theory, and explain how their ideas are advanced atomic models. **Teacher's Task:** Set up three stations labeled Planck, Bohr, and Schrödinger. *See Annex D for detailed activity sheets and materials.* (https://tinyurl.com/mtkmwupv) End with an exit reflection: *"The most important shift I saw in atomic theory was…"*	Targets Objective 1 by helping learners trace the development of quantum theory through station-based tasks. **Note to Teacher:** Use passages, diagrams, and task cards. Provide model answers for support and emphasize the progression from quantization to fixed orbits to probability clouds.

	Discovery Time (Laboratory Activity)	
	This activity is designed to simulate real-world technical roles in laboratory, engineering, and design settings—allowing students to apply quantum theory concepts through hands-on, safety-compliant tasks that build scientific and career-ready skills. *See Annex E for Detailed Activity Sheets and Rubrics.* (https://tinyurl.com/mtkmwupv)	Targets Objective 1 by linking atomic concepts to technical roles and applying safety, precision, and teamwork through a Technical Work Order format. **Note to Teacher:** Emphasize safety and accuracy. Guide students to connect flame colors, LED wavelengths, and orbital shapes to quantized transitions from Planck to Bohr to Schrödinger.
	Reading the Discoveries	
	Students will receive task cards with short passages on three scientists: **Planck**, **Bohr**, and **Schrödinger**. Each group reads their assigned passage, highlights the key idea, and completes the table provided in Annex F. *Resource Link:* https://tinyurl.com/mtkmwupv	Targets Objective 1 by helping learners trace quantum theory through passages, diagrams, and scientist contributions. **Note to Teacher:** Emphasize the progression from quantized energy to fixed orbits and probability clouds, while correcting misconceptions about electron paths.
	B.2. Discussing New Concept	
	Lecture Discussion and Interactive Notes	
	After completing the learning stations, the teacher will guide the class in synthesizing the contributions of Planck, Bohr, and Schrödinger. Using a timeline or concept map, students will connect how each scientist's idea was built upon the previous one, leading to the development of the Quantum Mechanical Model. The teacher will emphasize the shift from classical physics to quantum mechanics, clarifying that Planck introduced quantization of energy, Bohr applied quantization to atomic structure, and Schrödinger advanced the model with wave mechanics and orbitals. Students will be encouraged to fill in a 4-column chart to deepen their understanding. *See Annex G for the chart with model answer* (https://tinyurl.com/mtkmwupv)	Targets Objectives 1–3 by helping learners connect Planck's quantization, Bohr's model, and Schrödinger's orbitals through chart work and discussion. **Note to Teacher:** Guide students in completing the chart, emphasize the progression from quantized energy to fixed orbits and probability clouds, and clarify misconceptions about Bohr's orbits and Schrödinger's orbitals.

	Post – Laboratory Activity	
	After completing the experiments or models, each group will share their observations and discoveries with the class. The teacher will then guide students through processing questions to deepen understanding: • "What did you notice during your experiment or model?" • "Why do you think the colors or shapes appeared that way?" • "How does this connect to the scientist's contribution we are studying?" • "What new idea about atoms or energy can we learn from this?"	Targets Objectives 1–3 by linking observed colors and shapes to atomic principles through guided sharing and discussion. **Note to Teacher:** Ask students to explain observations using quantized energy, characteristic spectra, and probability regions. Clarify misconceptions about electrons emitting any color or orbitals showing exact paths.
	Watch Video Clips	
	Students will watch video clips and then answer some questions about each video clip after watching each. *1. Planck's quantum hypothesis - Max Planck's hypothesis on black body radiation | Explained in 5 minutes | VROOK* *Question: "What does quantization mean?"* *2. Bohr's Atomic Model - The Bohr Atom* *Question: ""What causes electrons to move from one energy level to another?"* *3. Schrödinger's Wave Functions & Orbitals - The Bohr Atom* *Question: "How are orbitals different from orbits?"*	Targets Objectives 1–3 by using multimedia examples to connect Planck's quantization, Bohr's atomic structure, and Schrödinger's probability-based orbitals. **Note to Teacher:** Pause after each clip for reflection. Clarify misconceptions about fixed orbits, orbitals, and quantized energy, and emphasize how each scientist advanced atomic theory.

	B.3. Developing Mastery	
	Conceptual Questions	
	To reinforce mastery and develop deeper conceptual understanding, students will answer the following guided conceptual questions: 1. Why did Bohr's model need improvement? 2. What model replaced Bohr's atomic model? 3. What is the quantum mechanical model? 4. What are atomic orbitals? 5. How are Bohr's fixed orbits different from quantum mechanical orbitals, and how does the quantum model still retain quantized energy levels? 6. What are the different orbital shapes? **Teacher's Task:** Guide for learners to connect each answer to the progression of atomic theory.	Targets Objectives 1–3. Shows Relevance by linking atomic models to deeper understanding, and Responsiveness as misconceptions are clarified through structured questions. The Constructivist–Collaborative–Interactive approach is evident as students analyze and discuss Bohr's model, the quantum model, and orbitals. **Note to the teacher:** Clarify misconceptions (e.g., Bohr's orbits remain valid; orbitals are exact paths). Reinforce that quantized energy levels persist in the quantum model, expressed through probability regions and orbital shapes.
	Sketch The Diagram	
	This activity is designed to help learners visualize the shift from Bohr's fixed electron orbits to Schrödinger's probability-based electron clouds, reinforcing the evolution of atomic models. *See Annex H for Detailed Activity Sheets* (https://tinyurl.com/mtkmwupv)	Targets Objectives 1–3 by having learners compare Bohr's fixed orbits and Schrödinger's orbitals through labeled sketches. **Note to Teacher:** Require clear labels and one-sentence notes on electron behavior. Use peer comparison to clarify the shift from fixed orbits to probability regions.
	Work In Pairs	
	This activity is designed to help learners explain how quantum theory solved problems that classical physics could not, emphasizing how scientific ideas evolve to address unexplained phenomena. *See Annex I for Detailed Activity Sheets and Peer Comparison Checklist* (https://tinyurl.com/mtkmwupv)	Targets Objectives 1–3 by having learners explain quantum theory in their own words and refine ideas through peer dialogue. **Note to Teacher:** Encourage original phrasing, clarify that quantum theory did not fully replace classical physics, and emphasize how it addressed issues such as blackbody radiation and atomic stability.

<table>
<tr><td rowspan="5">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Real - Life Scenario</td></tr>
<tr><td>Why do fireworks, neon signs, and gas-discharge lamps produce specific colors? Explain your answer using the idea of quantized energy levels

Sample Answer: Fireworks, neon signs, and gas-discharge lamps produce specific colors because their atoms have quantized energy levels. When energy is added, electrons jump to higher energy levels. When they fall back to lower levels, they release energy as light. The color depends on the energy difference between levels, which is unique for each element. That is why different atoms or ions emit characteristic wavelengths of light, producing different observed colors.</td><td>Targets Objectives 1–3 by linking quantized energy to fireworks, neon signs, and atomic emission spectra.

Note to Teacher: Emphasize that colors come from element-specific energy gaps. Clarify that electrons do not emit random colors and use the sample to answer observations to spectra.</td></tr>
<tr><td colspan="2">Probability Density Diagram</td></tr>
<tr><td>Task: Study a simple probability-density diagram and explain where an electron is most likely to be found. Compare this with Bohr’s fixed-orbit model in two sentences.

Expected Answer: In a probability-density diagram, an electron is most likely found in the regions where the diagram shows the highest probability density for that orbital, rather than along a fixed path. Unlike Bohr’s model, the quantum mechanical model describes likely regions, not exact circular orbits.</td><td>Targets Objective 3. Shows Relevance by visualizing electron probability regions, and Responsiveness as learners compare these with Bohr’s fixed paths. The Constructivist–Collaborative–Interactive approach is evident as students explain where electrons are most likely found.

Note to the teacher: Use it as a quick formative check. Encourage clear explanations and emphasize the shift from fixed orbits to probability-based regions.</td></tr>
</table>

	STEM Connection	
	Students will explore how quantized energy levels explain the colors produced by LEDs, lasers, and gas-discharge lamps. In pairs, they will list one everyday device (e.g., LED light, laser pointer, neon sign) and explain how electron transitions in quantized energy levels produce its color. **Guide Question:** How do quantized energy levels determine the specific colors we see in modern technologies like LEDs and lasers?	Targets Objective 3. Shows Relevance by linking quantized energy to LEDs and lasers, and Responsiveness as learners explain color production through energy gaps. **Note to the teacher:** Encourage connections to real examples. Clarify that colors come from specific energy gaps, not random emission, using contrasts like red lasers vs. blue LEDs.
	C.2. Making Generalization	
	Venn Diagram	
	Students complete a Venn diagram comparing the contributions of Planck, Bohr, and Schrödinger to quantum theory. Unique contributions go in the outer circles, while shared concepts are placed in overlapping sections. *See Annex J for Activity Sheets and Peer Comparison Checklist* (https://tinyurl.com/mtkmwupv)	Targets Objective 1 by helping learners compare Planck, Bohr, and Schrödinger's contributions through diagram completion. **Note to Teacher:** Guide for students to place unique ideas in the outer circles and shared concepts in the overlaps. Emphasize Planck's constant as a common thread and clarify fixed orbits versus probability clouds.
	Progression Of Ideas	
	Students will explain how ideas about the atom changed from classical physics to quantum theory. They will show how the contributions of Planck, Bohr, and Schrödinger, illustrate the progression of understanding electron behavior. They will write their answers in 3–4 sentences. **Guide Question:** How did each scientist's work build upon the previous one to form the quantum mechanical model?	Targets Objectives 1–3 by helping learners sequence Planck, Bohr, and Schrödinger's contributions and distinguish their models. **Note to Teacher:** Guide students to connect the contributions in order, clarify that Bohr and Schrödinger proposed different models, and emphasize the progressive development of atomic theory.

Real-Life Connection

Students will explain how quantum theory helps understand everyday technologies like lights, phones, or electronic devices.

Write 2–3 sentences showing how electron transitions and quantized energy levels make these devices work.

Guide Question:

How does quantum theory make it possible for the technologies we use daily, such as LEDs, semiconductors, or smartphones?

See Annex K for Classroom Integration Guide

(https://tinyurl.com/mtkmwupv)

Targets Objective 3. Shows Relevance by linking quantized energy to LEDs and lasers, and Responsiveness as learners explain color from energy gaps. The Constructivist–Collaborative–Interactive approach is evident as students connect theory to familiar devices.

Note to the teacher: Encourage real-world connections. Clarify that colors come from specific energy gaps, not random emission, using contrasts like red lasers vs. blue LEDs.

C.3. Evaluating Learning

Matching Type Quiz

Directions: Match each item in Column A with the correct description in Column B. Write the letter of your answer.

Column A	Column B
1. Planck 2. Bohr 3. Schrödinger 4. Fireworks colors 5. Atomic emission spectra	A. Introduced quantization of energy to explain blackbody radiation B. Proposed electrons move in fixed energy levels around the nucleus C. Described electrons as probability clouds in orbitals D. Colors produced by minerals when atoms release photons at specific energy differences E. Evidence that atoms have quantized energy levels, seen in distinct spectral lines

Targets Objectives 1–3. Shows Relevance by matching scientists to their contributions and Responsiveness as learners connect theory to real-life phenomena. The Constructivist–Collaborative–Interactive approach is evident as students link concepts through guided matching.

Note to the teacher: Guide to learners to match scientists with distinct contributions and applications. Clarify differences between Bohr's orbits and Schrödinger's clouds, connecting to fireworks and spectra.

	Illustration Task:	
	Student will draw a Bohr model and a Schrödinger model of the atom. Label each diagram and highlight the main difference: Bohr shows electrons in fixed orbits, while Schrödinger shows electrons in probability clouds. **Guide Question:** How does Schrödinger's model improve upon Bohr's idea of fixed orbits? *See Annex L for Scoring Rubric* (https://tinyurl.com/mtkmwupv)	Targets Objective 2 by having learners compare Bohr's fixed orbits and Schrödinger's probability clouds through labeled drawings. **Note to Teacher:** Emphasize the difference between fixed orbits and probability clouds and connect student outputs to the quantum mechanical model.
	Think-Explain-Share Exit Ticket	
	Students will write their answers to a piece of paper before leaving the class. "How does the quantum mechanical model better explain electron behavior than earlier models?" *To support deeper reasoning, remind students to consider:* -What limitations did earlier models (Bohr, Rutherford) have? -How does the quantum model describe electron movement differently? -Why does this explanation make atomic behavior more accurate?	Targets Objective 3. Shows Relevance by prompting reflection on how the quantum model improves earlier ones, and Responsiveness as misconceptions are clarified. The Constructivist–Collaborative–Interactive approach is evident through written reflection. **Note to the teacher:** Ask learners to explain improvements. Use responses to clarify misconceptions and highlight probability of regions vs. fixed orbits.
	C.4. Additional Activities	
	Quantum Panel Discussion	
	This activity is designed to let learners synthesize the contributions of Planck, Bohr, and Schrödinger by role-playing as panelists, showing how each scientist's idea advanced quantum theory. *See Annex M for the Activity Sheets.* (https://tinyurl.com/mtkmwupv)	Targets Objectives 1–3 by helping learners sequence scientists' contributions and clarify key differences through roleplay and discussion. **Note to Teacher:** Guide students to present contributions in order, distinguish Bohr's orbits from Schrödinger's clouds, and use questions to reinforce the shift from classical to quantum theory.

<table>
<tr><td></td><td colspan="2">Electron Journey</td></tr>
<tr><td></td><td>• Students act out electrons moving through different models: Bohr's fixed orbits vs. Schrödinger's orbitals.
• Teacher narrates scenarios, and students physically demonstrate electron behavior.
Debrief statement: This role-play is only a learning analogy. In the quantum mechanical model, electrons are not shown following visible tracks like planets; they are described using probability regions called orbitals.</td><td>Targets Objective 2 by helping learners compare Bohr's orbits and Schrödinger's probability regions through kinesthetic roleplay.
Note to Teacher: Narrate scenarios clearly emphasize fixed paths versus probability regions, and use reflections to correct misconceptions and show how Schrödinger improved Bohr's model.</td></tr>
<tr><td></td><td colspan="2">Orbitals Concept Map (for on-level learners and/or learners needing support)</td></tr>
<tr><td></td><td>This activity helps learners organize and connect key concepts in the quantum mechanical model, reinforcing relationships among ideas through a visual concept map.
See Annex N for the Activity Sheets.
(https://tinyurl.com/mtkmwupv)</td><td>Targets Objective 3 by helping learners connect orbitals, probability, wave–particle duality, and energy levels through visual mapping.
Note to Teacher: Provide keywords, guide logical connections, and clarify that orbitals are probability regions shaped by quantum rules.</td></tr>
<tr><td>V. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Multiple Choice: Read each question carefully. Choose the letter of the best answer from the given options.
1. Max Planck's major contribution to quantum theory was:
A. He developed the uncertainty principle.
B. He discovered the neutron.
C. He introduced electron orbitals.
D. He proposed that energy is absorbed or emitted in discrete packets called quanta.
2. According to Niels Bohr's atomic model, electrons:
A. Are distributed evenly in a positive sphere. C. Occupy fixed orbits with specific energy levels.
B. Move randomly around the nucleus. D. Stay only in pairs within atomic orbitals.
3. Erwin Schrödinger's wave mechanical model proposed that:
A. Electrons are described by probability distributions in orbitals.
B. Electrons are located only in fixed circular paths.
C. Electrons behave strictly as particles in motion.
D. Electrons cannot move into higher energy states.</td></tr>
</table>

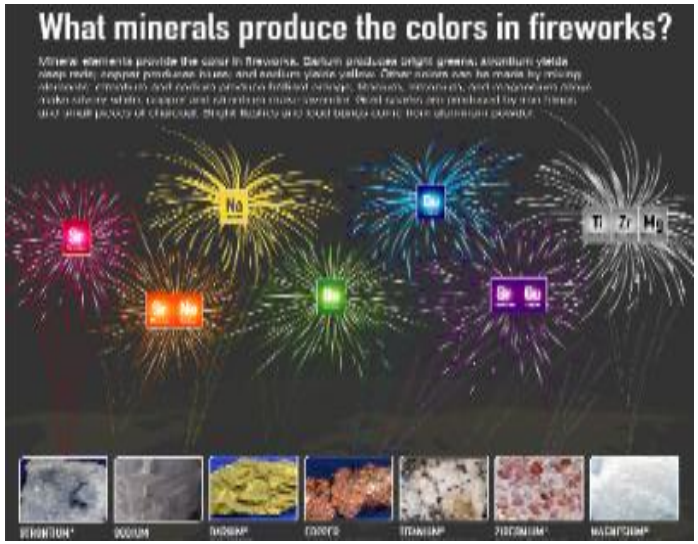
	4. Which statement best explains why the quantum mechanical model improved Bohr's model? A. It removed all energy levels. B. It proved that atoms have no nucleus. C. It showed that electrons never absorb energy. D. It described electrons as probability regions rather than fixed circular paths. 5. In the quantum mechanical model, orbitals are defined as: A. Empty spaces found between protons and neutrons. B. Fixed shells arranged with equal distances apart. **C. Regions in space where electrons are most likely to be found.** D. Spaces where electrons move in circular paths. **Additional Item:** In two to three sentences, explain why the quantum mechanical model gives a better explanation of electron behavior than the Bohr model. *See Annex O for the Scoring Guide* (https://tinyurl.com/mtkmwupv)
VI. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot to assist in organizing ideas, improving sentence clarity, and drafting activity options. The author(s) reviewed and finalized the content and take full responsibility for the final manuscript.

Learning Title/Topic:	**1. Quantum Mechanical Principles of Electron Arrangement** **2. Aufbau Principle** **3. Pauli Exclusion Principle** **4. Hund's Rule** **5. Electron Configuration** **6. Orbital Diagrams**	**Lesson Exemplar:**	7

I. OBJECTIVES	
A. Content Standard	The learners learn that electrons of elements are arranged according to different energy levels, subshells, and orbitals based on the quantum mechanical model;
B. Performance Standard	By the end of the quarter, learners make reliable measurements and record data using appropriate laboratory and/or measuring tools. They also apply significant figures, scientific notation, and unit conversion. Using the Quantum Mechanical Model, they describe electrons in levels and write electron configurations for elements. Learners explain what isotopes are and how they may be useful and possibly harmful.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Atomic number and its relation to number of electrons in a neutral atom; basic subatomic particles; historical atomic models including limits of the Bohr model; shells, sublevels, and valence electrons; interpretation of simple periodic-table information.
	In this lesson, the learners write the electronic configurations based on quantum mechanical principles;
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	**References:** a. OpenStax. Chemistry 2e. Houston: OpenStax, Rice University, 2019. https://openstax.org/books/chemistry-2e (openstax.org in Bing). b. Chemistry LibreTexts. "Electronic Structure of Atoms." Chemistry LibreTexts, 2021. https://chem.libretexts.org. c. United States Geological Survey (USGS). "Minerals in Fireworks." U.S. Geological Survey, n.d. https://www.usgs.gov. **Resources:** Periodic table, orbital-diagram worksheet, index cards or meta-cards, projector or printed visuals, markers, sample element cards, and cited print/digital chemistry references.
III. CONTENT (Sequencing Content)	Quantum mechanical principles of electron arrangement; Aufbau principle; Pauli Exclusion Principle; Hund's Rule; electron configuration; orbital diagrams.

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Explain the Aufbau principle, Pauli Exclusion Principle, and Hund’s Rule.
2. Determine the order of filling of orbitals using the periodic table or diagonal rule.
3. Write the correct electron configuration of elements.
4. Represent electron configurations using orbital diagrams.</td></tr>
<tr><td colspan="2">IV. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Think-Pair-Share</td></tr>
<tr><td>The teacher will display images of Bohr models of Carbon and Sodium and ask these recall questions:
● How many electrons does Carbon have?
● Where are electrons located in an atom?
● What happens when an atom gains or loses electrons?
Students will pair with a classmate to compare answers and share their ideas with the class.
Diagnostic Check: Ask: “Do electrons move in fixed circular paths like planets, or do they occupy regions of probability?”
Teacher Follow-Up: If learners describe electrons as planets in fixed paths, clarify that the Bohr model is useful historically, but the quantum mechanical model describes orbitals as regions where an electron is likely to be found.</td><td>This activity targets learning objectives 1 and 3. It manifests relevance by connecting familiar atomic models to the lesson on electron arrangement. It uses a constructivist and inquiry-based approach through recall questioning and peer exchange. The pedagogical strategy is Think–Pair–Share with teacher facilitation.
Note to the teacher: Use student responses to surface prior conceptions about electron number, location, and charge transfer, then bridge toward the formal principles of orbital filling.</td></tr>
<tr><td colspan="2">K – W – L Chart: “What Do I Know About Electrons?”</td></tr>
<tr><td>This activity is designed to activate prior knowledge, set learning goals, and consolidate new understanding about electrons and electron configurations.
Students will fill out the K-W-L Chart below.
<table>
<tr><th>What I Know (K)</th><th>What I Want to Know (W)</th><th>What I Learned (L)</th></tr>
<tr><td></td><td></td><td></td></tr>
</table>
</td><td>This activity targets objectives 2 and 3. It manifests responsiveness by activating prior knowledge, setting personal learning goals, and consolidating new understanding of electron configurations. It uses a metacognitive and learner-centered approach that encourages reflection and ownership of learning. The pedagogical strategy is KWL chart completion with guided discussion.</td></tr>
</table>

	Link to Activity Sheet: Annex A (https://tinyurl.com/2v252s8j) **Synthesis Question:** In what way do electron arrangements determine an element's position in the periodic table?	*Note to the teacher:* Highlight recurring questions in the "W" column to frame the lesson focus and revisit the "L" column to check alignment of student learning with objectives.
	Atomic Model Gallery Walk	
	The teacher will prepare large images of each atomic model (Dalton, Thomson, Rutherford, Bohr, Quantum Mechanical) around the room. Students will trace the historical development of atomic models, identifying how each was corrected or built upon the previous one. Link to Activity Sheet: Annex B (https://tinyurl.com/2v252s8j)	This activity targets objectives 1 and 4 by linking historical atomic models to modern orbital concepts. It shows relevance and uses Constructivist and Inquiry-based approaches. *Note to the teacher:* Emphasize how each model improved earlier ideas and use learner questions to transition to orbital diagrams
	A.2. Establishing the Purpose of the Lesson	
	Guided Question	
	The teacher will ask: *"Why do electrons occupy specific orbitals instead of random positions around the nucleus?"* Students will share initial ideas based on prior knowledge.	This activity targets objectives 1 and 4 by helping learners explain why electrons occupy specific orbitals. It shows relevance and uses Constructivist and Inquiry-based approaches through guided questioning and peer sharing. *Note to the teacher:* Use student responses to address misconceptions, such as electrons being "free floating," and guide learners toward orbital occupancy rules and quantum principles.
	Thumbs Up or Thumbs Down	
	The teacher will present statements and ask students to show **Thumbs Up** if they think the statement is scientifically accurate, or **Thumbs Down** if they think it is misleading. Suggested Statements: ● *"Electrons orbit the nucleus like planets."* ● *"Electrons exist in regions called orbitals."*	This activity targets objective 1 by addressing misconceptions about electron behavior. It shows relevance and responsiveness, using a Constructivist–Interactive approach through a Thumbs Up/Down diagnostic check.

	• *"Electrons can be found anywhere randomly around the nucleus."* After each vote, ask learners: *"Why did you choose thumbs up or thumbs down?"* *Clarification Note:* Answers to 1 and 2 may depend on which model we are talking about. Bohr's model makes statement 1 true and the second statement false, the opposite will happen if we consider Schrodinger's model.	*Note to the teacher:* Present statements one at a time, ask learners to justify responses briefly, then clarify before proceeding.
	Fireworks and Electrons	
	Students will watch the loop: https://tinyurl.com/23ny5nva Ask the learners: *"Why do different elements produce different colors in fireworks? What does this tell us about the arrangement of electrons in atoms?"*  *Teachers may use this image as a reference for short discussion.* Resource Link: Please see Annex C (https://tinyurl.com/2v252s8j)	The activity targets objectives 1 and 3 by linking electron configurations to fireworks colors. It shows relevance and responsiveness through visual demonstration and guided questioning. *Note to the teacher:* After each response, clarify that different minerals (e.g., sodium → yellow, copper → blue-green, strontium → red) produce characteristic colors because excited electrons emit light of specific wavelengths when returning to lower energy states.

<table>
<tr><td rowspan="6">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Teacher Demonstration</td></tr>
<tr><td>The teacher will use the diagonal rule as a classroom guide to illustrate the general order of orbital filling, while clarifying that electron configurations are determined by relative orbital energies rather than the mnemonic itself. The diagonal rule serves as a helpful guide, not the actual basis of electron filling behavior.
Common classroom examples of exceptions to the simple filling pattern include chromium and copper; these examples show that electron arrangement depends on orbital stability as well as the mnemonic order.</td><td>This activity targets objective 1 by linking orbital filling to electron configurations and addressing exceptions such as chromium and copper. It shows relevance and responsiveness.
Note to the teacher: Adjust sample elements as needed. Emphasize that the diagonal rule is a useful guide, but actual electron configurations depend on orbital stability and relative orbital energies.</td></tr>
<tr><td colspan="2">Learn-Me Station</td></tr>
<tr><td>This activity is designed to help students discover the rules of electron arrangement by allowing them to explore, observe, and infer rules through learner-centered stations.
Station 1: Where Should I Put the Electrons?
Station 2: How Many Electrons Can Fit?
Station 3: Should Electrons Share or Spread?
See Annex D for full activity sheet for tasks, expected discoveries, and materials. (https://tinyurl.com/2v252s8j)</td><td>This activity targets objectives 1 and 2. It promotes discovery learning by letting students infer rules at stations. The strategy used is exploratory station work with teacher synthesis.
Note to the teacher: Provide expected responses (Aufbau, Pauli, Hund) to guide correction and ensure accurate takeaways.</td></tr>
<tr><td colspan="2">Pattern Discovery – Which Arrangement is More Stable?</td></tr>
<tr><td>This activity is designed to help students recognize stability in electron arrangements by comparing different orbital diagrams and reasoning through observable patterns.
See Annex E for full activity sheet for tasks, expected discoveries, and materials. (https://tinyurl.com/2v252s8j)</td><td>This activity targets objectives 1 and 4. It encourages analytical reasoning by comparing orbital diagrams for stability. The strategy used is guided comparison with partner discussion.
Note to the teacher: Use expected responses (balance, reduced repulsion, lower energy) to connect student reasoning to Hund’s Rule.</td></tr>
</table>

	B.2. Discussing New Concept	
	Interactive Discussion	
	The teacher will explain the Aufbau Principle, Pauli Exclusion Principle, and Hund's Rule, using labeled diagrams and guided questions. Students will actively participate by answering questions, identifying examples of each rule, and correcting sample orbital diagrams presented by the teacher.	This activity targets objectives 1 and 4. It builds responsiveness by engaging learners in guided questioning and error correction, making abstract rules concrete through visual diagrams. The pedagogical strategy is interactive discussion with teacher scaffolding. *Note to the teacher:* Use student corrections of sample orbital diagrams to surface misconceptions and reinforce accurate application of Aufbau, Pauli, and Hund's Rule.
	Think–Sketch–Explain	
	Students will individually sketch a simple orbital diagram that best represents each of the three principles. After sketching, students will pair up and take turns explaining their drawings to a partner, explicitly naming the rule being applied and why. *Teachers may provide sample orbital diagram templates for learners who need support.*	This activity targets objectives 1 and 4. It fosters responsiveness by combining individual visualization with peer explanation, helping learners internalize the principles through sketching and verbal reasoning. The strategy is think–sketch–explain with partner sharing. *Note to the teacher:* Encourage students to explicitly name the principle in their explanation (Aufbau, Pauli, Hund) and correct any misconceptions on how orbitals are drawn or labeled.
	Role-Play Simulation – Electrons at Work	
	This activity, guided by the teacher's cues, is designed to let students act out how electrons fill orbitals. *See Annex F for full activity sheet for tasks, expected discoveries, and materials.* (https://tinyurl.com/2v252s8j)	This activity targets objectives 1 and 4. It makes abstract principles tangible through kinesthetic modeling. The strategy is role-play simulation with guided facilitation. *Note to the teacher:* Reinforce links between student actions (seating, spin) and formal principles.

	B.3. Developing Mastery	
	Building Electron Configurations	
	This activity strengthens learners' understanding of electron configurations and orbital diagrams through group work. Assigned elements: G1: O, Ne | G2: Na, Mg | G3: P, Cl | G4: K, Ca Each group will write the electron configuration, draw the orbital diagram, and explain how the three quantum mechanical principles are applied.	This activity targets objectives 2, 3, and 4 by engaging learners in collaborative practice on electron configurations and orbital diagrams. It uses small-group work with peer explanation to apply Aufbau, Pauli, and Hund's Rule. *Note to the teacher:* Provide challenging tasks among the fast learners and offer support to the struggling learners. Monitor reasoning and correct misconceptions in orbital diagrams.
	Electron Configuration Race	
	This activity reinforces mastery of electron configurations through teamwork and friendly competition. *See Annex G for full activity sheet for tasks, expected discoveries, and materials.* (https://tinyurl.com/2v252s8j)	This activity targets objectives 2 and 3. It builds engagement through competition while reinforcing accuracy in configurations. The strategy is a team race with teacher scoring. *Note to the teacher:* Ensure that the teams have the same distribution of learners who are high and low performing.
	Electron Configuration Challenge	
	Students act as **Atomic Structure Analysts**, determining the electron configuration and orbital diagram of an assigned element, identifying the quantum mechanical principles applied, and connecting these to a real-world STEM application. *See Annex H for full activity sheet for tasks, expected discoveries, and materials.* (https://tinyurl.com/2v252s8j)	This activity targets objectives 1–4. It integrates knowledge application and communication through group presentations. The strategy is collaborative output with oral presentation. *Note to the teacher:* Assess accuracy, clarity, and relevance of applications; use presentations to reinforce STEM connections.

<table>
<tr><td rowspan="4">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Real-World Reactivity Check</td></tr>
<tr><td>Students will apply electron configuration to explain why certain elements are reactive or stable.
Procedure:
• Teacher presents everyday scenarios (e.g., “Why does sodium react violently with water?” or “Why is it safe to use neon lights?”).
• Students analyze the electron configuration of the element involved and write a short explanation in their notebooks.
• Groups share answers, highlighting how valence electrons drive reactivity or stability.</td><td>This activity targets objectives 1 and 3. It shows relevance by linking electron configurations to everyday chemical behavior. It also promotes responsiveness as learners explain reactivity or stability through short written reflections. The Constructivist–Interactive approach is evident because students analyze scenarios, share group answers, and refine ideas with teacher guidance.
Note to the teacher: Emphasize how valence electrons drive reactivity or stability, and guide groups to connect their reasoning back to electron configurations.</td></tr>
<tr><td colspan="2">“Electron Configuration and Chemical Behavior”</td></tr>
<tr><td>The teacher will guide a discussion connecting electron configuration to valence electrons, chemical reactivity, and stability of noble gases.
Students will write a short explanation answering: “How does electron configuration help explain why noble gases are stable?”
Sample answer: Noble gases are stable because their electron configurations show a complete valence shell. This full outer shell means they have little tendency to gain or lose electrons, making them chemically inert.
Formative bridge task: Choose one assigned element and write 3-4 sentences explaining how its electron configuration helps explain one property, use, or behavior.
Please see Annex I for Scoring Guide for this task. (https://tinyurl.com/2v252s8j)</td><td>This activity targets objectives 1 and 3. It strengthens responsiveness by linking electron configurations to chemical reactivity and noble-gas stability. The pedagogical strategy is guided discussion with short written application.
Note to the teacher: Use the bridge task (3–4 sentence explanation for an assigned element) to check readiness and ensure all learners demonstrate application of electron configuration to real-world properties before moving to summative assessment.</td></tr>
</table>

	Color of Salts	
	This activity connects electron transitions to visible color. Instructions: • Show pictures of NaCl and $CuSO_4$. Other examples may include $KMnO_4$, $NiSO_4$, $MgSO_4$, and $CaCl_2$. • Learners write the electron configurations of Na and Cu. • Discuss why many transition-metal compounds are colored. Key idea: Transition-metal compounds are often colored because electrons in partially filled d orbitals absorb visible light and undergo transitions. Sodium salts like NaCl are usually colorless because they lack these d-electron transitions.	This activity targets objectives 1 and 3 by linking electron configurations to observable colors. It shows relevance and responsiveness through visual comparison of common salts and transition-metal compounds. *Note to teacher:* Emphasize that many transition-metal compounds are colored due to d-electron transitions, while sodium salts are usually colorless. The exact color depends on the ion and surrounding ligands.
	C.2. Making Generalization	
	One Word + Explanation	
	The teacher will present several keywords related to the lesson. The students will choose **one word** that best summarizes their understanding of electron configuration. **Example words:** structure, order, rules, orbitals, behavior After choosing, students will complete the statement: "I chose ___ because…" **Closing sentence:** These principles matter because they help us write electron configurations and orbital diagrams correctly for different elements.	This activity targets objectives 2 and 3. It builds responsiveness by prompting learners to summarize understanding in a single keyword with justification. The strategy is keyword reflection with guided explanation. **Note to the teacher:** Use chosen words to surface learner perspectives and connect them back to orbital filling and behavior.
	Word Bank Generalization	
	This activity requires students to complete a guided summary sentence using a word bank. **Word Bank:** Aufbau, Pauli Exclusion, Hund's Rule, orbitals, electrons, energy.	This activity targets objectives 1 and 2. It reinforces principles by guiding learners to complete structured statements using key terms, fostering responsiveness through active application. The guided sentence completion strategy fits the objectives by making orbital rules explicit and easier to internalize.

	Electrons fill **orbitals** in order of increasing **energy** levels following the **Aufbau** Principle, which states that lower energy orbitals are filled first. The **Pauli Exclusion** Principle explains that no two electrons in an atom can have the same set of quantum numbers, while **Hund's Rule** describes how electrons occupy equal-energy **orbitals** by spreading out before pairing. **Closing reflection:** Which principle—Aufbau, Pauli, or Hund—was hardest to apply today, and how did you correct your understanding?	*Note to the teacher:* Ensure learners correctly apply Aufbau, Pauli, and Hund's Rule, highlighting how each principle governs orbital filling.
	If I explain to a younger student…	
	Students will simplify their understanding of electron configuration by explaining it as if to a younger learner. Guide Question: "*How would you explain electron configuration to a Grade 7 student?"* **Readiness check:** Before the final task, ask learners to write the electron configuration and one orbital-diagram line for a teacher-assigned element. Use the response to decide whether learners may proceed independently, need a worked example, or participate in a short remediation group.	This activity targets objectives 1 and 3. It encourages responsiveness by simplifying complex ideas into age-appropriate explanations, fostering metacognition. The strategy is peer teaching simulation. *Note to the teacher:* Listen for clarity and accuracy; correct oversimplifications while affirming learner ownership of understanding.
	C.3. Evaluating Learning	
	Individual Quiz	
	Direction: Write the electron configuration and orbital diagram of the following elements. 1. Nitrogen 2. Magnesium 3. Chlorine 4. Potassium 5. Zinc	This activity targets objectives 2–4. It reinforces mastery by requiring learners to independently produce electron configurations and orbital diagrams for varied elements. *Note to the teacher:* Check accuracy and diagram clarity; use errors to identify misconceptions before moving to higher-order tasks.

	Decode the Element	
	Students will be given an element (randomly drawn). They will write its electron configuration, draw orbital diagram, and explain which principles are applied.	This activity targets objectives 1–4. It strengthens responsiveness by combining configuration writing, diagram drawing, and principle identification in one task. *Note to the teacher:* Ensure learners explicitly name the principle applied (Aufbau, Pauli, Hund) to connect practice with conceptual rules.
	Concept Check	
	Read each statement carefully. Identify which quantum mechanical principle it describes. Write the correct answer on the blank provided. Choose your answers from the following: **Aufbau Principle, Hund's Rule, Pauli Exclusion Principle**. _____1. Electrons occupy separate orbitals before pairing. _____2. Two electrons in one orbital must have opposite spins. _____3. Electrons fill lower energy levels first.	This activity targets objective 1. It consolidates understanding by matching statements to the correct principle. *Note to the teacher:* Use this quick check to confirm recognition of each principle; clarify distinctions if learners confuse Hund's Rule with Pauli Exclusion.
	C.4. Additional Activities	
	Enrichment: Research Task	
	Research one transition metal that exhibits exceptional electron configuration. Guide Questions: • What is the element? • What makes its configuration unique? • How is it useful in technology or industry? Please see Annex J for Scoring Guide for this task. (https://tinyurl.com/2v252s8j)	This activity targets Objectives 2 and 3 through independent inquiry on transition metals with exceptional electron configurations. It develops responsiveness by linking theory to real-world applications. *Note to the teacher:* Provide examples such as Cr and Cu, emphasizing stability from half-filled or fully filled d-subshells. Encourage links to uses in electronics, alloys, and catalysts.

<table>
<tr><td></td><td colspan="2">Remediation: Complete the Configuration</td></tr>
<tr><td></td><td>Learners will be given a partially completed orbital diagram of an element. They will finish the electron configuration and explain one filling rule applied in completing it (Aufbau Principle, Hund's Rule, or Pauli Exclusion Principle).

Example: Element: Oxygen (O)
Partially Completed Orbital Diagram:
1s ↑↓ 2s ↑↓ 2p ↑ ↑ __</td><td>This activity targets objectives 1 and 3 by engaging learners in completing orbital diagrams and explaining the rules applied. It shows relevance and responsiveness as learners justify choices using Aufbau, Hund's, or Pauli's Rule.
Note to the teacher: Ask learners to identify the rules used and check accuracy of orbital filling and electron pairing.</td></tr>
<tr><td></td><td colspan="2">Noble Gas</td></tr>
<tr><td></td><td>The student will choose a noble gas (Neon, Xenon) and write its electron configuration using the Aufbau principle. They will also draw a simple orbital diagram (boxes and arrows).

Additional question for advanced learners: Explain how the filled electron shells of Neon and Xenon demonstrate quantization of energy.</td><td>This activity targets objectives 1, 3, and 4 by applying the Aufbau principle to noble gases and showing stability through orbital diagrams. It uses individual practice with visual representation.
Note to the teacher: Emphasize that complete valence shells explain noble-gas stability and use diagrams to check orbital filling and spin pairing.</td></tr>
<tr><td>V. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Students will create a one-page infographic on one assigned element. Include atomic number, full or noble-gas electron configuration, an orbital diagram, a brief explanation of the three principles as applied, one verified real-life application, and at least one cited source in Chicago-style notes or reference form.
Please see Annex K for the complete rubric. (https://tinyurl.com/2v252s8j)

Teacher preparation note: Show one sample infographic and ask learners to identify what makes it accurate, clear, and evidence-based before they create their own output.</td></tr>
</table>

VI. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was the easiest for learners? Which part was the most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot and ChatGPT in to improve sentence organization, generate draft activity ideas, and refine the clarity of instructions. The author(s) reviewed and finalized the writing of the content. The author(s) takes full responsibility for the final version.

Learning Title/Topic:	The Quantum Theory and Electronic Structure of Atoms	Lesson Exemplar:	8

I. OBJECTIVES	
A. Content Standard	The learners learn that electrons of elements are arranged according to different energy levels, subshells, and orbitals based on the quantum mechanical model.
B. Performance Standard	Learners are able to apply their understanding of the quantum mechanical model by analyzing and predicting the arrangement of electrons in terms of energy levels, sublevels, and orbitals, in relation to electronic configurations of various elements.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners should have a foundational understanding of atomic structure, recognizing that atoms are composed of protons, neutrons, and electrons, with electrons located outside the nucleus. They should also understand that the atomic number determines the number of electrons in a neutral atom, which is essential for correctly arranging electrons. Prior knowledge of the Bohr Model is important, as it introduces the concept of electrons occupying specific energy levels or shells. Additionally, learners should recall that electrons occupy energy levels around the nucleus. In more advanced models, these energy levels are further divided into sublevels and orbitals, and energy depends on more than distance alone.
	In this lesson, the learners write electronic configurations of elements based on quantum mechanical principles.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew Stoltzfus. *Chemistry: The Central Science*. 14th ed. Pearson, 2018. • Department of Education (DepEd). *General Chemistry Curriculum Guide and Learning Modules for Senior High School Science*. Manila, Philippines: Department of Education. • Khan Academy – Quantum Mechanics and Atomic Orbitals. Western Oregon University Chemistry Textbook – Atoms and the Periodic Table ***Materials:*** printed element cards; pictures; periodic table; modern periodic table; orbital diagram; clue cards; scissors; glue; cartolina or bond paper; markers; projector or screen for video/link-based options; and activity sheets.
III. CONTENT *(Sequencing Content)*	The Quantum Theory and Electronic Structure of Atoms

IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Explain the relationship among main energy levels, sublevels, and orbitals. 2. Represent the arrangement of electrons in energy levels, sublevels, and orbitals. 3. Predict occupied energy levels, sublevels, and orbitals from the electronic configuration of an element. 4. Use the electron configuration of an element to identify the highest occupied orbital(s). 5. Construct orbital diagrams using quantum mechanical principles	
IV. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option1	
	Activity: *Think-Pair-Share* *(10 minutes)* **Procedure:** Ask the learners to pair up with a seatmate and, for 2-3 minutes, share their thoughts by answering the questions below: **Guide Questions:** 1. Why do electrons occupy different energy levels instead of staying near the nucleus?" 2. How are electrons arranged within an energy level? 3. Which element would have the configuration of $1s^2\ 2s^2\ 2p^6\ 3s^1$? 4. What is the electronic configuration of Ca^{2+}? (Take note that Ca^{2+} is a cation in which calcium donates two electrons, resulting in the same electron configuration as Argon)	This activity connects prior knowledge of electron configuration to new understanding guided by the 2C-2I-1R framework. Reflective, Collaborative and Inquiry-based approaches are used as the learners recall, justify and refine ideas. *Note to the teacher:* Begin with brief recall, address misconceptions, and guide learners toward accurate understanding
	Option 2	
	Activity: Bohr Model Review & Bridge Activity *(10 minutes)* **Procedure:** 1. Learners will be paired with their seatmate for the activity. 2. The teacher will display the Bohr Model of sodium (Na) and Iron (Fe), then ask: a. Label the diagram: How many energy levels (orbits) do sodium (Na) and Iron (Fe) have?	This activity addresses the relevance of helping learners build accurate conceptual understanding of key ideas in atomic structure. This activity is anchored on the 2C-2I-1R frameworl which enable the learners to articulate their ideas, compare interpretations, and

	b. How many electrons are in each energy level? c. What do the circles (orbits) represent in the Bohr model? Can the Bohr model adequately explain the arrangement of electrons in these elements? Why or why not? **Guide Questions:** 1. What are the limitations of the Bohr model? 2. How does the quantum mechanical model improve your understanding of electron arrangement compared to the Bohr model?	refine their understanding collaboratively. *Note to the teacher:* In this process, use visual aids to clearly distinguish between "orbit" and "orbital," guiding students to recognize that orbitals represent probability distributions of where electrons are likely to be found, as explained in quantum theory.
	Option 3	
	Activity: Orbital Sort *(10 minutes*) **Procedure**: The Sorting Challenge 1. Learners will be grouped in pairs and provided with a set of Orbital Cards. 2. Each card represents an orbital (s, p, d, or f) within specific energy levels. 3. Arrange the orbital cards from bottom to top (or left to right) in order of increasing energy, while applying the appropriate rules. 4. Once the "Sort" is complete, learners rotate to a partner to justify their arrangement using an audit pair. (See audit pair in **Annex** A) **Guide Questions:** 1. How does this "sorting" activity help you visualize something that cannot be directly observed? 2. What strategies did you use to decide where each electron should go? 3. In what ways could this activity help you predict properties of elements on the periodic table?	In this activity, electrons are arranged by energy level, sublevel, and orbitals. It also promotes responsiveness among the learners and encourages them to refine their understanding through active engagement. Guided by the reflective dimension of the 2C-2I-1R framework, students are prompted to examine and justify their answers with their partner through collaborative and inquiry-based learning. Learners work in pairs using orbital cards to explain their reasoning and address any errors they identify. *Note to the teacher:* Listen and validate the learner's configuration audit, so any misconceptions can be checked at once before proceeding to the next activity/lesson.

	A.2. Establishing the Purpose of the Lesson	
	Option 1	
	Activity: Motivational Question (20 Minutes) **Procedure:** 1. The teacher will read the motivational question aloud. The motivational question is" **How do scientists determine where electrons are located inside atoms?"** 2. The learners will write their initial answers to the two guide questions independently. Stress that there are no wrong answers at this stage; the goal is honest prior thinking, not correct chemistry. **Guide Questions:** 1. What tools or technologies might scientists use to study things they cannot see? 2. How can scientists conclude something they cannot directly observe?	This activity targets learning objectives 1 and 2. It is designed to spark curiosity and activate learners' knowledge about atomic structure, particularly the challenge of locating electrons within atoms. It manifests the IDF's guiding principles of relevance and reflection. *Note to the teacher:* Listen to learners as they answer the guide questions. Take note that the motivational question guides students to consider how scientists use tools and technology.
	Option 2	
	Activity: Colors of Electrons *(20 minutes*) Motivational Question **"How do scientists determine the color produced by different elements?**" **Procedure** 1. Divide learners into groups and show pictures of: a.Fireworks b.Neon lights c. LED lights (see Annex for pic) 2. Learners identify possible elements responsible for the colors. (Accomplish the table provided in **Annex B.**) **Guide Questions:** 1. What happens when electrons absorb energy?	This activity targets Objectives 1 and 2 since it deals with the arrangement and relationship of the main energy level, sublevel, and orbitals that are being observed visually in engaging phenomena. From an IDF perspective, this activity promotes relevance since learners analyze real-world examples. Inquiry-based and constructivist approaches are the pedagogies used. *Note to the teacher:* Explains that colors are produced when electrons absorb

	2. Why do electrons release light when returning to lower energy levels? 3. How is the arrangement of electrons in fireworks, Neon and LED lights related to the main energy levels, sublevels, and orbitals?	energy and move to higher energy levels. When electrons return to lower energy levels, they release energy in the form of light.
	Option 3:	
	Activity: Electron Hotel *(20 minutes)* **Procedure** 1. Group the learners into 5-6 members per group 2. Ask learners to imagine electrons as hotel guests. 3. Draw a hotel where floors are energy levels, room types are subshells, and beds are orbitals. Each bed in the orbital can occupy 2 electrons. 4. Each group will be given an orbital (eg. 2p,3s) where learners will draw a hotel representing the orbitals. 5. Sharing: Groups present and explain their models to the class. **Guide Questions:** 1. Which floor is the closest to the nucleus? 2. Which subshell has more "rooms"? 3. How many electrons can stay in the 2nd floor of the hotel? (Remember that only 2 electrons can occupy one orbital.)	This activity targets objectives 1 and 2 since the "Hotel Electron" activity uses an analogy of a hotel to represent how electrons occupy energy levels, sublevels, and orbitals. The activity reflects a constructivist and analogy-based approach, where new knowledge is built by connecting it to familiar experiences. *Note to the teacher:* Let the learners know that this activity is an engaging and learner-centered strategy that uses a hotel analogy to help them visualize the arrangement of electrons in atoms.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1	
	Activity: Orbital Model *(30 minutes)* **Procedure:** 1. Learners will be grouped into 5-6 members per group. 2. Using clay or paper cut-outs, learners create models of the orbitals (s,p,d,f). 3. The teacher will give each group an orbital (ex. 2s, 3p, 3s) and learners will use the orbital model. See **Annex C.** 4. Groups label their models and identify: orbital name, shape, number of orbitals, and electron capacity 5. The teacher will also clarify that the diagonal rule is a mnemonic and not the true cause of orbital filling.	This activity engages learners in constructing physical models of atomic orbitals, allowing them to translate abstract quantum concepts into tangible representations. Pedagogically, the activity reflects experiential and collaborative learning principles. *Note to the teacher:* Guide the learners in this activity since it is a hands-on and collaborative learning task designed to help them visualize and understand the

	Guide Questions: 1. How many orbitals are present in its sublevel? 2. How does this orbital contribute to electron arrangement in atoms?	different orbital shapes in the quantum mechanical model of the atom.
	Option 2	
	Activity: Three Principles *(30 minutes)* **Procedure:** 1. The teacher will give a review on three important principles: • **Aufbau Principle**,**Pauli Exclusion Principle**, and **Hund's Rule**. *2.* Identify which principle is violated and write the correct diagram description. See the table provided in **Annex D.** **Guide Questions** 1. How do these principles help in writing electron configurations? 2. Why are orbital diagrams important in chemistry? 3. How do electron arrangements affect chemical bonding?	This activity is designed to deepen learners' understanding of electron arrangement by applying the three fundamental rules—Aufbau Principle, Pauli Exclusion Principle, and Hund's Rule. From an Instructional Design Framework (IDF) perspective, it follows a guided inquiry. *Note to the teacher:* Encourage students to explain why a diagram violates a principle, not just name the rule.
	Option 3	
	Activity: Electron Orbital Analogy-Boarding House*(30 minutes)* **Procedure:** 1. The teacher will discuss the boarding house, which is a simulation of an electron orbital analogy. 2. He/She will also remind learners that electrons do not literally behave like renters; the analogy only helps visualize orbital filling patterns. 3. After figuring out the boarding house (provided in **Annex E**) and its manager code, the learners will answer the guide questions below for the group presentation. **Guide Questions:** 1. Which floor does the boarding house rent out beds on first? 2. If there were 20 renters, what would the manager's code look like? Identify the main energy level, sublevels, and orbitals.	This activity targets objectives 2 and 3. It uses the "boarding house" analogy to make the abstract process of electron arrangement more concrete and accessible. It follows a constructivist and analogy-based approach. The activity reflects experiential, collaborative, and inquiry-based learning principles as pedagogy. *Note to the teacher:* The analogy is powerful for helping students visualize how electrons fill orbitals. Be explicit that "renters," "rooms," and "floors" only

	3. Which quantum mechanical principle explains why some renters stay alone before sharing rooms?	represent electrons, orbitals, and energy levels—not actual physical behavior.
	B.2. Discussing New Concept	
	Option 1	
	Activity: Guided Lecture-Quantum Numbers *(30 minutes)* Quantum numbers are set of four values that describe the exact "address" of an electron in an atom -its energy level, shape of its orbital, orientation and spin. Earlier models describe electrons as moving in fixed paths, but modern science explains that electrons exist in regions of probability called orbitals. (Refer to **Annex F** for comprehensive discussion and guided lecture.) Guide Questions 1. Why do electrons fill lower energy levels first? 2. What happens when all orbitals in a sublevel are half-filled? 3. Determine the set of quantum numbers for the electrons of the following elements: a.Cl b.Mg c.Sc	This guided lecture targets objectives 2 and 3 by introducing quantum numbers through step by step visual construction of atomic structure. It helps learners connect energy levels, sublevels, orbitals, and electron spins using a scaffolded explicit instruction approach. *Note to the teacher:* Encourage learners to draw each step and explain each quantum number. Address common difficulties, such as confusion between quantum numbers with orbital notation.
	Option 2	
	Activity: Orbital: Probability Cloud *(30 minutes)* **Procedure:** The teacher will discuss the four main types of orbitals and their shape (See **Annex G** for comprehensive discussion.) **A. The Four Main Types of Orbitals and Their Shapes** a. **s** Orbitals (Spherical) b. **p** Orbitals (Dumbbell-shaped c. **d** Orbitals (Clover-shaped**)** d. **f** Orbitals (Multiple Lobes**)** **Guide Questions** 1. How do quantum numbers help explain where electrons are placed and why they follow a specific arrangement in atoms?	This activity targets objectives 2 and 3. It lets the learners visualize where electrons are most likely to be found while connecting shapes to energy and quantum numbers. The activity reflects conceptual and inquiry-based learning as its pedagogy. *Note to the teacher:* When presenting orbitals as probability clouds, emphasize that these are regions of high probability, not fixed paths or exact positions. Use clear visuals and, if possible, gestures to show how shapes differ and how complexity increases from s to f.

	2. List the values of n, ℓ, mℓ for an orbital in the 4d subshell. 3. As the shape of an orbital becomes more complex (more lobes, more nodes), what happens to the energy of the electrons in it? How does shape connect to energy?	
	Option 3	
	Activity: Quantum Number Detective *(30 minutes)* **Procedure**: Divide the class into small groups. Each group gets element cards and then answer the following questions: For each element: 1. Write the electron configuration. 2. Identify the last electron added. 3. Determine its quantum numbers (n, **ℓ**, m**ℓ**, m_s) and accomplish the table in **Annex H**. **Guide Questions:** 1. Why do electrons occupy separate orbitals first? 2. What is the highest occupied orbital among the given elements? 3. How do quantum numbers provide a deeper explanation of electron configuration in atoms?	This activity targets objective 4 for it follows an inquiry-based and task-oriented approach, where students actively construct and analyze element cards and identify patterns in electron arrangement. The activity reflects collaborative and problem-based learning, encouraging learners to work in groups, discuss reasoning, and justify their answers. *Note to the teacher:* Anticipate common difficulties, such as identifying the "last electron," assigning correct mℓ values, or confusing sublevels. Encourage discussion within groups.
	B.3. Developing Mastery	
	Option 1	
	Activity: The "Build-a-Shell" Challenge *(30 minutes)* In this scenario, an atom is a high-rise apartment building. Your job is to assign "tenants" (electrons) to their correct rooms based on the building's strict zoning laws (the Pauli Exclusion Principle and Hund's Rule). **Procedure:** 1. Using a sheet of paper or a whiteboard, create a table for the first three floors (n=1, 2, 3).	From an Instructional Design Framework (IDF) perspective, this activity follows a guided discovery and structured task approach, where learners actively generate valid "addresses" (quantum number sets). Pedagogically, the activity reflects constructivist and collaborative learning principles.

	2. Your goal is to list every possible valid "address" for an electron on those floors. See **Annex I.**) **Guide Questions:** 1. As the floor number (n) increases, what happens to the number of possible room types (l)? 2. How do these quantum numbers help learners to write electron configurations more accurately?	*Note to the teacher:* This activity works best when learners clearly understand that each "address" corresponds to a unique set of quantum numbers.
	Option 2	
	Activity: Orbital Diagram *(30 minutes)* **Procedure:** • Divide learners into groups. Assign elements to each group. • Each group will submit one completed orbital diagram. **Directions for the learners** 1. Identify the set of quantum numbers of the given element. 2. Draw the orbital diagram and identify the highest occupied orbitals. (place arrows ↑↓ representing electrons in the correct orbitals) 3. In two to three sentences, explain how the electron configuration supports the arrangement of electrons in an atom.	This activity targets objective 5. From an IDF perspective, it follows a task-based and application-focused approach. The activity reflects collaborative and inquiry-based learning as learners work in small groups to analyze elements. *Note to the teacher:* Ask learners to justify each answer using electron configuration rules in drawing an orbital diagram, then address misconceptions before moving to the next section.
	Option 3	
	Activity: The Reverse Engineer *(30 minutes)* **Procedure:** 1. Take a standard electron configuration and "decode" the quantum numbers for the **very last electron** added and draw an orbital diagram of the given elements. **a. Helium ($1s^2$)** **b. Carbon ($1s^2\ 2s^2\ 2p^2$)** 2. Learners will do the reverse this time, quantum numbers will be given, and learners will identify the element. Accomplish the table in **Annex J**. **Guide Questions:**	This activity strengthens learners' understanding of the relationship between electron configuration and quantum numbers by engaging them in a "reverse engineering" process. From an (IDF) perspective, it follows an application and transfer-based approach, where students move flexibly between representations. *Note to the teacher:* Provide one guided example before independent or group

	1. How did the quantum numbers help you track the elements? 2. How do the three principles work together to ensure correct answers?	work and then move around the room to check for misconceptions.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1	
	A**ctivity: Real-World Engineering** *(30 minutes)* **Procedure:** Divide students into small groups (2–4 members). Each group will discuss how electron behavior connects to real-world technologies, and then the students will answer the given questions. (Details of the scenarios are provided in **Annex K.**) a. The LED Flash b. The Signature Glow c. Chemical Reactivity **Guide Questions:** 1. How are all three scenarios connected through electron behavior? 2. Why is understanding electron behavior important in engineering and technology?	This activity connects abstract concepts of electron behavior to real-world applications, helping learners see the relevance of atomic theory in everyday technologies. Collaboration and inquiry-based learning are used as pedagogies. *Note to the teacher:* Move around the room during discussions and ask probing questions that push students to make deeper connections across the three scenarios.
	Option 2	
	Activity: Real-Life Connection Stations *(30 minutes)* **Procedure:** Divide the class into three stations. Each station shows a real-life application. (Refer to **Annex M** for different scenarios.) **Guide Questions:** 1. What role do electrons play in all three stations? 2. How are bonding, light, and electricity connected through electron behavior? 3. Why is understanding electrons important in real-life applications?	This activity uses rotating real-life stations to connect electron behavior to bonding, light emission and technology. It reflects active, inquiry-based and collaborative learning as learners observe, predict and explain phenomena. *Note to the teacher:* Orient learners before rotation, emphasizing electron behavior as the common idea. Encourage explanations beyond simple observations.

	Option 3:	
	Activity: Young Scientists at Work *(30 minutes)* **Procedure:** Work with your group (5-6 members per group). Choose one scenario below and then answer the given questions. **Scenario (Choose ONE)** (details of the scenario are found in **Annex N**) ***Scenario 1***: Battery Designer ***Scenario 2***: Fireworks Chemist ***Scenario 3***: Electronics Engineer From your chosen scenario, you must: 1. identify the element; and 2. determine the main energy level, sublevel, and orbitals of the element. **Guide Questions:** 1. How do electron arrangements affect the behavior of atoms in chemical reactions? 2. Why is it important to understand orbitals? 3. How does understanding energy levels and orbitals help in real-life applications?	This activity positions learners as "young scientists," engaging them in authentic, scenario-based tasks that connect electron configuration to real-world applications. It follows a problem-based and contextualized learning approach. Collaborative and inquiry-driven learning are the pedagogies used. *Note to the teacher: P*rompt deeper thinking by asking learners to relate their answers to real chemical properties and applications. Watch for common errors, such as incorrect configurations or weak explanations of electron behavior.
	C.2. Making Generalization	
	Option 1	
	Activity: Mapping the Quantum Numbers *(30 minutes)* **Part A –** Group Brainstorming 1. Divide the class into small groups. 2. Ask students to brainstorm important terms related to quantum numbers.	This activity engages learners in constructing a concept map to organize and connect ideas about quantum numbers, promoting a deeper and more integrated understanding of the topic. From a 2C-2I-1R perspective, it follows a constructivist and knowledge-

	Part B – Concept Map Construction 1. Students will organize the terms by connecting related ideas using arrows or lines. 2. They will write short descriptions for each quantum number. **Guide Questions** 1. What does each quantum number describe? 2. How are energy levels related to sublevels and orbitals? 3. How do quantum numbers help describe electrons completely?	organization approach. Pedagogically, the activity reflects collaborative and visual learning strategies. *Note to the teacher:* Encourage learners to explain how and why concepts are related to each other.
	Option 2	
	Activity: The Quantum Number Challenge *(30 minutes)* Quantum numbers are important in describing the arrangement and behavior of electrons in an atom. **Guide questions:** 1. How do the four quantum numbers work together to describe an electron completely? 2. Why are quantum numbers important in understanding the properties of elements? 3. Write the electron configuration of Sulfur and identify the highest occupied main energy level, the occupied sublevels, and the orbital diagram of the valence electrons.	This activity reflects inquiry-based and higher-order thinking strategies as learners analyze, explain, and connect abstract quantum concepts to observable properties of elements. It is also aligned with 2C2I1R skills because the activity fosters critical thinking skills. *Note to the teacher:* Encourage students to articulate their thinking clearly, either orally or in writing, to strengthen both understanding and communication skills.
	Option 3:	
	Activity: **Three Filling Principles** (*30 minutes)* **Procedure:** 1. Divide the learners into three groups. 2. Assign one filling principle to each group: Group 1 – Aufbau Principle, Group 2 – Pauli Exclusion Principle, and Group 3 – Hund's Rule.	This activity engages learners in analyzing and representing the three key electron-filling rules through group work. Also, it reflects constructivist and inquiry-based learning, encouraging students to actively interpret, and apply scientific rules. It also integrates 2C2I1R

	Directions for the learners: 1. Define the assigned principle in your own words. 2. Draw or illustrate how the principle works using orbital diagrams. 3. Give at least one example of electron arrangement applying the principle, and identify the highest occupied main energy level, the occupied sublevels, and the last occupied orbitals.	skills by promoting critical thinking, and collaboration. *Note to the teacher:* Encourage collaboration by assigning roles (e.g., illustrator, presenter, checker) to ensure active participation of learners.
	C.3. Evaluating Learning	
	Option 1	
	I. Directions: 1. Draw the Orbital diagram of the element Zn. 2. Determine the set of quantum numbers of the element Zn. What is the shape of 3p orbitals?	
	Option 2	
	In this evaluation, learners' understanding and application of **quantum numbers** based on principles from Quantum Mechanics will be evaluated. It progresses from identifying the number of orbitals and electrons in energy levels to applying relationships among quantum numbers, and finally to analyzing the validity of given sets. Overall, it measures both conceptual understanding and reasoning skills in describing electron arrangement in atoms. (Please refer to **Annex P** for the evaluation.)	
	Option 3	
	This evaluation will measure the learners' ability to interpret **quantum numbers** and connect them to the position of elements in the periodic table, grounded on Quantum Mechanics. Students will translate each set of quantum numbers into electron location and identify the corresponding element, demonstrating understanding of electron configuration and atomic structure. (Please see **Annex Q** for this evaluation.)	

	C.4. Additional Activities
	Option 1: Enrichment
	Activity: Extend learning by predicting electron configurations and set of quantum numbers of: Cations & Anions (Na^{+}, Mg^{2+}, Al^{3+}, F^{-}, N^{3-})
	Option 2: Reinforcement
	The teacher may provide an evaluation that will assess the learners' ability to apply **quantum numbers** in determining valid sets and identifying corresponding orbitals and elements based on Quantum Mechanics. (Please refer to **Annex R** for this evaluation.)
	Option 3: Remediation
	The teacher may give multiple-choice evaluation that will gauge the learners' understanding of fundamental principles of electron configuration, including orbital filling order, electron capacity, and key rules such as the Aufbau Principle, the Hund's Rule, and the Pauli Exclusion Principle.
V. ASSESSMENT *(Assessing Learnings)*	**Direction:** Answer the following questions. 1. For $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$, identify the occupied main energy levels and sublevels. 2. Compare the highest occupied sublevel in Na, Mg, and Al using their electronic configurations. 3. Identify the energy level, sublevel, and orbital numbers of the following: a. It is an up-spin 4d electron with an orbital orientation of 0. b. The electron is in the 3rd energy level, p_x-orbital, and down spin. **Performance Task:** Given the electron configuration of three selected elements (Na, Br, & Fe), prepare a one-page comparison showing their highest occupied energy levels, sublevels, orbital occupancy, and one real-world implication of their electron arrangement. (See the attached rubric.)

VI. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was the easiest for learners? Which part was the most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?
VII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot and ChatGPT to improve sentence organization, general draft activity ideas, and refine the clarity of instructions. The author(s) reviewed and finalized the writing of the content. The author(s) takes full responsibility for the final version.

Learning Title/Topic:	**Development of the Periodic Table: Mendeleev's Arrangement, Pattern Recognition, and Prediction of Undiscovered Elements**	**Lesson Exemplar:**	9

I. OBJECTIVES	
A. Content Standard	The learners focus on how Dmitri Mendeleev organized elements by atomic mass and repeating properties, left gaps for undiscovered elements, and demonstrated the power of pattern recognition in science.
B. Performance Standard	Learners explain how Dmitri Mendeleev developed the periodic table by arranging elements according to atomic mass, recognizing repeating properties, leaving gaps, and predicting undiscovered elements.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	• Before learning how Dmitri Mendeleev developed the Periodic Table of Elements, learners should already have a basic understanding of elements and atoms, including the idea that each element is made up of atoms with unique properties. • They should be familiar with the basic structure of the atom—protons, neutrons, and electrons—and how these relate to an element's identity. In addition, learners need prior knowledge of physical and chemical properties, such as observable characteristics and how substances react. • An awareness of early ways scientists classified elements, like grouping them into metals and nonmetals, is also important. • Finally, learners should understand that patterns and trends can exist in scientific data, which will help them appreciate how Mendeleev recognized repeating properties and used these patterns to organize elements systematically.
	The learners explain how Mendeleev developed the periodic table of elements.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• Brown et al. Chemistry: The Central Science. 14th ed. Pearson, 2018. • Department of Education (DepEd). *General Chemistry Curriculum Guide and Learning Modules for Senior High School Science*. Manila, Philippines: Department of Education. • International Union of Pure and Applied Chemistry (IUPAC). "Periodic Table of Elements." Available at: https://iupac.org/what-we-do/periodic-table-of-elements/

	• Royal Society of Chemistry. "Development of the Periodic Table." Available at: http Materials: Teacher Materials: projector, periodic table chart, video link, sample Mendeleev Periodic Table of Elements Learner Materials: element cards, KWL chart templates, scissors, glue, cartolina or bond paper, markers, activity sheets.	
III. CONTENT (Sequencing Content)	Development of the Periodic Table: Mendeleev's Arrangement, Pattern Recognition, and Prediction of Undiscovered Elements	
IV. OBJECTIVES (Setting Clear Objectives and Analyzing the Tasks)	***Unpacked Learning Competencies*** 1. Identify Mendeleev's major contribution to the development of Periodic Table. 2. Describe how he used repeating properties and gaps to predict undiscovered elements. 3. Explain why pattern recognition was important in the development of the periodic table.	
V. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1	
	Activity: KWL-Chart *(10 minutes)* **Procedure:** Learners will write what they know and want to know about the periodic table. They will be paired with their seatmate and share their thoughts about the topic. After sharing their thoughts, learners will be asked to answer the guide questions and present the summary of their answer to the class. **Guide Questions:** 1. What is the most interesting thing you know and want to know the periodic table? 2. Which of your questions were answered?	This activity activates prior knowledge of elements, atomic structure, symbols, and basic properties to help learners understand the Periodic Law and the periodic table. *Note to the teacher:* Ensure learners understand elements, atomic structure, and common properties, such as metals and nonmetals, before starting.

	3. State one idea you are confident about and one idea you are unsure about how elements were organized before the modern periodic table.	
	Option 2	
	Activity: Element Sorting Activity (*10 minutes)* The teacher will divide the class into groups and provide each group with a set of element cards. Learners will observe the cards and classify the elements according to their observable similarities. They will discuss within their groups the basis for their classifications and explain the characteristics or patterns they used in grouping the elements. After the discussion, representatives from each group will present their answers. **Guide Questions**: 1. How did your group classify the elements? 2. What pattern did you notice? 3. Why is classification important in science? 4. How is this similar to what Mendeleev did?	The Element Sorting Activity supports the targeted objectives by engaging learners in organizing elements based on observable properties. This approach promotes relevance and responsiveness (IDF) as students actively interact with materials and relate abstract concepts. *Note to the teacher:* Allow students some freedom on how they group the elements, so they can genuinely engage in pattern recognition.
	Option 3	
	Activity: Picture Analysis *(10 minutes)* Show learners different pictures found in nature. Example: Rainbow, calendar arrangements, musical notes, tile designs, honeycomb structures, etc. Let the learners answer the guide questions. **Guide questions:** 1. What do these examples have in common? 2. What similarities do you observe in the picture? 3. Why is recognizing patterns important? 4. Can patterns help organize information?	The activity uses inquiry-based pedagogy, encouraging learners to draw connections between familiar patterns in nature and abstract scientific concepts. *Note to the teacher:* Tell the learners that just like patterns appear in rainbows, calendars, and music, patterns also appear among elements.

	A.2. Establishing the Purpose of the Lesson *Today, learners will discover how Mendeleev used atomic mass, repeating properties, and gaps to organize elements and predict missing ones.*	
	Option 1	
	Activity: Predict the Missing Element (*20 minutes)* Learners will use patterns in the Periodic Table to predict the properties of an unknown element, just like Dmitri Mendeleev. Refer to Annex A. **Task: Answer the following:** What should be the approximate atomic mass of the missing element? Predict its density Will it be a metal, nonmetal, or metalloid? Describe one possible chemical property **Guide Questions** 1. What pattern do you see in atomic mass? 2. How do properties change from top to bottom?	This activity targets learning objective 1 and is anchored on IDF relevance since learners are guided to understand the application of the concept independently. Inquiry-based and constructivist pedagogy are used in this activity. *Note to the teacher:* Guide learners through this activity. Begin with prompting questions, then allow students to make their own predictions based on observed trends.
	Option 2	
	Activity: Scientist in Action- Role Play *(20 minutes)* Divide the class into 5–6 groups and assign each group one scientist, such as John Newlands, Lothar Meyer, Henry Mosely,or Dmitri Mendele. Each group will research the assigned scientist and prepare a 3-4 minute role-play showing the scientist's contribution to the development of periodic table. Group members may take roles such as scientist,narrator, visual presenter, or supporting cash. After the presentation, each group will answer one or two questions from the teacher or classmates using the guide questions. Refer to Annex B for the rubric.	This activity supports the targeted objectives by immersing learners in the process of scientific discovery, allowing them to actively experience how knowledge about the periodic table was developed. It enhances relevance and responsiveness (IDF). This strategy promotes a constructivist and inquiry-based approach (2C–2I–1R), as learners collaboratively explore ideas. *Note to the teacher* – Guide learners to balance performance with accurate scientific understanding.

	Guide Questions: 1. What was the main contribution of your assigned scientist to the development of the periodic table? How did it differ from what other scientists did? 2. What challenges did scientists face in trying to classify elements before periodic table was fully developed?	
	Option 3	
	Activity: Build the Scientist's Puzzle *(20 Minutes)* **Procedure:** 1. Divide the class into small groups. 2. Give each group a mixed set of element cards containing: Element name, Symbol, Atomic mass, Simple properties. 3. Tell learners that they must arrange the cards in a meaningful way without using the modern periodic table as a reference. 4. Encourage learners to look for: Similar properties, Repeating pattern, and Increasing atomic mass. **Guide Questions:** 1. What patterns did you observe among the elements? 2. What difficulties did you encounter while organizing the elements? 3. Why is classification important in science?	This activity targets objectives 2 and 3 because it reflects a constructivist and inquiry-based approach (2C–2I–1R), as learners analyze relationships, test possible arrangements, and collaboratively refine their thinking. *Note to the teacher:* Focus on guiding students to think through the *process* of organizing information rather than simply completing the task.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1	
	Activity: Meet the Scientist- Timeline Presentation*(30 minutes)* **Procedure:** Divide the class into **5-6 members**. Each group will choose one scientist who contributed to the periodic table and present the scientist's main contribution, evidence, challenge, and importance to chemistry.	This activity targets objective 1 since it explains how pattern recognition led to the development of the periodic table. The activity is grounded on constructivist and inquiry-based pedagogies. *Note to the teacher:* Let the learners explore how scientists used patterns to classify elements and address any misconceptions.

	The group may use a role-play, talk show, skit, dramatization, or multimedia presentation. See **Annex C** for the timeline and rubric.	
	Option 2	
	Activity: Early Periodic Table Comparison *(30 minutes)* ***Procedure*** Let the learners compare the periodic table with the modern periodic table. Accomplish the table to establish comparison between the periodic table and the modern periodic table. See **Annex D** for Table Comparison. **Guide Questions:** 1. What similarities can you observe between Mendeleev's table and the modern periodic table? 2. What differences do you notice in the arrangement of elements? 3. Which table appears more complete? Why?	This activity targets objective 1 since it compares the periodic table with the modern periodic table. The activity is grounded in constructivist and inquiry-based pedagogy. *Note to the teacher:* Guide students to go beyond listing differences and focus on why changes were necessary.
	Option 3	
	Activity: Video Presentation *(30 minutes)* **Procedure:** Show a short educational video about the history and development of the periodic table. Refer to **Annex E** for the video presentation**.** **Guide Questions:** 1. What realization did you gain from the video? 2. Why is the periodic table considered one of the most important tools in chemistry today?	This activity targets objectives 1 and 2. It enables the learners to construct knowledge while integrating visuals, narration, and creativity to explain scientific concepts. *Note to the teacher:* Guide learners to focus on clarity of explanation rather than visual effects.

	B.2. Discussing New Concept	
	Option 1	
	Activity: Guided Discussion *(30 minutes)* The teacher will discuss Mendeleev's contribution to the periodic table, focusing on the arrangement of elements by atomic mass, periodicity, spaces for undiscovered elements, and predictions of eka-silicon, eka-aluminum, and eka-boron. Learners work in groups of 4-5 using a simplified incomplete periodic table and clue cards. After completing the table, each group will present its output. See **Annex F**. **Guide Questions:** 1. Why did Mendeleev arrange elements according to atomic mass? 2. How did his predictions help prove the usefulness of the periodic table? 3. Why is Mendeleev important in chemistry?	This activity targets objectives 1, 2 and 3 since it deals with Mendeleev's contribution to the discovery of the periodic table. The lesson begins with teacher-guided explanation and gradually transitions to student-centered analysis through group tasks and presentations. *Note to the teacher:* Encourage the learners to justify why a space is left blank and how they predict properties of missing elements.
	Option 2	
	Activity: Arrange the Elements *(30 minutes)* **Procedure:** 1. The teacher will divide the learners into groups who will be given a set of element cards similar to those used during Mendeleev's time. 2. Learners will arrange element cards and write a short written explanation of the pattern used, such as increasing atomic mass and similar chemical properties. **Guide Questions** 1. What patterns did you observe among the elements?	This activity targets objectives 1, 2 and 3. The activity is grounded on constructivist and inquiry-based pedagogy as students actively construct understanding by discovering patterns and justifying their classifications. *Note to the teacher:* Encourage active participation of learners for them to appreciate how scientific ideas are developed through observation and logical reasoning.

	2. Which do elements show similar properties? 3. Why is arranging elements systematically important?	
	Option 3	
	Activity: Fill the Gap *(30 minutes)* As a continuation of the discussion, ask learners why Mendeleev left gaps, how he knew some elements were undiscovered, and why his work was important. Learners then complete statements using ideas from the lesson**.** **Completion Statements:*:*** 1. Mendeleev left gaps because _____ 2. He predicted elements by observing _____ 3. Patterns helped scientists _____ 4. Mendeleev's work became important because _____ 5. The discovery of new elements later proved that _____	This activity targets objectives 1, 2 and 3. The activity is grounded on constructivist and inquiry-based pedagogy. Learners actively construct understanding by discovering patterns and justifying their classifications. *Note to the teacher:* In this activity, let the learners analyze the significance of the gaps left in Mendeleev's table and understand how scientific predictions are based on evidence and recurring patterns.
	B.3. Developing Mastery	
	Option 1	
	Activity: Mystery Element *(30 minutes)* Students will be grouped and will be asked to analyze clues to identify elements predicted by Dmitri Mendeleev. The teacher will explain that Mendeleev predicted elements by observing patterns, leaving gaps, and describing unknown elements. Each group will receive a mystery clue card, identify the actual element, match it with Mendeleev's predicted name,	This activity targets objective 2 since it guides the learners to make an analysis of known element properties to independently infer the characteristics of an unknown element, with feedback provided through discussion and justification of the answer. *Note to the teacher:* This activity is designed to develop learners' investigative and analytical skills by allowing

	and explain how the clues fit the element. Also, each group will present the mystery element, clues used, how Mendeleev predicted it, and a brief comparison of the predicted and actual properties. See **Annex G** for clue cards. **Guide Questions:** 1. What clues helped you identify the element? 2. How did patterns help in solving the mystery? 3. Why was Mendeleev's prediction important?	them to identify and predict the characteristics of an unknown element using clues, patterns, and periodic trends.
	Option 2	
	Activity: Mendeleev's Predicted Element Research **Procedure:** Learners will work individually or in pairs for this activity. Each learner or pair will select one of Mendeleev's predicted elements and conduct research using available reference materials. The learners will gather information about the predicted name of the element, the actual discovered element, the year it was discovered, and the scientist responsible for its discovery. In addition, learners will compare the predicted properties with the actual properties of the element and identify its importance and practical uses.	This activity targets objectives 1, 2, and 3. This is grounded on inquiry-based and constructivist pedagogy, as students actively investigate historical and scientific evidence and analyze the accuracy of predictions. *Note to the teacher:* Guide the learners to focus on comparison and analysis, not just information gathering.
	Option 3	
	Activity: Concept Mapping *(30 minutes)* The class will be divided into groups of 4 to 5 learners. Each group will create a concept map that illustrates the relationship among Mendeleev's contributions, the importance of periodicity, and the development of the periodic table.	Grounded on constructivist pedagogy, the activity allows students to actively connect concepts, showing relationships and hierarchies that deepen understanding.

	Learners are expected to include a main concept, at least five keywords, connecting lines or arrows, and brief explanations showing the connections among ideas. After completing the concept map, each group will present its output to the class and explain how the concepts are related to one another.	*Note to the teacher:* Help learners organize and connect important concepts related to the development of the periodic table through visual representation.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1	
	Activity: The Three Prophecies (*30 minutes)* **Procedure:** 1. Divide the class into **three expert groups**. Each group will receive one "prophecy case file. • EKA-ALUMINIUM-GALLIUM • EKA-SILICON-GERMANIUM • EKA BORON- SCANDIUM 2. Each group will research on the discovery and prediction of Mendeleev, with the element assigned to each group. 3. Each group will write their electronic configuration and properties such as atomic mass, appearance, density, and boiling point. 4. Each group will identify the practical applications of each element discovered by Mendeleev.	This activity targets objectives 2 and 3. It encourages the learners to research and learn collaboratively through group discussion and sharing. Grounded on inquiry-based and constructivist pedagogy, the activity engages students in examining real historical evidence, allowing them to compare predictions with actual discoveries. *Note to the teacher:* Help learners to analyze how scientific observation and logical reasoning make accurate predictions.
	Option 2	
	Activity: Jigsaw Teaching *(30 minutes)* **Procedure:** Reorganize groups so that each new group has one expert from Group A, one from Group B, and one from Group C.	This activity promotes collaborative and cooperative learning by assigning learners as “experts” on different topics and requiring them to teach their peers. It aligns with constructivist pedagogy.

	Task: Each expert will teach his or her element's story, predictions, and practical applications to his or her new group members. The group then will complete a comparison chart among the three elements discovered by Mendeleev. Afterwards, the group will complete the table and present the completed table. See **Annex H** for the table.	*Note to the teacher:* This activity encourages accountability and teamwork as each learner contributes information needed for the group's overall understanding.
	Option 3	
	Activity: Design challenge: Build Mendeleev's Periodic Table *(30 minutes)* Learners will imagine that they are Mendeleev in 1869 with a set of 20 element cards. Their task is to organize the elements into a table that shows repeating patterns in properties when arranged by atomic mass. The challenge has three parts: **sort the elements, predict gaps, and evaluate the design**. See **Annex I** for the complete activity guide. **Guide Questions:** 1. You had to decide: arrange by atomic mass or by properties. Which did you prioritize, and why? 2. How did leaving gaps feel as a design decision? Was it hard to accept that your table was "incomplete"?	This activity applies IDF by engaging learners in active collaboration, idea sharing, and critical thinking as they analyze patterns and relationships among elements. *Note to the teacher:* Learners can use periodic trends to estimate the properties of an unknown element, mirroring the logic of Mendeleev's original predictions.
	C.2. Making Generalization	
	Option 1	
	Activity: Patterns, Predictions, and Periodic Table *(30 minutes)* **Procedure:**	This activity promotes inquiry-based and constructivist learning by engaging learners in identifying patterns among elements and using these patterns to make

	Use the concept map which is based on historical accounts of Dmitri Mendeleev's development of the Periodic Table and supported by standard chemistry references such as Brown et al. (2018) and resources from the Royal Society of Chemistry. Afterwards, answer the questions below. (Please refer to Annex J.) **Guide Questions:** 1. How can scientists today use the periodic table to solve real-life problems? 2. How did Mendeleev's discovery show that patterns in elements can be used to organize and predict their properties? (Answers to questions are provided in Annex J.)	predictions about their properties and placement in the periodic table. *Note to the teacher:* This activity is designed to help learners organize and connect important concepts related to the development of the periodic table through visual representation.
	Option 2	
	K-W-L Chart Learners are expected to provide their responses in **"What I Learned."** This is an individual activity. After completing the KWL chart, learners will answer the guide questions. **Guide Questions**: 1. What important contributions did Mendeleev make to science? 2. Why is pattern recognition important in scientific discoveries? 3. What important realization did you gain from learning about Mendeleev's contributions to science?	The final "Learned" component promotes reflection, allowing students to synthesize how pattern recognition led to the discovery of the periodic table. This aligns with the pedagogical strategy where collaborative reasoning and critical thinking are emphasized. *Note to the teacher:* Guide them to write specific ideas, concepts, or realizations related to the topic.

	Option 3	
	Activity: My Science Realization *(30 minutes)* Learners will reflect on the lessons about patterns, periodicity, and the development of the periodic table. The learners will express one meaningful realization about how pattern recognition works in science. **My Realization**: Write your 2-3 sentence realization about pattern recognition in science:	Grounded on constructivist pedagogy, the activity encourages learners to make meaning from their experiences, connect ideas across activities, and evaluate their own understanding. *Note to the teacher-* Encourage learners to appreciate scientific discoveries.
	C.3. Evaluating Learning	
	Option 1	
	The "Discovery Timeline" Comparative Table *(30 minutes)* This helps students distinguish between Mendeleev's original work and the Modern Periodic Table. **Task:** Have students complete a comparison table based on the limitations discussed earlier. (The table is provided in Annex K.)	
	Option 2	
	Activity: Mini Periodic Table Challenge *(30 minutes)* **Procedure:** 1. Learners will create a mini-periodic table on paper or cartolina. 2. They must highlight the elements predicted by Dmitri Mendeleev using colors or symbols. 3. The mini table should include element names and symbols, predicted elements, and labels or notes explaining the predictions. See **Annex L** for the rubric.	
	Option 3	
	Activity: Be Mendeleev: Organize, Predict, and Present (30 minutes) In groups, the learners will arrange element cards by increasing atomic mass and elements with similar chemical properties in the same column. The teacher will identify one gap in the table, and learners will predict the missing element's approximate atomic mass, physical state, type, and reactivity based on observed patterns.	

	The groups will present their output as a poster, short oral presentation, written scientific report, or element card table with reflection. See **Annex M** for the rubric. **Guide Questions:** 1. Explain the significance of Mendeleev's discovery and its impact on modern Science. 2. Connect Mendeleev's discovery to science today. Choose one field (medicine, materials science, electronics, etc.) and explain in 3-4 sentences how the periodic table continues to be used as a scientific tool in that field.
	C.4. Additional Activities
	Option 1: Enrichment
	Activity: Periodic Table Upgrade Challenge *(30 minutes)* Students will work in groups of 5-6 to compare Mendeleev's table with the modern periodic table by upgrading an incomplete or incorrect Mendeleev-style table. Each group will receive a table and element cards, fix the arrangement using patterns in properties and modern organization, then present and explain its revised table. **ESRU Guide Questions** **Elicit:** 'What pattern did you notice?' **Recognize:** 'What repeating properties did you see? **Use**: Can the pattern work with another group of elements? **Evaluate:** 'Does the pattern still work when the missing element is added?
	Option 2: Reinforcement
	Activity: The Periodic Table in Everyday Life - Poster Making Activity Learners will create an informative and creative poster that illustrates the importance of the periodic table, which includes: a. Historical fact b. Pattern identified c. Prediction explained d.Its usefulness today Presentation will follow the poster-making activity. See **Annex O** for the rubric.

	Option 3: Remediation
	Write a short reflection about the following questions: 1. Which activity best helped learners understand how Mendeleev predicted missing elements? 2. Which misconception about the periodic table remained after the lesson? 3. Were learners able to explain why pattern recognition mattered in Mendeleev's work? (Rubrics are provided in **Annex P**).
VI. ASSESSMENT *(Assessing Learnings)*	Please refer to Annex Q for the Assessment.
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of lesson implementation. Reflect on learners' performance, determine which activities and lesson parts were the most and the least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was the easiest for learners? Which part was the most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again? 7. Which activity best helped learners understand how Mendeleev predicted missing elements? 8. Which misconception about the periodic table remained after the lesson? 9. Were learners able to explain why pattern recognition mattered in Mendeleev's work?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used ChatGPT and Gemini for idea generation, activity drafting, and grammar refinement. The author(s) reviewed, validated, and finalized the content. The author(s) takes full responsibility for this.

Learning Title/Topic:	**1. Atomic Radius** **2. Ionization Energy** **3. Electronegativity** **4. Electron Affinity** **5. Shielding Effect and Effective Nuclear Charge** **6. Trends Across Periods and Down Groups**	**Lesson Exemplar:**	10

I. OBJECTIVES	
A. Content Standard	The learners understand that periodic trends arise from variations in electron configuration and effective nuclear charge, allowing the prediction of atomic and chemical properties of elements.
B. Performance Standard	Learners use periodic trends, electron configuration, shielding effect, and effective nuclear charge to compare, explain, and predict the properties of selected elements in written explanations, data-analysis tasks, and real-life applications.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Essential prerequisite knowledge: 1. Atomic Structure and Subatomic Particles 2. main energy levels, sublevels, and orbitals in relation to the electronic configuration of elements
	Learning Competency: Use periodic trends to predict the properties of elements (atomic radius, ionization energy, electron affinity, electronegativity).
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	***Materials:*** periodic table chart, learner activity sheets, meta cards, graphing paper, colored pens, projector or screen, curated trend graphs, teacher-prepared data table, PubChem Periodic Table offline printed copies of all figures for low-tech implementation ***Source of PubChem App*** PubChem Periodic Table - https://pubchem.ncbi.nlm.nih.gov/periodic-table/#property=GroupBlock ***Sources of graphs and pictures:*** Chemistry LibreTexts. "2.11 Trends of the Periodic Table." March 4, 2019. https://chem.libretexts.org/Courses/Grand_Rapids_Community_College/CHM_120_-_Survey_of_General_Chemistry%28Neils%29/2%3A_Atomic_Structure/2.11%3A_Electron_Configurations%2C_Valence_Electrons%2C_and_the_Periodic_Table.

	Chemistry LibreTexts. “3.3: Trends in Ionization Energy.” November 26, 2018. https://chem.libretexts.org/Courses/Oregon_Institute_of_Technology/OIT%3A_CHE_202_-_General_Chemistry_II/Unit_3%3A_Periodic_Patterns/3.3%3A_Trends_in_Ionization_Energy. Chemistry LibreTexts. “Electron Affinity.” October 2, 2013. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_%28Physical_and_Theoretical_Chemistry%29/Physical_Properties_of_Matter/Atomic_and_Molecular_Properties/Electron_Affinity. Chemlin.org. “Diagram: Pauling’s Scale of Electronegativity.” 2024. https://www.chemlin.org/chemical-formulae/fp/pdiagram/pauling-electronegativity-diagram.svg. Chemical Education Xchange. “Periodic Trends Guided Inquiry Activity.” January 28, 2019. https://www.chemedx.org/activity/periodic-trends-guided-inquiry-activity. Worksheets Library. “Periodic Table Template Worksheets Library.” 2024. https://worksheets.clipart-library.com/worksheet/blank-periodic-table-worksheet-29.html.	
III. CONTENT *(Sequencing Content)*	1. Atomic Radius 2. Ionization Energy 3. Electronegativity 4. Electron Affinity 5. Shielding Effect and Effective Nuclear Charge 6. Trends Across Periods and Down Groups.	
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	At the end of the lesson, learners will be able to: 1. define atomic radius, ionization energy, electronegativity, and electron affinity; 2. describe trends across a period and down a group; 3. arrange given elements according to periodic trends; and 4. explain the role of the periodic table in predicting element properties.	
V. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge (Elicit)***	
	Option 1	
	Find the Element’s Position- This activity uses a blank periodic table to help learners identify patterns in groups and periods and relate element placement to atomic structure.	This activity targets objectives 2 and 3 by linking atomic number and periodic structure through collaborative element mapping. It uses Constructivist and Inquiry-based approaches.

	Instructions: Map the given element cards on the blank periodic table without using outside references. Use only the card information and periodic table patterns. After completing the table, answer the guide questions and explain each element's position using electron configuration, energy levels, and valence electrons.	*Note to the teacher:* Use 2–3 diagnostic questions, clarify that rows show energy levels while columns show valence electrons, and address misconceptions about elements in the same row. The blank table and guide questions are provided separately.
	Option 2	
	Activity: Electronic Configuration and the Periodic Table In this activity, students will work in groups to explore how electronic configuration relates to the arrangement of elements in the periodic table. **Instructions:** Identify each element's electronic configuration, valence electrons, and position. Map the elements correctly on a blank periodic table. Observe patterns across periods and groups and then answer the guide questions. Explain one element's placement using atomic structure concepts.	This activity targets objectives 2 and 3 by connecting electron configuration to periodic trends through collaborative analysis. It reflects relevance, responsiveness, and inclusion, using Constructivist and Inquiry-based approaches. *Note to the teacher:* Ask 2–3 diagnostic questions (e.g., identifying the period and family of Li, Na, and K) and correct the misconception that rows indicate valence electrons by explaining that rows show energy levels, while columns show valence electrons.
	Option 3	
	Activity: Atomic Structure and the Periodic Table In this activity, learners will examine how atomic structure relates to element placement in the periodic table. **Instructions:** Complete the table by identifying each element's electron configuration, valence electrons, and position. Then, map the elements on a blank periodic table, observe patterns across periods and groups, answer guide questions, and explain one element's placement using atomic structure concepts.	This activity targets objectives 1, 2, and 3. It manifests relevance and inclusion by connecting electron configuration and atomic structure to element position in the periodic table. It uses Constructivist and Inquiry-based approaches, with drawing and guided questioning as the main pedagogical strategies.

<table>
<tr><td></td><td colspan="2">A.2. Establishing the Purpose of the Lesson (Engage)</td></tr>
<tr><td></td><td colspan="2">Option 1</td></tr>
<tr><td></td><td>The teacher will inform learners that the lesson will focus on properties of elements (atomic radius, ionization energy, electron affinity, electronegativity).

Periodic Trends Vocabulary
Directions: From the given purpose and goal of the lesson, list at least three terms related to periodic trends, then define each term or give an example. Write your answers on a meta-card and post them in the appropriate column.

<table><tr><th>Terms</th><th>Meaning/Description/Example</th></tr><tr><td></td><td></td></tr></table>
Terms: atomic radius, ionization energy, electron affinity, electronegativity, shielding effect, period, family, electronic configuration
What patterns can be observed among the periodic trends, and how does the periodic table help predict the properties of elements?</td><td>This activity targets objectives 1 and 4 by building shared understanding of periodic-trend vocabulary. It reflects relevance and responsiveness using a Constructivist approach through collaborative definition building and class discussion.
For discussion: Review completed terms as a class. Let learners share meanings, clarify misconceptions, and provide examples.

Tech-supported option: Use ClassPoint during synchronous sessions through Google Meet, Zoom, or Microsoft Teams. Prepare two slides: one word cloud for collecting terms and one short-answer slide for meanings, descriptions, or example</td></tr>
<tr><td></td><td colspan="2">Option 2</td></tr>
<tr><td></td><td>Trend Anticipation Guide
Introduce the anticipation guide to build curiosity about properties of elements (atomic radius, ionization energy, electron affinity, electronegativity). The students should agree or disagree with the statements before and after instruction. Facilitate the discussion using the guide questions.</td><td>This activity targets objectives 2 and 4. It manifests relevance by activating prior knowledge and curiosity about periodic trends. It uses an Inquiry-based approach, with prediction and diagnostic questioning as the main pedagogical strategies.

Note to the teacher: The anticipation guide is provided in a separate sheet.</td></tr>
</table>

	Guide Questions: 1. What are the patterns presented in the anticipation guide? 2. Why does position in the periodic table matter? The teacher then explains: *"Today's lesson will help us* predict the properties of elements (atomic radius, ionization energy, electron affinity, electronegativity).	The anticipation-guide statements include intentionally incorrect ideas to surface misconceptions. Revisit each statement after instruction and ask learners to correct it using evidence from periodic trends.
	Option 3	
	Periodic Trends in Action (Group Task) **Instructions:** The class will be divided into four groups. Each group will be assigned one property of elements. Using the given element pair, answer the guide question and explain the reasoning based on periodic trends. After group presentations, ask the students: How does the periodic table help you predict the properties of elements in real-life applications?	This activity targets objectives 1–4 by helping learners reason aloud, make predictions, and refine ideas with peers. It reflects relevance, responsiveness, and inclusion using Collaborative and Inquiry-based approaches. *Note to the teacher:* Use predictions to identify misconceptions, guide discussion toward periodic patterns, and connect each comparison to the correct periodic trend.
B. Instituting New Knowledge	***B.1. Presenting Examples (Explore)***	
	Option 1	
	Activity: From the Position to Trends Analysis Students will work in groups of four to complete the learning activity sheet and submit one group output. They will: 1. complete a table on element positions; 2. plot and analyze graphs on atomic radius and ionization energy; and 3. explain sample graphs for electronegativity and electron affinity in relation to effective nuclear charge and shielding effect.	This activity targets objectives 1–4 by linking numerical data and atomic structure to periodic trends. It uses an Inquiry-based approach through data plotting and guided analysis. *Note to the teacher:* Treat electron affinity as a general trend but remind learners that some elements do not follow a smooth pattern. Use selected examples without presenting the trend as exception-free.

	Processing Question: How does increasing effective nuclear charge across a period explain the decrease in atomic radius and increase in ionization energy? **Expected Output:** Each group will submit the completed graphs and a written answer of at least two sentences using the terms atomic radius, shielding effect, and effective nuclear charge.	**Implementation note:** Use the LAS. Let students graph atomic radius and first ionization energy, while providing ready-made graphs for electronegativity and electron affinity. Focus on pattern recognition, misconceptions, and links to periodic table positions. **Offline alternative:** Provide printed trend maps and teacher-prepared screenshots for learners without internet access.
	Option 2	
	Activity: The Plotted Trend The activity focuses on helping students understand periodic trends such as atomic radius, ionization energy, electronegativity, and electron affinity. Learners analyze how these properties change across periods and groups and explain these trends using concepts like shielding effect and effective nuclear charge. **Instructions:** Work in groups of four and use the PubChem Periodic Table App (or provided printed materials for offline use) to observe patterns in selected elements. Accomplish the following: 1. Select different properties (atomic radius, ionization energy, electronegativity, electron affinity) in the drop down. 2. Observe and compare trends across periods and groups. 3. Answer guide questions explaining the observed patterns. 4. Submit one group output.	This activity targets objectives 1–4 by using visual tools to make periodic trends concrete and accessible. It reflects relevance and inclusion and uses an Inquiry-based approach through guided observation and interpretation. *Note to the teacher:* Treat electron affinity as a general trend but clarify that some elements do not follow a perfectly smooth pattern. **Implementation note:** Use the LAS. The PubChem app may be used online or for blended learning. For on-site classes, use learning stations or two sessions: atomic radius and ionization energy, then electronegativity and electron affinity. **Offline alternative:** Provide printed trend maps and screenshots for learners without internet access.

	Option 3	
	Trend Analysis The activity guides students in analyzing given graphs to understand periodic trends (atomic radius, ionization energy, electronegativity, and electron affinity) and explains these using shielding effects and effective nuclear charge. **Instructions:** Work in groups to interpret trend diagrams, identify patterns across periods and groups, and answer the guide questions to explain the observed trends using key concepts. **Expected output:** In groups of four, submit a written answer of the guide questions and explanation containing at least two sentences that use the terms atomic radius, shielding effect, and effective nuclear charge.	This activity targets objectives 1, 2, and 4 by reinforcing correct interpretations of periodic trends through Guided Inquiry, graph analysis, group discussion, and teacher questioning. *Note to the teacher:* Treat electron affinity as a general trend, noting that some elements do not follow a smooth pattern. **Implementation note:** Let students graph atomic radius and first ionization energy, then interpret prepared graphs for electronegativity and electron affinity. After each task, use one strong explanation and one misconception for discussion. **Accessibility note:** Provide printed diagrams, enlarged tables, and a word bank.
	B.2. Discussing New Concept (Explain)	
	Option 1	
	Claim-Evidence- Reasoning **Instruction:** In groups of four, complete the CER table in 10 minutes, submit one group output, and prepare one evidence-based explanation using the terms period, group, shielding effect, and effective nuclear charge. **Processing questions:** 1. How does atomic size influence ionization energy in the examples above? 2. Why do elements on the right side of the periodic table tend to have higher electronegativity and electron affinity? 3. How do shielding and energy levels affect the trends seen in Mg vs Sr and Li vs F? 4. If Ga and K formed ions, which would lose an electron more easily? Why?	This activity targets objectives 1–4 by strengthening scientific reasoning and justification skills. It reflects relevance and inclusion and uses Inquiry-based approach through CER construction and presentation. **Implementation note:** Facilitate CER sharing, address unsupported reasoning, and connect explanations to periodic trends and atomic structure, including atomic radius, ionization energy, electronegativity, and electron affinity. **Teacher action:** Use one strong explanation and one misconception after each task to guide the next mini discussion.

	Option 2	
	Spot the error The activity develops students' understanding of periodic trends by identifying incorrect statements and correcting them using concepts like atomic radius, ionization energy, electronegativity, and electron affinity. **Instructions:** 1. Four statements made by a "Confused Chemist" are provided in a table. In groups of four, complete the table in 10 minutes, submit one group output, and prepare one evidence-based explanation using the terms period, group, shielding effect, and effective nuclear charge 2. Answer the guide questions that follow.	This activity targets objectives 1, 2, and 4 by addressing misconceptions about periodic trends. It reflects responsiveness and uses Collaborative and Guided Inquiry approaches through group analysis, guide questions, discussion, and synthesis. *Note to the teacher:* Use student explanations to diagnose misconceptions, reinforce correct trend reasoning, and explain how periodic position affects element behavior. **Teacher action:** Use one strong explanation and one misconception after each task to guide the discussion.
	Option 3	
	Guided Discussion The part develops students' understanding of periodic trends through guided discussion, allowing them to analyze patterns in atomic radius, ionization energy, electronegativity, and electron affinity and relate these to atomic structure. The teacher will use a guided inquiry approach by following this outline: I. **Introduction** – Present element data (atomic number, electron configuration, etc.). II. **Guided Questioning** – Identify patterns in period, group, valence electrons, and energy levels. III. **Understanding Arrangement** – Explain organization of the periodic table. IV. **Teacher Input** – Define periodic trends and key properties. V. **Deepening Understanding** – Discuss trends in: • Atomic radius	This activity targets objectives 1–4. It manifests relevance and responsiveness by synthesizing atomic structure, position, and trends into coherent explanations. The teacher uses a guided inquiry approach by presenting data, asking structured questions, explaining key concepts, and engaging students in discussion and comparison tasks to deepen understanding. *Note to the teacher:* For this lesson, treat electron affinity as a general trend, but remind learners that some elements do not follow a perfectly smooth pattern. Use selected examples to emphasize the trend without overstating it as exception-free. **Implementation note:** 1. Facilitate discussion by consistently linking observations to periodic position, clarify misconceptions, and emphasize cause–effect relationships behind each trend.

- Ionization energy
- Electronegativity
- Electron affinity

VI. **Comparison Questions** – Compare elements using trends.

VII. **Application Activity** – Arrange elements based on given trends.

2. Use the diagram to point out the direction of increasing and decreasing trends, then ask learners to connect the arrows to electron configuration and effective nuclear charge.

B.3. Developing Mastery

Option 1

Sequencing Challenge

Instructions: Each row below shows a set of elements and a specific periodic trend. Arrange the elements in the correct order based on the trend indicated.

Set of Elements	***Trend***	***Answer***	***Justify your answer in I-2 sentences***
K, F, Ba, Pb, B, and I	decreasing atomic radius		

This activity targets objectives 1–4. It manifests relevance by engaging learners in ordering elements using trend logic. It uses Inquiry-based approach, with sequencing and short justification as the main pedagogical strategies.

Note to teacher: The complete ***Sequencing Challenge*** is provided in a separate sheet.

Option 2

Comparison Problems

Instruction: For each pair, circle the element that best fits the description.

	Justify your answer in 1 sentence
1. Larger atomic size: K or Ca	
2. Higher ionization energy: Mg or Sr	
3. Higher electronegativity: P or Se	

This activity targets objectives 1–4. It manifests relevance and inclusion by requiring concise application of periodic trends to paired elements. It uses Inquiry-based approach, with comparison and one-sentence justification as the main pedagogical strategies.

	4. Greater electron affinity: O or S 5. Smaller atomic radius: Na or Cl	
	Option 3: Structured Problem-Set	
	This structured problem-set activity helps students analyze periodic trends such as electronegativity, ionization energy, atomic radius, and electron affinity. It strengthens critical thinking by requiring comparisons of elements within groups and periods based on their properties. Students will examine groups of elements. They will analyze their properties using periodic trends to identify which one best fits each given characteristic based on logical reasoning and their understanding of the periodic table.	This activity targets objectives 1–4 by reinforcing systematic use of periodic trends in grouped elements. It reflects responsiveness and uses Inquiry-based approach through guided problem solving. *Note to the teacher:* Treat electron affinity as a general trend with exceptions. Use selected Grade 12-appropriate examples without presenting the trend as perfectly smooth.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application (Elaborate)***	
	Option 1: Material Selection Challenge	
	Scenario: Selecting materials for specific purpose ***Essential questions:*** 1. How does the relatively low ionization energy of metals relate to their tendency to lose electrons, and how does this property contribute to their common uses? 2. How does potassium's ability to lose electrons relate to its use in batteries and fertilizers? 3. Why is chlorine effective in disinfecting drinking water and swimming pools? ***Required output:*** Choose one (1) to answer. Make three to four sentence justification linking trends to the application.	This activity targets objectives 1, 2, and 4. It manifests relevance by connecting ionization energy to real-world material use. It uses an integrative approach, with application-based reasoning as the main pedagogical strategy.

	Option 2: Periodic Trends in Daily Products	
	Instruction: Choose one item commonly used at home or in the community such as iodized salt, bleach, aluminum cookware, or fertilizer and explain how a periodic trend helps account for one of its useful properties.	This activity targets objectives 1, 2, and 4. It manifests relevance and inclusion by linking periodic trends to familiar household products. It uses an integrative approach, with real-world explanation as the main pedagogical strategy. *Note to the teacher:* Encourage students to identify the relevant trend and explain its contribution to product properties, using examples like iodized salt, bleach, aluminum cookware, fertilizer, and common metals.
	Option 3: Real-Life Safety Analysis	
	Instruction: *s*Below are questions regarding elements and their trends. Choose one (1) question to answer. 1. Why must sodium be stored in oil, and how does its large atomic radius contribute to its high reactivity with air and water? 2. Why are less reactive metals, which have higher ionization energies, preferred for use in construction materials? 3. Why are halogens used in disinfectants, and how does their high electronegativity make them effective but dangerous if not handled carefully? 4. Why do halogens readily gain electrons due to their high electron affinity, and how does electron affinity help predict this behavior in practical contexts such as disinfectants? Safety note: This activity is for analysis only. Do not handle sodium, chlorine-containing substances, or any reactive chemicals unless the teacher provides proper safety supervision and equipment.	This activity targets objectives 1, 2, and 4. It manifests relevance and responsibility by connecting periodic trends to reactivity and safety. It uses an integrative approach, with trend-based analysis of hazards as the main pedagogical strategy. *Note to the teacher:* Emphasize the idea that periodic trends such as atomic radius, ionization energy, electronegativity, and electron affinity explain why some elements react easily, why others are stable, and why elements are used differently in daily life. **Safety reminder:** The lesson discusses hazardous substances for conceptual analysis only. No learner should handle reactive metals or halogens without teacher supervision and proper protective equipment.

C.2. Making Generalization

Option 1: The "Big Picture" Generalization

Summarize the trends of the properties of the elements in the periodic table. Complete the table below.

Trend Direction	Atomic Radius	Ionization Energy	Electrone gativity	Electron Affinity
Period: Left → Right				
Family: Top → Bottom				

This activity targets objectives 1, 2, and 4. It manifests responsiveness by synthesizing learning into a unified understanding of trends. It uses a reflective approach, with summary table completion as the main pedagogical strategy.

Option 2: Anticipation Guide Continuation

Use the same anticipation guide. Ask the students to answer the "after" part. Verify with the student what changed in their responses.

This activity targets objectives 2 and 4. It manifests inclusion by allowing all learners to express understanding and questions. It uses a reflective approach, with self-assessment and synthesis as the main pedagogical strategies.

Option 3: Exit Ticket (Quick Check)

Students will reflect on their learning about periodic trends before leaving the lesson. They will use the 321 Exit Ticket:

3	Things you learned	Key Takeaways from the discussion
2	Things you found interesting	Concepts, facts or real-world applications that stood out
1	Question you still have	Any unclear points or topics you would like to explore further

This activity targets objectives 2 and 4. It manifests inclusion by allowing all learners to express understanding and questions. It uses a reflective approach, with self-assessment and synthesis as the main pedagogical strategies.

Follow-up note: Use the 3-2-1 exit ticket responses to identify one misconception to address at the start of the next lesson.

C.3. Evaluating Learning (Evaluate)

Option 1: Periodic Trends Assessment

Readiness check: compare the two elements along our periodic trends then justify one answer in a sentence before proceeding to the graded evaluation.

	Compare (>)	Justification
Atomic Number: As and F		
Ionization Energy: As and F		
Electronegativity: Sr and Si		
Electron Affinity: Sr and Si		

Periodic Trends Assessment

This assessment evaluates students' understanding of periodic trends by requiring them to define key properties (atomic radius, ionization energy, electronegativity, and electron affinity), identify trends using arrows, and explain the reason behind these patterns.

Instructions: Complete the table by matching definitions and indicating trends (↑ or ↓). Then, answer the question in one sentence. For Part II, arrange the elements and give brief justifications based on periodic trends.

This activity targets objectives 1–4 by requiring learners to define periodic properties, describe trend directions, and arrange elements with justification. It reflects relevance and responsiveness and uses Inquiry-based approach through individual written responses.

Note to the teacher: Check accuracy of definitions and trends; ensure explanations using periodic position or shielding and address common errors. Before C.3, learners justify one trend using electron configuration, shielding, and effective nuclear charge. Provide simplified tables and partial models for learners who need support.

Option 2: Sequencing Problem Set

Readiness check: Compare the two elements along our periodic trends then justify one answer in a sentence before proceeding to the graded evaluation.

	Compare (>)	Justification
Atomic Number: As and F		
Ionization Energy: As and F		
Electronegativity: Sr and Si		
Electron Affinity: Sr and Si		

Sequencing Problem Set

In a table, each row below shows a set of elements and a specific periodic trend. Given three unfamiliar sets of elements, predict the relative order of the specified property and justify each answer in one or two sentences using periodic trends.

This activity targets objectives 1–4 by assessing learners' ability to apply periodic trends to unfamiliar element sets. It reflects relevance and uses Inquiry-based approach through sequencing and brief justification.

Note to the teacher: Emphasize justification over memorization, require references to trend direction, and address sequencing errors during feedback.

Teacher feedback: Display the correct order and ask learners to explain one ordering decision aloud.

The complete sequencing problem set is provided in a separate sheet.

Option 3: Periodic Trends Practice: Comparing Element Properties

Readiness check: Compare the two elements along our periodic trends then justify one answer in a sentence before proceeding to the graded evaluation.

	>	Justification
Atomic Number: As and F		
Ionization Energy: As and F		
Electronegativity: Sr and Si		
Electron Affinity: Sr and Si		

This activity targets objectives 1, 2, 3, and 4. It manifests responsiveness by checking students' accuracy and speed in applying periodic trends to element pairs. It uses Inquiry-based approach, with quick comparison and concise justification as the main pedagogical strategies.

Note to the teacher: Encourage students to mentally identify the relevant trend for each pair and clarify common errors during review.

	Periodic Trends Practice: Comparing Element Properties In this activity, learners will compare pairs of elements to identify which one best fits a given property based on periodic trends such as atomic size and ionization energy. The students will encircle the element in each pair that matches the described property.	The complete **Periodic Trends Practice set** is provided in a separate sheet.
	C.4. Additional Activities (Extend)	
	Option 1: Periodic Trends Remediation Activity	
	This remediation activity helps students reinforce their understanding of periodic trends by graphing atomic radius, ionization energy, and electronegativity using a blank periodic table and a given data set. It focuses on visualizing patterns and connecting them to atomic structure. **Instructions:** 1. Use the provided data set and a blank periodic table. 2. Draw **circles** to represent atomic radius. 3. Draw **red energy bars** for ionization energy. 4. Draw **blue energy bars** for electronegativity. Ensure that the size or height reflects the relative values shown in the data. 5. After graphing, answer the guide questions and complete the concept statements based on your observations.	This activity targets objectives 1, 2, and 4. It manifests responsiveness by reinforcing concepts through visual modeling. It uses a constructivist approach, with guided drawing and explanation as the main pedagogical strategies. **Accommodation notes:** For learners who need support, provide a partially filled trend table and a word bank. For advanced learners, require a written justification and one exception to a general trend.
	Option 2: Enhancement Activity: Periodic Trends CER Worksheet	
	In this activity, learners apply the Claim–Evidence–Reasoning (CER) framework to analyze periodic trends by ordering elements based on required properties. The students will complete the table by stating a claim, providing evidence, and explaining reasoning to support the order of elements from smallest to largest atomic size.	This activity targets objectives 1–4 by deepening reasoning about periodic trends within a single period. It reflects relevance and uses Inquiry-based approach through evidence-based justification. *Note to the teacher:* The complete Periodic Trends CER Worksheet is provided separately.

<table>
<tr><td></td><td></td><td>Accommodation note: Provide a partially filled trend table and word bank for learners who need support. For advanced learners, require a written justification and one exception to a general trend.</td></tr>
<tr><td></td><td colspan="2">Option 3: Enhancement Activity: Predict the Trends</td></tr>
<tr><td></td><td>Instruction: Based on their positions in the periodic table, predict the following:
1. Mg, Sr, Si, Cl, I
A. Which element has the smallest atomic radius?
B. Which element has the largest atomic radius?
2. Li, Rb, N, F, I
A. Which element has the lowest ionization energy?
B. Which element has the highest ionization energy?</td><td>This activity targets objectives 1–4. It manifests relevance by strengthening prediction skills across varied element sets. It uses Inquiry-based approach, with trend-based comparison and justification as the main pedagogical strategies.
Note to the teacher: The complete Predict the Trends Worksheet is provided in a separate sheet.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Performance Task:
Your best friend has missed the last two weeks of school because he/she got sick. He/she asked you to explain what we have been working on in class so he/she can be prepared for the test when he/she returns next week.
Prepare a one-page study guide for your best friend. Include the four periodic properties, trend directions, one reason for each trend, and two solved comparison examples.
Performance-task extension: Include one original comparison question using an unfamiliar set of elements and provide a brief explanation of the answer.</td></tr>
<tr><td>VII. REFLECTION
(Feedback and Continuous Improvement)</td><td colspan="2">Use the following reflection prompts to guide your evaluation of the lesson implementation. Reflect on learners' performance, determine which activities and lesson parts were the most and the least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery.
1. How many learners successfully demonstrated the learning objectives based on the assessment results?
2. Which activity helped learners understand the lesson the most? Which activity helped the least?
3. Which part of the lesson was the easiest for learners? Which part was the most difficult?
4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support?
5. What did the assessment results show about learners' understanding of the lesson?
6. What improvement would you make if you taught this lesson again?</td></tr>
</table>

	Additional reflection prompt: Which of the four target properties—atomic radius, ionization energy, electronegativity, or electron affinity—showed the weakest learner mastery, and what reteaching step will be used next? ***Use of reflection evidence:*** Exit-ticket misconceptions will be grouped into 'needs reteaching,' 'ready for enrichment,' and 'ready for assessment' to guide the next lesson's opening activity. Use exit-ticket and assessment evidence to classify learners for reteaching, guided practice, or enrichment in the next lesson.
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar, the author used Gemini AI to check draft statements in the anticipation guide, generate graph for electronegativity and electron affinity and to help draft an initial rubric for the assessment. The author reviewed, revised, and finalized all content and takes full responsibility for the finished LE.

Learning Title/Topic:	**1. Atomic Structure** **2. Isotopes** **3. Radioisotopes** **4. Radiation Types**	**Lesson Exemplar:**	11

I. OBJECTIVES	
Content Standard	The learners learn that radioisotopes may occur naturally or be human-made and can be described in terms of the type of radiation they emit.
Performance Standard	The learners prepare and communicate accurate explanations, tables, or information materials that classify selected radioisotopes as natural or human-made and describe their emission type and half-life.
Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners recall atomic structure, the roles of protons, neutrons, and electrons, and the idea that isotopes are atoms of the same element with different numbers of neutrons.
	Learning Competency: Identify natural and human-made radioisotopes and their properties in terms of the type of radiation emitted and their half- life.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. Chemistry: The Central Science. 14th ed. Pearson, 2018. OpenStax. Chemistry 2e. OpenStax, 2019. U.S. Environmental Protection Agency. “Radionuclide Basics: Cobalt-60.” U.S. Environmental Protection Agency. “Radionuclide Basics: Iodine-131.” Materials: printed isotope cards, reference tables, calculator, worksheets, manila paper, markers, projector or TV, optional simulation/video links
III. CONTENT *(Sequencing Content)*	Atomic Structure Isotopes Radioisotopes Radiation Types · Alpha (α): Heavy particles that can be stopped by paper or skin · Beta (β): Fast-moving electrons that can penetrate light materials · Gamma (γ): High-energy electromagnetic waves that require thick shielding like lead Half-Life Applications

IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Classify selected radioisotopes as natural or human-made. 2. Identify the type of radiation emitted by selected radioisotopes. 3. Compare radioisotopes based on half-life and rate of decay. 4. Predict the remaining mass of a radioactive sample after a given number of half-lives.	
V. PROCEDURES		**ANNOTATIONS**
Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1: What Makes Up Atomic Mass?	
	This review activity helps students recall that mass number is the sum of protons and neutrons. They will practice identifying these particles, calculating mass numbers, and explaining why atoms of the same element can have different masses. **Instruction:** Conduct a review about atomic mass. Use the questions provided in the review notes.	This activity targets learning objectives 1 and 3 by helping learners understand isotopes and radioisotopes through protons, neutrons, and atomic mass. It uses a constructivist approach through guided recall, calculation, and explanation. *Note to the teacher:* Review notes are provided in a separate sheet.
	Option 2: Build the Atom	
	This activity focuses on engaging participants in a meaningful task that promotes understanding, participation, and skill development related to the given topic. It encourages collaboration and critical thinking through guided steps and interaction. It also helps reinforce key concepts by allowing learners to apply what they have learned in a practical way. **Instructions:** Complete the table below by filling in the number of protons, neutrons, and electrons for each element. Then, draw a simple atomic model (Bohr model) showing the nucleus (protons + neutrons) and electrons in shells.	This activity targets objectives 1 and 3 by helping learners explain how changes in neutrons affect atomic mass, isotopes, radioisotopes, and stability. It uses a constructivist approach through guided questioning, table completion, and atomic modeling. *Note to the teacher:* After a brief isotope review, proceed to the idea that some isotopes are unstable and radioactive.
	Option 3: "True or False" Sort	
	Present each statement to the class one at a time or display them all on the board. Ask students to identify whether each statement is a “Fact” or “Fiction” by writing their answers in their notebooks or raising labeled cards (Fact/Fiction). Facilitate a brief discussion after	This activity targets objectives 1 and 3 by reinforcing atomic structure, atomic mass, and isotopes as foundations for understanding radioisotopes. It uses constructivist and

	each item to explain the correct answer and address misconceptions, instead of using a prepared table. A. Adding a neutron to an atom makes it heavier but keeps it the same element. B. Electrons are the heaviest part of the atom. C. The atomic mass is found by adding protons and electrons. D. The nucleus contains nearly 100% of an atom's total mass. E. Neutrons have no electrical charge, so they do not have any mass.	inquiry-based strategies through fact–misconception sorting and guided explanation. *Note to the teacher:* After a brief isotope review, proceed to the idea that some isotopes are unstable and radioactive.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: What are Isotopes?	
	Instructions: Match the given elements into pairs. Afterwards, answer the guide questions. Carbon-12, Chlorine-37, Hydrogen-2, Carbon-14, Chlorine-35, Hydrogen-1 Guide Questions: 1. Are they the same element or different elements? 2. What number tells us the element's identity? 3. What are isotopes, and how do radioisotopes differ from them?	This activity supports objectives 1 and 2 by helping students distinguish isotopes and understand how neutron number affects them. It uses Constructivist and Inquiry-based approaches with matching and guided discussion to connect atomic identity, mass number, and isotopes, including stable and radioactive ones. *Note to the teacher:* After a brief isotope review, add this bridge statement: "Some isotopes are stable, while others are unstable and release radiation. These unstable isotopes are called radioisotopes, and they can be described by the type of radiation they emit and by their half-life."
	Option 2: The Isotope Match-Up	
	This activity engages students in identifying and comparing isotopes by calculating mass number based on the number of protons and neutrons. It helps learners understand how atoms of the same element can have different masses while sharing the same number of protons. Through analysis and guide questions, students develop a deeper understanding of isotopes and how radioisotopes differ from stable atoms.	This activity targets objectives 1 and 2. It manifests relevance, responsiveness, and inclusion by helping students compute atomic mass and recognize that atoms of the same element may differ due to varying numbers of neutrons. It uses Constructivist and Inquiry-based approaches, with guided calculation,

	Instruction: Calculate the masses of 4 different "Mystery Atoms" and write their element symbols with their mass number.	matching, and concept discussion as the main pedagogical strategies.
	Option 3: The Case of Atoms of the Same Element	
	Scenario: Two atoms belong to the same element because both have 6 protons, which gives them the same atomic identity. However, they have different masses because they contain different numbers of neutrons. Atom A has 6 protons and 6 neutrons, while Atom B has 6 protons and 8 neutrons. Your task is to investigate why atoms of the same element can have different masses and explain what makes these atoms unique. Guide questions/items: 1. Are Atom A and Atom B the same element? Why? 2. Calculate the mass number of each atom. 3. Which subatomic particle causes the difference in mass between Atom A and Atom B? 4. Which subatomic particle determines the identity of an element, and which particle has the greatest effect on atomic mass? 5. What are isotopes and how do radioisotopes differ from them?	This activity targets objectives 1 and 2. It manifests relevance, responsiveness, and inclusion by engaging students in investigating why atoms of the same element can have different masses and what makes them unique. It uses Constructivist and Inquiry-based approaches, with guided investigation, calculation, and explanation through questioning as the main pedagogical strategies.
Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1:What are radio isotopes?	
	This activity introduces students to radioisotopes by examining their sources, types of radiation, and half-lives using a reference table. It develops analytical skills as students identify patterns, compare properties, and draw conclusions about radioactive decay and stability. **Instructions:** Study the reference table carefully, then answer the analysis questions based on the given data. Support your answers using evidence from the table and explain your reasoning clearly.	This activity targets objectives 1–3 by having students analyze radioisotope data to compare sources, radiation types, half-lives, and decay rates. *Note to the teacher:* Present radioisotopes for comparison only. Guide students to compare alpha, beta, and gamma radiation by energy and penetration. Note that heavier elements often emit alpha and emphasize that half-life is not directly based on mass or radiation type.

	Option 2: The Radioisotope Sorting Lab	
	The Radioisotope Sorting Lab engages students in classifying isotopes based on their decay mode and half-life, helping them understand how radiation type and decay rate determine grouping and real-world applications. **General Instruction:** Use the reference table to classify each isotope into Categories A–D based on the given criteria, then answer the analysis questions using evidence from the data.	This activity supports objectives 1–3 by helping students classify radioisotopes using real data on radiation type and half-life. It uses Inquiry-based and Constructivist approaches with sorting, classification, and guided analysis. *Note to the teacher:* Radioisotopes are shown to highlight differences in sources, radiation types, and half-lives—not in a strict sequence. The goal is to compare natural vs. human-made isotopes, radiation types, and how long they last.
	Option 3: *Path Classification*	
	This activity allows learners to classify radioisotopes based on their radiation type (gamma vs. non-gamma) and half-life duration. By analyzing patterns in decay mode and stability, students will build their understanding of how radioisotopes are grouped and how these properties affect their detection and applications. **Instructions** 1. Study the reference table. 2. Sort isotopes into Gamma-Detected or Non-Gamma groups. 3. Classify each by half-life: Very Short, Moderate, or Extremely Long. 4. Combine both criteria for final classification. 5. Answer analysis questions using evidence from the table.	This activity targets objectives 1–3 by guiding students to classify radioisotopes using decay mode and half-life. It uses inquiry-based learning through guided data analysis, sorting, and reflective questioning. *Note to the teacher:* The complete Path Classification activity is provided in a separate sheet. **Teacher Support Note:** Provide a vocabulary guide and read key parts of the reference table aloud before learners classify the radioisotopes.
	B.2. Discussing New Concept	
	Option 1: Exploring Radioisotopes and Decay	
	In this activity, students will explore radioisotopes and radioactive decay using a reference table. They will analyze information to complete a Claim–Evidence–Reasoning (CER) table, answer guide questions, and solve problems involving half-life. The activity helps students understand how radiation type, origin, and half-life affect the behavior and mass of radioisotopes over time.	This activity supports objectives 1–4 by having students analyze radioisotope data using Claim–Evidence–Reasoning and guided computation. *Note to the teacher:* Complete activity sheet is provided separately. Provide a vocabulary guide

	Instructions: a. Study the reference table. b. Complete the CER table using the data. c. State a claim, provide evidence, and explain your reasoning. d. Answer all guide questions clearly. e. Show solutions for computations.	and read key reference-table parts before classification. **Core target:** Classify radioisotopes as natural or human-made and identify emission type and half-life. **Extension target:** Explain selected uses, risks, and simple decay equations.
	Option 2: Read between the Rays: Radioisotopes, Radiation, and Half-Life	
	This activity will be done in groups. The teacher will provide copies of reading text related with Radioisotopes, Radiation, and Half-Life, Before the learners gather by group, the teacher will also share the discussion questions as guide for the learners as they read. **General Instructions:** a. Form groups as assigned by the teacher. b. Read the given text carefully within your group. c. Use the guide questions to discuss and understand the content. d. Work collaboratively to answer all questions clearly and accurately.	This activity supports objectives 1–4 through guided reading and analysis of radioisotopes, radiation types, and half-life. *Note to the teacher:* Guide learners in predicting products of alpha, beta, and gamma decay to support nuclear equation writing. Use the processing notes as reference. The complete activity sheet is provided separately.
	Option 3: Radioactive Decay Analysis	
	This activity is designed to develop your understanding of radioactive decay through classification, analysis, and computation. You will use the reference table to identify radioisotopes, classify them by origin and emission type, write nuclear equations, and solve half-life problems. Your responses should be clear, accurate, and supported by proper reasoning. **Instructions:** Read the reference table carefully. Answer all guide questions using the given data. Classify radioisotopes and identify their emission types correctly. Show complete solutions for all computation problems. Write clear and correct nuclear equations where required.	This activity targets objectives 1–4 by engaging students in analyzing radioisotope data and applying concepts of radiation, half-life, and decay. It uses Inquiry-based and Constructivist approaches through data interpretation, equation writing, and problem-solving. **Teacher support note:** Provide a vocabulary guide and read the key parts of the reference table aloud before asking learners to classify the radioisotopes.

	B.3. Developing Mastery	
	Option 1: *Radioisotope Information Sheet Analysis*	
	Read each question carefully and answer completely. Show your solution for computation problems and justify your answer in one sentence using the given radioisotope information. Use the sample model as a guide and make sure to show clear solutions and accurate answers for each item. Sample model: Initial mass = 48 g After one half-life, 48 ÷ 2 = 24 g After two half-lives, 24 ÷ 2 = 12 g Therefore, the amount remaining after two half-lives is 12 g.	This activity targets objectives 1–4 by guiding students to analyze Technetium-99m in terms of production, radiation type, half-life, classification, and decay prediction. It uses Inquiry-based approach through guided analysis, equation writing, and half-life calculation. *Note to teacher:* The complete activity sheet is provided separately.
	Option 2: Problem Set	
	This activity is designed to strengthen your understanding of radioisotopes through independent problem-solving. You will identify emission types, solve half-life computations, compare decay rates, and write nuclear equations. Use the sample model as a guide and make sure to show clear solutions and accurate answers for each item. Sample model: Initial mass = 48 g After one half-life, 48 ÷ 2 = 24 g After two half-lives, 24 ÷ 2 = 12 g Therefore, the amount remaining after two half-lives is 12 g.	This activity targets objectives 2, 3, and 4. It manifests relevance and responsiveness by requiring students to independently apply concepts of radiation type, half-life, decay rate, and mass remaining through computation and equation writing. It uses Inquiry-based approach, with individual problem solving and mathematical reasoning as the main pedagogical strategies.
	Option 3: Radioisotope Decay and Half-Life Analysis Table	
	This activity provides students with the partially completed table on Phosphorus-32. Students will fill in the missing information, including the beta decay equation, classification (natural or man-made), and the remaining mass after three half-life cycles. The teacher will guide the students to show their solutions clearly and use	This activity targets Learning Objectives 1, 3, and 4 by guiding students to analyze a radioisotope's properties and apply half-life concepts. It uses Inquiry-based approach through table completion, equation writing, and guided calculations.

	appropriate nuclear symbols and calculations when completing the task.	
Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1: *Nuclear Application*	
	Activity Flow: The teacher will present real-life uses of radioisotopes in medicine, industry, and the environment, including examples from local contexts. **Prompt:** "How are radioisotopes used safely in different fields of life?" Learners share initial ideas. The teacher will assign tasks on classification, explanation of applications, and half-life calculations, emphasizing the role of radioisotopes in solving real-world problems.	This activity targets objectives 1, 3, and 4 by linking radioisotope properties, such as emission type, half-life, and decay rate, to medical diagnosis and treatment. It uses an integrative, Inquiry-based approach through classification, guided explanation, and half-life computation. *Note to the teacher:* The Nuclear Application Activity is provided in a separate sheet.
	Option 2: Home and Industry Safety	
	Activity Flow: The teacher will present examples of Americium-241 and Iridium-192 used in household safety and industry. **Prompt:** "How can radioactive materials be safely used in everyday life and industry?" Learners will share responses. The teacher will assign tasks on classification, half-life computation, and explanation of uses and safety, emphasizing real-world applications.	This activity targets objectives 1, 3, and 4 by linking radioisotope properties, such as radiation type, half-life, and decay rate, to household and industrial safety. It uses integrative, Inquiry-based approach through classification, guided explanation, and half-life computation. *Note to the teacher:* Separate Home and Industry Safety activity sheet and answer key are provided.
	Option 3: Environmental Tracking and Archaeology	
	Activity Flow: The teacher will present a short case about how scientists use radioisotopes to study the environment and determine the age of ancient objects. Two examples are shown: Carbon-14 for archaeology and Cesium-137 for environmental tracing.	This activity targets objectives 1, 3, and 4. It manifests relevance and responsiveness by connecting the properties of radioisotopes—emission type and half-life—to real-world applications in environmental monitoring. It uses integrative, Inquiry-based approach, with

<table>
<tr><td></td><td>Prompt:
“How do scientists use radioisotopes to study the past and monitor the environment?”
Learners will share initial ideas.
The teacher will then introduce the activity tasks and emphasize that the activity develops understanding of real-world applications of radioisotopes while using data analysis and reasoning skills.</td><td>data interpretation, guided questioning, and half-life computation as the main pedagogical strategies.
Note to the Teacher: A separate sheet is provided with details for Environmental Tracking and Archaeology activity. Answer Key is also provided.</td></tr>
<tr><td></td><td colspan="2">C.2. Making Generalization</td></tr>
<tr><td></td><td colspan="2">Option 1: One-Sentence Big Idea</td></tr>
<tr><td></td><td>Instructions:
1. Think about what you learned in this lesson.
2. Write one sentence that summarizes the “big idea” of the lesson in a post it and post it on the board.
Example starter:
1. The emission type and half-life of a radioisotope determine how it is used safely and how its mass changes over time.
2. Radioisotopes are classified as ___ or ___ based on ___, emit ___, and their half-life determines ___.” Including an example could support learner understanding.</td><td>This activity targets objectives 1,2, 3, and 4. It manifests relevance, responsiveness, and inclusion by giving all learners an opportunity to synthesize and express their understanding of radioisotopes, radiation, and half-life in their own words. It uses a reflective approach, with summarization and personal meaning-making as the main pedagogical strategies.</td></tr>
<tr><td></td><td colspan="2">Option 2: Exit Ticket (Quick Check)</td></tr>
<tr><td></td><td>Students will reflect on their learning about radioisotopes, type of emission and half-life before leaving the lesson. They will use the 321 Exit Ticket:
<table>
<tr><td>3</td><td>Things you learned</td><td>Key Takeaways from the discussion</td></tr>
<tr><td>2</td><td>Things you found interesting</td><td>Concepts, facts or real-world applications that stood out</td></tr>
<tr><td>1</td><td>Question you still have</td><td>Any unclear points or topics you would like to explore further</td></tr>
</table></td><td>This activity targets objectives 2–4 by helping students review key concepts on radioisotopes, radiation, and half-life. It uses a reflective approach through a 3-2-1 exit ticket to check understanding and encourage questions.
Note to the teacher: Consider the following structured reflection templates or sentence frames to support learners in summarizing their observations and conclusions.
3- I learned that radioisotopes can be _____.
One important idea about half-life is _____.</td></tr>
</table>

		2- I found it interesting that _____. A real-world example that caught my attention is _____. 1- I am still wondering about _____.
	Option 3: Guided Sentence Completion	
	Instruction: Complete the following sentences. 1. Radioisotopes are classified based on _____ and _____. 2. Radioisotopes may emit different types of particles: _____, _____, and/or _____. 3. Every time one half-life passes, the mass of the parent radioisotope remaining _____. 4. If you start with 25 g of Carbon-14, _____ will be the remaining mass after its half-life.	This activity targets objectives 1, 2, 3, and 4. It manifests relevance, responsiveness, and inclusion by allowing students to consolidate essential concepts on radioisotope classification, radiation types, and half-life through structured sentence completion. It uses a constructivist and reflective approach, with guided recall and completion of key statements as the main pedagogical strategies.
	C.3. Evaluating Learning	
	Option 1: Quiz	
	This quiz is designed to assess your understanding of radioisotopes through classification, identification, computation, and application. Instructions: Part 1. Classify radioisotopes as natural or man-made Part II. Identify their radiation types. Part III. Solve half-life problems. Part IV. Compare isotopes based on decay rate. Part V. Explain real-world uses in medicine. Your answers should show accuracy, clear reasoning, and correct computations.	This quiz addresses objectives 1–4 by having students classify radioisotopes, identify radiation types, compare decay rates, and compute half-life. It connects learning to real-world applications and uses inquiry-based tasks to develop understanding and reasoning skills. *Note to the teacher:* Before C.3, ask learners to classify two unfamiliar isotopes and solve one half-life item independently as a readiness check. A separate sheet is provided with details for Quiz. Answer Key is also provided.

	Option 2: Half-Life Word Problem	
	This activity is designed to strengthen your understanding of half-life through step-by-step computation. You will complete decay sequences and a half-life chart by dividing the mass by half at each interval. Your answers should show correct values and demonstrate how radioactive substances decrease over time. **Instructions:** Use the idea of half-life: after each half-life period, the mass is reduced by half. Identify the initial mass and half-life. Divide the mass by 2 at each half-life interval. Fill in the blanks with the correct mass (in grams).	This activity targets objectives 1–4 by assessing students' classification of radioisotopes and application of half-life concepts to predict remaining mass. It uses inquiry-based learning through independent classification, computation, and written responses. *Note to the teacher: S*eparate Half-Life Word Problem sheet and answer key are provided.
	Option 3: CER Assessment	
	This assessment is designed to develop your ability to construct scientific explanations using the Claim–Evidence–Reasoning (CER) framework. You will evaluate statements about radioisotopes and half-life, then form a clear claim, support it with accurate evidence, and explain your reasoning. Your responses should demonstrate correct understanding, logical thinking, and clear explanation of scientific concepts. **Instruction:** For each question, complete the Claim–Evidence–Reasoning (CER) table.	This activity targets objectives 1–4 by having students apply CER to analyze radioisotope properties and mass changes. It uses Inquiry-based approach through table completion and evidence-based explanations. *Note to the teacher:* A separate sheet is provided with details for CER Assessment. Answer Key is also provided.
	C.4. Additional Activities	
	Option 1: Applied Problems (For Enhancement)	
	This activity deepens students' understanding of half-life and radioactive decay through problem-solving. Learners will compute remaining mass, determine the number of half-lives, compare decay rates, and relate isotopes to real-life uses. Instructions: Read each problem carefully, identify the half-life, determine how many half-lives have passed, and apply the rule that each half-life reduces the mass by half. Write clear final answers and give brief explanations for comparison questions.	This activity targets objectives 3 and 4 by having students apply half-life rules and decay reasoning to real-world computational and comparison problems. It uses inquiry-based learning through independent problem solving, step-by-step computation, and brief justification. *Note to the teacher: S*eparate Applied Problems Enhancement sheet and answer key are provided.

	Option 2: Half-Life Calculations Table Activity	
	This activity helps students practice calculating half-lives and determining the remaining mass of substances over time. It strengthens their understanding of radioactive decay through step-by-step computation and application of formulas. **Instructions:** Complete the table by finding the number of half-lives and the remaining mass for each case. Show all necessary computations to support your answers. Use the given formulas as a guide in solving each problem accurately.	This activity targets objectives 3 and 4. It manifests relevance and responsiveness by requiring students to apply their understanding of half-life, decay cycles, and remaining mass through structured computation and data interpretation. It uses Inquiry-based approach, with table completion and step-by-step calculation as the main pedagogical strategies.
	Option 3: Understanding Radioisotopes and Half-Life Remediation	
	The teacher will present brief situations on fast and slow radioactive decay and asks, "How can we tell if an isotope decays quickly or slowly?" After learners respond, the teacher will connect their answers to half-life and decay rate, then introduce the remediation tasks: identifying fast or slow decay, analyzing emission and decay situations, and completing a half-life computation table. The activity strengthens understanding of radioisotopes, decay rates, and half-life calculations.	This activity targets objectives 1, 3, and 4 by reinforcing decay rate, emission type, and half-life calculations through guided remediation. It uses constructivist and inquiry-based learning through step-by-step questions, classification, and structured computation. *Note to the teacher:* A separate remediation activity sheet is provided.
VI. ASSESSMENT *(Assessing Learnings)*	**Performance Standard:** Learners will prepare clear and scientifically accurate information material that classifies selected radioisotopes as natural or human-made and explains their emission type, half-life, uses, and risks for a beginner audience. **Radioisotopes Around Us** This performance task will help you apply radioactivity concepts in real-life situations and communicate them clearly. You will research selected radioisotopes, including their type, radiation, half-life, and uses or risks, and present the information in a simple 1–2 page sheet for beginners. Ensure accuracy, clear organization, and easy-to-understand explanations using reliable sources.	
VII. REFLECTION *(**Feedback** and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were the most and the least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery.	

	1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was the easiest for learners? Which part was the most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again? Lesson-specific reflection prompts: 1. Which misconceptions about natural versus human-made radioisotopes remained after the lesson? 2. Which half-life task best showed whether learners could move from classification to quantitative reasoning? Reflection prompt: Why is it important to communicate accurately about the uses and risks of radioisotopes when teaching beginners or the public?'
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Gemini and Microsoft Copilot to organize lesson ideas, improve language clarity, and check selected factual statements in the reading texts. The author(s) reviewed and finalized the writing of the content. The author(s) take(s) full responsibility for the content of this LE.
IX. Attachments	All attachments can be accessed through this link: https://bit.ly/SHS_ELECTIVES_CHEM_Q1_LE11_attachments

Learning Title/Topic:	**1. Isotopes and radioisotopes** **2. Applications in medicine, industry, environmental science** **3. Benefits, risks, and safe use**	**Lesson Exemplar:**	12

I. OBJECTIVES	
Content Standard	The learners understand that isotopes have the same number of protons but different numbers of neutrons and that selected radioisotopes have important applications in medicine, industry, and environmental science.
Performance Standard	Learners classify selected isotopes according to their uses, explain how isotope properties support their applications, and communicate benefits, limitations, and safety considerations through oral, written, or graphic outputs.
Learning Competencies	***Prerequisite Knowledge and Skills***
	Essential prerequisite knowledge: 1. Atomic Structure & Subatomic Particles 2. main energy levels, sublevels, and orbitals in relation to the electronic configuration of elements
	Learning Competency: Describe the applications of isotopes in medicine, industry, and environmental science.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	Materials: periodic table; isotope cards; scenario cards; KWL chart; meta cards; markers; projector; printed station sheets References: Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018. OpenStax. Chemistry 2e. Houston, TX: OpenStax, Rice University, 2019. https://openstax.org/details/books/chemistry-2e. Centers for Disease Control and Prevention (CDC).“Cobalt-60.” Last updated April 17, 2024. https://www.cdc.gov/radiation-emergencies/hcp/isotopes/cobalt-60.html. [cdc.gov] Environmental Protection Agency (EPA).“Radionuclide Basics: Technetium-99.” Last updated January 22, 2026. https://www.epa.gov/radiation/radionuclide-basics-technetium-99. [epa.gov] International Atomic Energy Agency (IAEA). Isotope Methods for Dating Old Groundwater. Vienna: IAEA, 2013. https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1587_web.pdf. [www-pub.iaea.org] United States Geological Survey (USGS).“Tracing and Dating Young Ground Water.” https://pubs.usgs.gov/fs/FS-134-99/. [pubs.usgs.gov]

	Nondestructive Evaluation Resource Center."Radiography: Isotope Sources." https://www.nde-ed.org/NDETechniques/Radiography/EquipmentMaterials/isotopesources.xhtml. [nde-ed.org] QSA Global, Inc."Iridium-192 Sealed Sources for Industrial Radiography." https://www.qsa-global.com/iridium-192-sealed-sources. [qsa-global.com]	
III. CONTENT *(Sequencing Content)*	Isotopes and Radioisotopes applications in medicine, industry, environmental science benefits, risks, and safe use	
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Classify selected isotopes according to their applications in medicine, industry, and environmental science. 2. Describe how specific isotopes are used in each field and what property makes each useful. 3. Explain the benefits, risks, and safety considerations in the responsible use of isotopes. 4. Communicate the responsible and safe use of isotope technologies in real-life contexts.	
V. PROCEDURES		**ANNOTATIONS**
Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1: Think-Pair-Share	
	Ask learners: "What makes two atoms isotopes of each other?" Students will first write their own answers, then discuss with a partner. Each pair will share one idea with the class. Expected Output: Learners should explain that isotopes have the same number of protons, belong to the same element, but have different numbers of neutrons, resulting in different mass numbers. They may also note that isotopes have similar chemical properties but may differ in physical properties such as mass.	This activity targets objectives 2 and 3 by using isotope concepts as a foundation for discussing uses, benefits, and risks. It applies Constructivist and Collaborative learning approaches through individual thinking, pair sharing, inquiry questioning, and guided discussion.
	Option 2: Picture-Based Prompt	
	Show students two atomic symbols of the same element, ^{12}C and ^{14}C. Explain that both atoms have 6 protons, but one has 6 neutrons while the other has 8 neutrons. Ask learners to observe and answer: What is similar? What is different? How are the two atoms related? **Expected Output:** Students should explain that both atoms are carbon because they have the same number of protons, but they	This activity targets objectives 2–3 by helping students identify isotopes through visual comparison of atomic structure. It uses concrete images, guided questioning, and sharing to support diverse learners and promote constructivist, inquiry-based, and collaborative learning.

	have different numbers of neutrons and mass numbers. Therefore, they are isotopes of the same element.	
	Option 3: Mystery Atom Challenge	
	Students will be given clues about an unknown atom. Using these clues, they will work in teams to identify: 1. the element; 2. whether it is an isotope; and 3. whether it is a radioisotope. **Team Task** In your group, answer the following: 1. What element is the atom? 2. Is this atom an isotope of another atom? Why? 3. Is this atom a radioisotope? Explain your answer.	This activity targets objectives 1, 2, and 3. It manifests relevance, responsiveness, and inclusion by engaging students in a collaborative, problem-solving task to identify elements, isotopes, and radioisotopes using given clues related to protons, neutrons, stability, and real-world uses. It uses Collaborative and Inquiry-based approaches, with team analysis, clue interpretation, and guided explanation as the main pedagogical strategies. *Note to the teacher:* The complete activity for Mystery Atom Challenge is provided in a separate sheet.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: *K-W-L Chart Activity*	
	Distribute the K-W-L charts with three columns: What I Already Know, What I Want to Know, and What I Learned. Students complete the K column by writing what they know about isotope applications in medicine, industry, and environmental science. In the W column, they write questions that they want to be answered. The L column will be completed during the lesson and on Day 4 for reflection and synthesis.	This activity targets objectives 1, 2, and 4 by activating prior knowledge, curiosity, and reflection on isotope applications in medicine, industry, and environmental science. It uses a constructivist and reflective approach through KWL chart completion and guided reflection.
	Option 2:A Local Issue Briefing	
	Learners will examine a local issue, such as cancer treatment, infrastructure safety, or environmental monitoring, and explore how isotopes help scientists detect or measure things that cannot be seen directly.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by contextualizing the lesson in a local, real-world issue and activating students' prior experiences related to medicine, industry, and environmental science. It uses Integrative and Constructivist

<table>
<tr><td></td><td>Instructions: Observe the teacher-provided material. ANswer the question “How can scientists see or measure things that are not visible?” Afterwards, share ideas with the class, connect these ideas to isotope use, and write 3–5 sentences explaining how isotopes help solve a local problem.</td><td>approaches, with guided questioning, whole-class discussion, and contextualization as the main pedagogical strategies.</td></tr>
<tr><td></td><td colspan="2">Option 3:STEAM Vocabulary</td></tr>
<tr><td></td><td>Introduce the STEAM vocabulary. Ask the students to write 3 words or terms related to the lesson/topic and define/describe or give examples related to the term.
Materials Needed:
• meta cards or small pieces of paper
• markers or pens
Instructions: From the given purpose and goal of the lesson, give at least 3 terms and define/describe or give examples related to these terms. Write your answers in a meta-card. Post them in the appropriate column.<table><tr><td>Terms</td><td>Meaning/ Description</td><td>Example</td></tr><tr><td></td><td></td><td></td></tr></table></td><td>This activity targets objectives 1 and 4. It manifests relevance, responsiveness, and inclusion by building shared understanding of key radioisotope concepts and real-world applications through student-generated vocabulary, definitions, and examples. It uses Constructivist approach, with meta-card writing, categorization, and guided class discussion as the main pedagogical strategies.</td></tr>
<tr><td rowspan="3">Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: Isotope Sorting Challenge</td></tr>
<tr><td>Provide each group with a graphic organizer with three columns: Medicine, Industry, and Environmental Science. Give isotope cards such as Carbon-14, Cobalt-60, Technetium-99m, Iodine-131, Uranium-235, and Americium-241.
Learners will read each isotope card, decide which field it belongs to, and write one sentence explaining their answer.

Output Format:
Isotope / Field / Application / Reason</td><td>This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by engaging students in collaborative classification of isotopes according to real-world applications in medicine, industry, and environmental science. It uses Collaborative and Inquiry-based approaches, with card sorting, justification writing, and group discussion as the main pedagogical strategies.</td></tr>
</table>

	Example: Carbon-14 / Environmental Science–Archaeology / Dating fossils / Its radioactive decay helps estimate age.	
	Option 2: Isotope Corner Quest	
	Students analyze real-life scenario cards to identify the appropriate isotope and classify its use as medicine, industry, or environmental science. Instructions: Each group will receive a scenario card, discuss the isotope and category for 30 seconds, move to the correct corner, explain its reasoning, and earn points for accurate answers and clear justification.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by engaging students in active, collaborative decision-making as they apply isotope properties to real-world scenarios in medicine, industry, and environmental science. It uses Collaborative and Inquiry-based approaches, with scenario analysis, movement-based classification, and oral scientific justification as the main pedagogical strategies. *Note to the teacher:* **C**omplete implementation notes are provided in a separate sheet.
	Option 3:Isotope Matching Challenge	
	Isotope Matching Challenge is an activity where students analyze real-life scenarios and match them with the most appropriate isotope and its application. Students will read each scenario, choose an isotope from the given list, classify its use (medicine, industry, or environmental science), and write a short justification. The activity helps develop understanding of isotope uses and supports reasoning through scientific explanation.	This activity targets objectives 1, 2, and 4 by having students match isotopes to real-world uses in medicine, industry, and environmental science, then justify their choices. It uses collaborative and inquiry-based learning through scenario analysis, classification, and written justification. *Note to the teacher:* A complete activity sheet is provided separately.

	B.2. Discussing New Concept	
	Option 1:Isotope Corner Quest	
	This activity uses a gallery walk approach where students rotate through three stations (Medicine, Industry, and Environmental Science) to solve real-world problems using isotopes. The learners will analyze scenarios, use mini-info cards as references, and work collaboratively to propose solutions. The activity is followed by a class discussion to review answers, clarify concepts, and deepen understanding of isotope applications and radioactive decay.	This activity supports key learning objectives by using collaborative, real-world problem-solving on isotope applications in medicine, industry, and environmental science. It uses inquiry-based strategies such as gallery walk, scenario analysis, and class discussion. *Note to the teacher:* Complete implementation notes are provided separately.
	Option 2:Expert Jigsaw Panels	
	Expert Jigsaw Panels is a collaborative learning activity where students become "experts" on isotope applications in medicine, industry, or environmental science. The teacher will group students into expert teams, provide reading or video materials, and guide them to create a panel summary. Students will then be reorganized into mixed groups where they teach their assigned topic to peers and answer questions, followed by a class discussion to reinforce key concepts.	This activity targets objectives 1–3 by building on students' prior knowledge and experiences to introduce new concepts clearly. It uses constructivist and inquiry-based learning through teacher-guided explanation, questioning, and interactive discussion. *Note to the teacher:* Complete implementation notes are provided separately.
	Option 3:Match-Up & Impact Rank	
	Match-Up & Impact Rank is a collaborative activity where students match isotope cards with their correct applications, fields, benefits, and risks. After matching, groups will rank the top three most beneficial isotope applications based on safety, usefulness, and societal impact. Students will receive mixed cards containing isotope names, applications, fields, and benefits, then justify their final ranking through group discussion.	This activity targets objectives 1, 2, and 4 by engaging students in collaborative matching and ranking of isotope applications in medicine, industry, and environmental science. It uses collaborative, integrative, and inquiry-based learning through card matching, discussion, ranking, and justification. *Note to the teacher:* A complete Match-Up and Impact Rank activity sheet is provided separately.

	B.3. Developing Mastery	
	Option 1:Matching Exercise	
	Instructions: Match each isotope with its application. Write the letter and give a brief reason. 1._____ Iodine-131 2._____ Cobalt-60 3._____ Carbon-14 Applications: A. Dating fossils and ancient materials B. Detecting flaws in metals and pipelines C. Diagnosing or treating thyroid disorders Answer Key: 1-C, 2-B, 3-A.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by allowing students to practice accurate identification of isotope applications using familiar, real-world examples. It uses a Constructivist and Inquiry-based approaches, with matching, recall, and quick application as the main pedagogical strategies.
	Option 2: Guided Identification	
	This activity helps students identify the correct field, isotope, and application by analyzing real-life situations and applying their understanding of isotope uses. It encourages critical thinking by connecting concepts to practical examples. It also develops students' ability to explain how isotopes are used in different fields.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by guiding students to apply their understanding of isotopes and their real-world uses in medicine, industry, and environmental science through clear, contextual scenarios. It uses Constructivist and Inquiry-based approaches, with guided identification and short written explanations as the main pedagogical strategies. *Note to the teacher:* A complete activity sheet for this Guided Identification is provided in separate sheet

	Option 3: Isotope Applications: Field Identification	
	This activity requires identifying the correct field, selecting an appropriate isotope, and providing a scientific reason for its use in each situation. It helps develop understanding of real-world applications of isotopes and strengthens reasoning skills through concise explanations. Students will complete a table by identifying the correct field, selecting a possible isotope, and giving a scientific reason for its use in each situation. Instruction: Read each statement carefully, then write the appropriate field, name a suitable isotope, and provide one clear reason based on its properties and application.	This activity targets objectives 1, 2, and 4 by having students apply isotope concepts to real-world situations in medicine, industry, and environmental science. It uses constructivist and inquiry-based learning through scenario-based classification. *Note to the teacher:* A complete activity sheet is provided separately.
Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1:Challenging Question	
	Cobalt-60 is used in both cancer treatment and food irradiation. Why is the same isotope safe for food but carefully controlled for medical use? (Hint: Think about dosage and exposure time. Dose refers to the amount of radiation received; exposure time refers to how long a person or object is exposed.)	This activity targets key learning objectives by helping students apply radiation type, dose, and exposure concepts to real-world situations through inquiry-based reasoning. ***Answer:*** Cobalt-60 is safe for food irradiation because food receives a low dose for a short time, killing bacteria without making the food radioactive. In cancer treatment, higher doses target living tissue, so radiation must be carefully controlled to protect healthy cells.
	Option 2:Benefit–Threat Analysis Chart (T-chart)	
	Benefit–Threat Analysis Chart (T-chart) is an analytical activity where students examine the advantages and risks of using isotopes across different fields. Students will list one major benefit and one possible threat for each field, then reflect on whether the benefits outweigh the risks by supporting their answer with examples from medicine, industry, and environmental science.	This activity targets objectives 1, 2, and 4 by helping students compare the benefits and risks of isotope use in medicine, industry, and environmental science. It uses Integrative and Reflective approaches through T-chart analysis, group discussion, and value-based justification.

<table>
<tr><td></td><td>Students will complete a T-chart by identifying one benefit and one risk of isotope use in each field. Afterwards, they will answer the reflection question using clear examples and reasoning.</td><td></td></tr>
<tr><td></td><td colspan="2">Option 3:Written Reflection</td></tr>
<tr><td></td><td>Instruction: Reflect and answer the following questions:
1. Some people worry about the dangers of radiation. Based on what you learned, do the benefits of medical isotopes outweigh the risks? Explain.
2. Scientists may use isotope tracing or sediment dating to study where pollution came from and when it entered the environment.
a. Which isotope method would you use?
b. What would you measure?
c. How would you prove the factory was responsible?</td><td>This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by engaging students in reflective and applied reasoning about the benefits and risks of radioisotopes in medical and environmental contexts. It uses Integrative and Reflective approaches, with written reflection and real-world problem analysis as the main pedagogical strategies.</td></tr>
<tr><td></td><td colspan="2">C.2. Making Generalization</td></tr>
<tr><td></td><td colspan="2">Option 1:K-W-L Chart Activity Continuation</td></tr>
<tr><td></td><td>Recall individual or group K-W-L (Know–Want to Know–Learned) chart.
<table><tr><td>What I Already Know</td><td>What I want to Know</td><td>What I Learned</td></tr><tr><td></td><td></td><td></td></tr></table>Student will answer the “What I Learned” column. Students should write at least one isotope, one field of use, and one benefit or safety issue.</td><td>This activity targets objectives 2 and 4. It manifests relevance, responsiveness, and inclusion by guiding students to synthesize their learning and articulate key understandings about isotopes and their applications based on the lesson sequence. It uses Reflective approach, with KWL chart completion and guided synthesis as the main pedagogical strategies.</td></tr>
<tr><td></td><td colspan="2">Option 2:Asking for the Big Idea</td></tr>
<tr><td></td><td>Answer the following question:
1. What was the easiest part of learning about isotope applications? What was the most confusing?</td><td>This activity targets objectives 2 and 4. It manifests relevance, responsiveness, and inclusion by prompting students to reflect on their learning experience, identify areas of clarity and difficulty, and articulate understanding by explaining an</td></tr>
</table>

<table>
<tr><td></td><td>2. If you had to teach one isotope application to a younger student, which one would you choose and how would you explain it in one sentence?
Sentence starter: One isotope application I can explain clearly is _____ because _____.</td><td>isotope application in simple terms. It uses Reflective and Constructivist approaches, with guided questioning and synthesis of ideas as the main pedagogical strategies.</td></tr>
<tr><td></td><td colspan="2">Option 3: Exit Ticket Format (3–2–1)</td></tr>
<tr><td></td><td>Students will use the 321 Exit Ticket:
<table><tr><td>3</td><td>Things you learned</td><td>isotope applications learned</td></tr><tr><td>2</td><td>Things you found interesting</td><td>benefits or risks</td></tr><tr><td>1</td><td>Question you still have</td><td>question about safe and responsible isotope use</td></tr></table></td><td>This activity targets objectives 2 and 4 by helping students summarize key learnings, insights, and questions about radioisotopes, radiation, and half-life. It uses Reflective approach through the 3–2–1 exit ticket to synthesize learning and guide future instruction.</td></tr>
<tr><td></td><td colspan="2">C.3. Evaluating Learning</td></tr>
<tr><td></td><td colspan="2">Option 1: Identifying Applications</td></tr>
<tr><td></td><td>This activity helps students identify the correct applications of different isotopes through matching, scenario analysis, and short-answer responses. Students will match isotopes to their uses, analyze real-life situations, and explain the properties that make each isotope useful in its field.</td><td>This activity targets objectives 1, 2, and 4 by assessing students’ ability to match radioisotopes with real-world uses in medicine, industry, and environmental science. It uses inquiry-based learning through matching, scenario identification, and short explanations.
Note to the teacher: A complete activity sheet is provided separately.</td></tr>
<tr><td></td><td colspan="2">Option 2: Multiple Choice Test</td></tr>
<tr><td></td><td>This multiple-choice test assesses students’ understanding of different radioactive isotopes and their practical applications in medicine, industry, and science. Each question presents a real-life situation, and students must choose the correct isotope based on its typical use, such as medical diagnosis, industrial inspection, imaging, or dating ancient materials. Students will</td><td>This activity targets objectives 1, 2, and 4 by assessing students’ ability to match radioisotopes with real-world applications in medicine, industry, and environmental science. It uses inquiry-based learning through individual multiple-choice analysis and application of concepts.</td></tr>
</table>

	choose the best answer that identifies the isotope and its application.	*Note to the teacher:* A copy of the test and answer key is provided separately.
	Option 3:Constructed -Response Test	
	This constructed-response test evaluates students' ability to classify isotopes based on their fields of application and explain their uses in real-life contexts. Students will organize information in a chart and provide brief written answers demonstrating their understanding of how isotopes are used in medicine, industry, and environmental science. Students will also provide brief explanations on the given questions.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by assessing students' ability to classify radioisotopes, explain their specific applications, and articulate the benefits and problem-solving roles of isotopes in medicine, industry, and environmental science. It uses Constructivist and Inquiry-based approaches, with chart completion and short written explanations as the main pedagogical strategies. *Note to the. teacher:* A copy of the test is provided in separate sheet.
	C.4. Additional Activities	
	Option 1:Community Impact Reflection	
	Instruction: Reflect on one field of application of isotopes and answer the following questions: 1. How does isotope use help the community? 2. What risk may occur? 3. What safety practice is needed?	This activity targets objectives 1, 2, and 4 by guiding students to reflect on the benefits, risks, and responsible use of isotopes in the community. It uses Integrative and Reflective approaches through guided written reflection and value-based reasoning.
	Option 2: Safety and Responsibility Reflection	
	Instruction: Read the guide questions carefully and answer them in complete sentences. 1. In what ways do isotopes make work in this field safer, faster, or more accurate for professionals and the public?	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by guiding students to reflect on how radioisotopes are used safely and responsibly, while considering potential risks and the importance of regulation in

	(e.g., early disease detection, stronger infrastructure, accurate environmental data) 2. What safety concerns might arise if radioactive isotopes are not handled, stored, or disposed of properly? 3. Why is it important for scientists, workers, and governments to follow strict rules when using radioactive materials?	protecting people and the environment. It uses Integrative and Reflective approaches, with guided questioning and written reflection as the main pedagogical strategies.
	Option 3: Science, Ethics, and Society Reflection	
	Instruction: Reflect on the application of radioisotopes hospital treatment, pipeline inspection, food irradiation, or pollution tracing. Choose one field and discuss ethical responsibility. Write short but thoughtful responses.	This activity targets objectives 1, 2, and 4. It manifests relevance, responsiveness, and inclusion by encouraging students to critically examine the ethical, social, and community impacts of isotope use in medicine, industry, and environmental protection. It uses Integrative and Reflective approaches, with guided ethical questioning and written reflection as the main pedagogical strategies.
VI. ASSESSMENT *(Assessing Learnings)*	**Community Decision Case Study: Using Isotopes Responsibly** This performance task aims to develop students' ability to analyze real-world applications of radioactive isotopes, classify their uses across different fields, and evaluate their benefits and risks. It also encourages critical thinking and responsible decision-making by applying scientific knowledge to community issues involving the safe and effective use of isotopes. *Note to the teacher:* A copy of the performance task is provided in a separate sheet.	
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson implementation. Reflect on learners' performance, determine which activities and lesson parts were the most and the least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was the easiest for learners? Which part was the most difficult?	

	4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar, the author used Microsoft Copilot to check and improve statements and question, and to help draft an initial rubric for the assessment. The author reviewed, revised, and finalized all content and takes full responsibility for the finished LE.

Learning Title/Topic:	**Chemical Bonding and Compounds** • **Examples of ionic and covalent compounds in everyday life** • **Properties of ionic and covalent compounds** • **Differentiating ionic and covalent compounds using real-life examples**	**Lesson Exemplar:**	13

I. OBJECTIVES	
A. Content Standard	*The learners learn that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.*
B. Performance Standard	*By the end of the quarter*, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and investigate to compare substances based on these interactions. *Lesson performance focus: By the end of the lesson, learners classify common substances as ionic or covalent using composition and observable property evidence and explain how bonding helps account for selected real-life uses.*
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners should understand basic atomic structure and the role of valence electrons in bonding. They should know how to use the periodic table and be familiar with common substances like salt, sugar, water, and plastics. They are expected to recognize simple properties such as melting point, solubility, and conductivity, and be able to observe, describe, classify, and explain cause-and-effect relationships. Finally, they should carry out simple experiments using correct scientific terms.
	The learners determine ionic and covalent compounds found in everyday life, environment, and industries.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• Brown, Theodore L., et al. *Chemistry: The Central Science*. 14th ed. Boston: Pearson Education, 2018. • Helmenstine, Anne Marie. "Examples of Ionic Compounds in Everyday Life." Science Notes and Projects, March 10, 2021. Updated January 12, 2023. Accessed May 5, 2026. https://sciencenotes.org/examples-of-ionic-compounds-in-everyday-life/. • Chemistry LibreTexts. "Contrasting Ionic Compounds and Covalent Compounds." Accessed May 5, 2026. https://chem.libretexts.org/Courses/Portland_Community_College/CH151/07_Molecules_Covalent_Bonding/7.2_Contrasting_Ionic_and_Covalent_Compounds.

	• Veerendra. "Properties of Ionic and Covalent Compounds." *A Plus Topper*, October 21, 2024. https://www.aplustopper.com/properties-of-ionic-and-covalent-compounds/ •
III. CONTENT *(Sequencing Content)*	***Chemical Bonding and Compounds*** • Examples of ionic and covalent compounds in everyday life. • Properties of ionic and covalent compounds. • Differentiating ionic and covalent compounds using real-life examples.
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Identify everyday substances at home, in the environment, and in industries as ionic or covalent compounds. 2. Classify named substances as ionic or covalent by using property evidence such as conductivity, solubility, and physical form together with composition-based reasoning. 3. Explain how differences in bonding help account for selected real-life uses of ionic and covalent compounds in home, environmental, and industrial contexts.

V. PROCEDURES	**ANNOTATIONS**
	A.1. Activating Prior Knowledge
	Option 1. Household Hunt
A. Activating Prior Knowledge	The teacher shows the items: salt, sugar, water, and paraffin wax. Learners recall how they've used or interacted with them. Guide the learners to think about what they already know from experience. The teacher asks the following questions: 1. When you add salt to the soup, does it disappear quickly? Does it taste sharp or salty? 2. When you add sugar to coffee, how does it dissolve? Does it taste sweet instead of salty? 3. When you light a candle, does the wax dissolve in water or just melt with heat? 4. Which of these do you think are ionic, and which are covalent, based on how they behave in everyday life? The teacher then confirms the correct classification.
	The activity supports Learning Objectives 1 and 3 and applies to IDF principles of relevance and responsiveness by linking familiar substances to scientific ideas. It shows Constructivist and Integrative features as learners sort items, explain reasoning, and discuss observations. Record learners' justifications, identify whether they are using evidence or guessing, then correct misconceptions before moving on.

	Option 2. Picture Sort	
	The teacher shows pictures of common household substances, such as sodium chloride, potassium nitrate, sucrose, water, and paraffin wax. Learners sort the pictures into two categories: "likely ionic" and "likely covalent." They then explain why they placed each item in its category. Process Questions 1. What differences do you notice in how these everyday substances behave when mixed with water, based on your everyday experience? 2. Which substances seem to change when mixed with water, and which seem to remain the same? What makes you say so?	The activity supports Learning Objectives 1 and 3 and applies to IDF principles of relevance and responsiveness. Do not include metals or mixtures in a first-pass ionic/covalent sorting task unless the lesson explicitly teaches a third category or mixture analysis. Teacher clarification: Solubility alone is not enough to classify a substance. Use both composition-based reasoning and appropriate property evidence.
	Option 3. Odd One Out: Quick Sort	
	Learners are shown three substances like salt, sugar, and plastic (plastic bags, bottles, food wraps) while the teacher asks: "Which of these substances do you think is different in nature from the others based on how it is commonly used or behaves in daily life? Explain your reason.	The activity supports Learning Objectives 1 and 3 and applies to IDF principles of relevance and responsiveness. Note: Salt and sugar are similar because both dissolve in water, while plastic does not. Salt and sugar are used as substances you mix, but plastic is used as an object.
	A.2. Establishing the Purpose of the Lesson	
	Option 1. Real-Life Connection: Bonding in My Bag	
	To establish the purpose of the lesson, the teacher says "From the product you brought, identify one main chemical substance or material to focus on (for example, salt in a salt packet, sucrose in candy, or polyethylene in a plastic wrapper). Predict whether that substance is ionic or covalent and explain your reason."	The activity shows Constructivist and Integrative features as learners sort items, explain reasoning, and discuss observations. Teacher elicits classification of substances; learners respond with reasoning; teacher recognizes ideas and uses feedback to confirm ionic vs covalent distinctions.

	Option 2. Scientific Inquiry: "Property Clues"	
	The teacher presents two samples, such as salt and sugar. The teacher demonstrates or carefully guides learners to observe salt mixed with water; sugar mixed with water. While doing this, the teacher asks neutral, descriptive questions, "What do you observe when salt is mixed with water? "What do you observe when sugar is mixed with water?" If a simple conductivity tester is available, the teacher demonstrates only and avoids technical explanations of ions. The teacher then asks, "Based on these observations, which substance do you think scientists might classify as ionic, and which is covalent? This is only a prediction."	The activity supports Learning Objectives 1 and 3 and applies to IDF principles of relevance and responsiveness. It demonstrates Constructivist and Integrative features. The teacher facilitates guided observation and discussion. Teacher clarification: Salt and sugar can both dissolve in water. A stronger clue is that salt solution conducts electricity because it contains mobile ions, while sugar solution does not conduct because it contains neutral molecules.
	Option 3 Quick Reflection Slip	
	The teacher asks the learners to write a brief reflection slip answering the question: "Which household items do you think are ionic compounds and which are covalent compounds, and why?" After collecting their responses, the teacher explains that the purpose of the lesson is to help learners understand how chemical bonds determine the properties of everyday substances and how these differences matter in real life, industry, and the environment.	The activity supports Learning Objectives 1 and 3 and applies to IDF principles of relevance and responsiveness by linking household items to scientific classification. It shows Constructivist and Integrative features of the 2C-2I-1R approach. The teacher elicits learners' reflections, recognizes their classifications, and uses responses to link bonding types with everyday properties.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1 SlideShare – Ionic and Covalent Bond	
	To introduce the new concept, the teacher uses a short PowerPoint presentation with visuals of everyday substances such as salt, sugar, and plastic. Process Questions 1. What do you notice about how electrons are shown in the ionic bonding diagram compared with the covalent bonding diagram?	The teacher elicits learners' observations about electron behavior in the diagrams, recognizes correct responses, and uses these ideas to clarify that ionic bonding involves electron transfer while covalent bonding involves electron sharing. Link for the power point presentation

	2. In the slide showing ionic bonding, what happens to the electrons? How is this different from what happens in the covalent bonding slide? 3. Which bonding type involves electron transfer, and which involves electron sharing based on the diagrams shown?	**Del Castillo, Mardel B.** Ionic and Covalent Bond. PowerPoint presentation, SlideShare, n.d. https://www.slideshare.net/slideshow/ionic-and-covalent-bond/238328566.
	Option 2. Kitchen Chemistry Challenge	
	The teacher says: "Imagine you are at home preparing breakfast. You use salt, sugar, and water. These look ordinary—but chemically; they behave very differently. Today, we'll discover why." The teacher presents familiar items (real or picture): salt (NaCl), sugar ($C_{12}H_{22}O_{11}$), and water (H_2O). Then ask guiding questions while demonstrating or describing. Guiding Questions 1. What happens when salt and sugar are added to water? Do they behave the same way? 2. Which of these household substances do you think are ionic and which is covalent? Why do you think? 3. How can properties like solubility and conductivity help us classify a substance as ionic or covalent? Link for video showing conductivity test **https://www.youtube.com/shorts/QrT9QcER4Xc**	Addresses Objectives 1 and 3 using a relevant, responsive, and constructivist guided discussion. The teacher elicits learners' observations about how salt, sugar, and water behave, recognizes their predictions, and uses these responses to introduce how solubility and conductivity help distinguish ionic and covalent compounds. Salt (NaCl): Consists mainly of ions arranged in a lattice formation. Sugar (sucrose): Consists mainly of molecules. Water (H_2O): Consists mainly of molecules. Expected Output: Oral responses (with optional brief written notes)
	Option 3. Classifying Everyday Substances as Ionic or Covalent	
	The teacher presents three familiar materials such as baking soda (ionic), candle wax (covalent), and plastic container (covalent). Learners will answer the guide questions in pairs and share their answers to the class. Guide Questions 1. Which of these substances dissolve in water easily, and which do not? 2. Which substances do you think are ionic and which are covalent? Why do you think so?	The activity supports Learning Objectives 1 and 3, applying IDF principles of relevance and responsiveness by linking familiar materials to bonding concepts. It shows Constructivist and Integrative features as learners compare properties and predict ionic vs covalent types. All examples used should represent single, well-defined substances, not mixtures. Properties such as solubility or conductivity

	3. How can solubility and electrical conductivity observations in suitable substances, such as baking soda solutions, help scientists classify materials as ionic or covalent, while materials like candle wax and plastics are identified based on their solid structure and everyday use? 4. How do solubility, conductivity, and structure help you classify materials as ionic or covalent?	are discussed only as observations and are applied only to substances where they are appropriate.
	B.2. Discussing New Concept	
	Option 1. Everyday Applications of Ionic and Covalent	
	Learners in groups examine common applications of compounds found at home, in the environment, and in industries. For each assigned application, learners identify whether the compound used is ionic or covalent and determine the property that helps distinguish its type. Each group briefly shares their findings with the class. Process Questions 1. What type of compound (ionic or covalent) is commonly used in your assigned application? 2. What observable property (e.g., solubility, conductivity, physical form) helps you determine this type? 3. How does this compound differ from the other type of observable properties or behavior?	The activity supports Learning Objectives 1 and 3, applying IDF principles of relevance and responsiveness by linking every day and industrial compounds to bonding concepts. It shows Constructivist and Integrative features. Teacher consolidates responses to emphasize how bonding types explain observable properties and real-world applications. Link for common application of compound https://docs.google.com/document/d/1zWBGMD7n5BIPVfdkb-LF9XXh-8rRC3jR/edit?usp=sharing
	Option 2. Property- Based Concept	
	Learners work in small groups to complete a concept organizer. Each group is assigned one well-defined common substance like baking soda, sugar, candle wax, or plastic. Groups complete the organizer by identifying: • Type of compound (ionic or covalent), • Observable property (e.g., solubility, conductivity if applicable, physical form), • What does this property suggest about the compound type? Groups briefly share their findings with the class.	The activity supports Objectives 1–3 by applying through relevance and responsiveness. Learners classify familiar substances, relate properties to bonding type, and explain real-life applications, showing Constructivist and Integrative approaches. Teacher clarification: Use composition and suitable property evidence. Solubility or conductivity alone is not a universal test.

	Option 3. Compare-and-Explain: Ionic or Covalent	
	The teacher assigns each group paired substances commonly encountered such as salt vs. sugar; inorganic fertilizer (ammonium nitrate (NH_4NO_3) vs. plastic; and sodium chloride vs. paraffin wax. Groups compare the pair by discussing: 1. Which one is ionic and which is covalent? 2. One key property that distinguishes them? 3. How does this difference help determine compound type? **Key properties** • salt vs sugar-electricity conductivity in solution • ammonium nitrate vs plastic- solubility and electrical conductivity in water • baking powder vs candle wax- solubility and electrical conductivity in water.	Possible Answer 1. Salt: Ionic; vs. Sugar Salt: Ionic; dissolves and conducts electricity. 2. Sugar: Covalent; dissolves but does not conduct electricity. 3. Ammonium nitrate: Ionic; dissolves and conducts electricity 4. Plastic: Covalent polymer; insoluble and nonconductive 5. Sodium chloride: Ionic; dissolves and conducts electricity 6. Paraffin wax: Covalent; insoluble and nonconductive
	B.3. Developing Mastery	
	Option 1. Property- Based Classification	
	Learners work in small groups. Each group is given one information card describing a well-defined substance like sucrose (solid sample), sodium bicarbonate ($NaHCO_3$), and polyethylene (PE) with a short list of observable properties such as solubility in water, electrical conductivity, and physical form at room temperature. The group determines the type of compound (ionic or covalent), the property used to classify it and give similar real-life example. Groups then briefly share their classification and reasoning with the class.	Addresses Objectives 1 and 3 through a relevant, responsive, and constructivist guided discussion. Formative check: Ask each learner to classify one new substance and state the evidence or basis of classification. Reinforcement: Use comparison cards that pair composition clues with appropriate observable properties.
	Option 2. Explain- Reflect- Refine	
	Each group writes a short explanation of ionic compounds, and a short explanation of covalent compounds using starters provided by the teacher. Groups exchange explanations and revise them based on peer feedback.	Addresses Objectives 1 and 3 through relevant, responsive, and constructivist guided discussion

	Possible Reflection: ● Explanation of ionic compounds: Ionic compounds are formed when electrons are transferred from one atom to another, producing charged ions that attract each other. They often dissolve in water and can conduct electricity in solutions. ● Explanation of covalent compounds: Covalent compounds are formed when atoms share electrons, resulting in molecules. They usually do not conduct electricity and may exist as solids, liquids, or gases.	The teacher elicits group explanations and uses peer-revised responses to strengthen understanding of ionic and covalent compounds. Expected Output: Two brief written explanations describing ionic and covalent compounds, revised based on peer feedback.
	Option 3. Concept Check Reflection	
	Learners individually complete the following statements: • One key difference between ionic and covalent compounds is _____. • One property used to classify ionic compounds is _____. • One real-life example of a covalent compound is _____. Note: Many ionic compounds are crystalline solids and conduct electricity when molten or dissolved, while many covalent substances consist of molecules and usually do not conduct electricity in solution.	Possible answer to complete the reflection ionic compounds involve electron transfer, while covalent compounds involve electron sharing. their ability to conduct electricity when dissolved in water. One real-life example of a covalent compound is sugar.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1. Bonding in Everyday Situations	
	Learners work in small groups. Each group is given a clear, well-defined real-life substance such as Epsom salt (magnesium sulfate heptahydrate, $MgSO_4 \cdot 7H_2O$), paraffin wax, and plastic spoon (polymer). For their assigned situation, the group identifies the type of compound and the one property (e.g., solubility, conductivity) that explains the substance's behavior.	Addresses Objectives 1 and 3 using a relevant, responsive, and constructivist guided discussion. Teacher Note: Each situation refers to a specific substance, not an entire product or mixture. Only apply solubility or conductivity tests to substances that properly dissolve in water.

	Option 2. Which Compound Fits?	
	Learners work in small groups. Each group shall be presented with clearly defined everyday needs, each linked to a specific, well-defined substance. For each situation, learners decide whether an ionic or covalent compound best fits and identify one observable property that supports their choice. • Epsom salt (magnesium sulfate heptahydrate, $MgSO_4 \cdot 7H_2O$)- substance that must conduct electricity in water. • Plastic (polymer) material used for food packaging. • Baking soda (sodium bicarbonate, $NaHCO_3$)- compound found in fertilizers or cleaning products	This shows Constructivist and Integrative features as learners collaborate, use evidence, and connect bonding types to real-life applications. Safety Note: Do not taste substances. Use small amounts, wash hands after the activity, and let only the teacher handle conductivity-r=testing equipment. Output: Brief oral group response with short note, evidence-based justification, and correct terminology
	Option 3. Home -Environment Industry Map	
	Learners create a simple chart or concept map showing one ionic compound and one covalent compound found at home, environment, and industry. Learners indicate the type of compound; observable property; and how it differs from the other type. Emphasize that observable properties should be appropriate to the substance (e.g., conductivity only for dissolved ionic compounds, physical form for solids like plastics) to avoid misconceptions when comparing ionic and covalent compounds.	The activity supports Objectives 1–3 by applying IDF principles of relevance and responsiveness. This shows Constructivist and Integrative features, as learners use evidence-based reasoning. Note: Teacher elicits charts/maps; learners respond with classifications and properties; teacher recognizes correct reasoning and uses responses to connect bonding types with everyday applications.
	C.2. Making Generalization	
	Option 1. Finish the Statement	
	Readiness check: Classify sodium chloride and sucrose as ionic or covalent, then write one property clue for each and explain that solubility alone is not sufficient evidence.	Expected possible answers: for option 1 1. Ionic compounds are usually <u>crystalline solids</u>, while covalent compounds are

	Learners orally or in writing complete the following: 1. Ionic compounds are usually __ while covalent compounds are____. 2. A substance that conducts electricity when dissolved is likely _____. 3. Ionic and covalent compounds can be differentiated based on their _____ and _____.	molecular substances that can exist as solids, liquids, or gases. 2. A substance that conducts electricity when dissolved is likely ionic. 3. Ionic and covalent compounds can be differentiated based on their electrical conductivity and solubility.
	Option 2. Concept Mapping	
	Learners complete a concept map showing the relationships between: • Type of compound (ionic/covalent). • Observable properties (solubility, conductivity, and physical form). • Examples found at home, in the environment, and in industries.	Addresses Objectives 1 and 3 using a relevant, responsive, and constructivist guided discussion. Expected Output: A completed concept map that correctly shows the relationship between type of compound and observable properties.
	Option 3. One-Sentence Rule	
	Learners write one clear sentence that captures the lesson. "Write one sentence that explains how ionic and covalent compounds differ based on their properties and how this helps us identify them in real life."	Teacher Note: Encourage learners to summarize the lesson using properties discussed in class (such as solubility or conductivity) and to relate these differences to real-life identification, not definitions alone.
	C.3. Evaluating Learning	
	Option 1. Quick Classification Check	
	Learner will classify each substance as ionic or covalent 1. Sodium chloride (NaCl) 3. Water (H_2O) 5. Polyethylene (C_2H_4) 2. Table sugar ($C_{12}H_{22}O_{11}$) . Potassium nitrate (KNO_3).	Possible answers: 1. Ionic 3. Covalent 5. Covalent 2. Covalent 4. Ionic
	Option 2. True or False	
	Directions: Write **T** if the statement is true and **F** if it is false. 1. Ionic compounds usually conduct electricity when dissolved. 2. Covalent compounds are commonly used in plastics. 3. All compounds dissolved in water are ionic.	The teacher elicits learners' True/False responses, recognizes correct statements and misconceptions, and uses them to clarify how observable properties and real-life examples distinguish ionic from covalent compounds.

	4. Observable properties can help distinguish ionic compounds from covalent compounds. 5. Ammonium nitrate (NH_4NO_3) is an inorganic fertilizer that is ionic and soluble in water.	Expected Answer: 1. T 2.T 3. F 4. T 5. T
	Option 3. Identify-Support-Differentiate	
	Learners read each item carefully and answer briefly. 1. Identify whether each substance is ionic or covalent: Salt Sugar 2. State one observable property (e.g., solubility, conductivity, physical form) that helps classify each substance. 3. Differentiate ionic and covalent compounds by completing the sentence. Ionic compounds differ from covalent compounds because _____.	Expected Answer: 1. Salt- Ionic Sugar- Covalent Salt: It dissolves in water and conducts electricity in solution. 2. Sugar: It dissolves in water but does not conduct electricity. 3. Ionic compounds form through electron transfer and produce ions, while covalent compounds form through electron sharing and produce molecules.
	C.4. Additional Activities	
	Option 1. Enrichment: Home Chemistry Photo Log	
	Learners take or collect photos of three (3) household items and for each item they need to name the substance or compound, identify whether it is ionic or covalent, state one observable property (e.g., solubility, conductivity, physical form) that supports the classification, and indicate where the item is commonly used (home, environment, or industry). Link for suggested scoring rubric https://docs.google.com/document/d/1zWBGMD7n5BIPVfdkb-LF9XXh-8rRC3jR/edit?usp=sharing	Targets Objectives 1 and 3; and emphasizes relevance and responsiveness through a constructivist, reflective task using real-life examples. The teacher elicits learners' classifications from the photo logs, recognizes correct use of observable properties, and uses responses to reinforce distinctions between ionic and covalent compounds.
	Option 2. Reinforcement: Compound Classification Card Sort	
	Learners work individually or in pairs. They are given a set of compound cards and property clue cards. Sample compound cards (sodium chloride, sucrose, water, potassium nitrate, paraffin wax, and polyethylene). Sample property clue cards (conducts electricity	The teacher elicits learners' card matches, recognizes correct use of property clues, and uses responses to reinforce how observable properties distinguish ionic and covalent compounds.

	when dissolved; dissolves in water but does not conduct electricity; forms solid crystals; and is made of long molecular chains).	Learners correctly match each compound card with the appropriate property clue card.
	Option 3. Remediation: Two-Column Sort	
	The teacher begins by telling the class that they will sort everyday substances into two groups: ionic compounds and covalent compounds. A substance is presented, such as salt, and learners guess which column it belongs to. The teacher then confirms the correct answer, explains the observable property that supports the classification, and gives immediate feedback. The process continues with other examples like sugar, baking soda, candle wax, and ammonium nitrate.	The activity meets Objectives 1–3, applying IDF principles by sorting familiar substances into ionic and covalent groups with property-based feedback, showing Constructivist and Integrative features. Learners respond with guesses; teacher recognizes correct classifications and uses them to connect bonding types with observable properties and everyday uses.
VI. ASSESSMENT *(Assessing Learnings)*	The teacher will facilitate the given assessment to evaluate learners' learning. 1. Which of the following substances is an ionic compound? A. plastic B. sodium chloride C. sugar D. water 2. Which substance is classified as a covalent compound? A. sugar B. sodium chloride C. potassium nitrate D. potassium chloride 3. Which property is most associated with ionic compounds? A. soft and flexible C. low melting point B. insoluble in water D. conduct electricity when dissolved in water 4. A compound dissolves in water but does NOT conduct electricity. What type of compound is most likely? A. anion B. cation C. covalent D. ionic 5. Which property helps classify potassium nitrate, a common fertilizer salt, as an ionic compound? A. It is soft and flexible. C. It is a gas at room temperature. B. It forms neutral molecules only. D. It dissolves in water and produces ions. 6 Polyethylene is widely used for packaging because it is durable and does not dissolve easily in water. This material is best classified as a _____ material. A. acidic B. cation C. covalent polymer D. ionic 7. Which property commonly distinguishes many ionic compounds from many covalent compounds? A. Ionic compounds are usually soft, while covalent compounds are hard. B. Ionic compounds are always liquids, while covalent compounds are solids.	

C. Ionic compounds have low melting points, while covalent compounds have high melting points.

D. Ionic compounds conduct electricity when dissolved in water, while most covalent compounds do not.

8. A learner claims that all compounds that dissolve in water are ionic. Which observation best disproves this claim?

A. Plastics are strong materials and resist breaking.

B. Sugar dissolves in water but does not conduct electricity.

C. Salt conducts electricity when dissolved in liquid like water.

D. Fertilizers dissolve in water and provide nutrients that support plant growth

9. Which statement best differentiates covalent compounds from ionic compounds?

A. Ionic compounds are formed only from nonmetal elements and atoms.

B. Ionic and covalent compounds share the same physical properties overall.

C. Covalent compounds usually conduct electricity when dissolves in water

D. Covalent substances form molecules, while ionic compounds consist of charged ions.

10. It is important to understand whether a compound is ionic or covalent before using it to _____.

A. measure its mass and quantity before use.

B. determine its brand and source before use.

C. predict its properties, uses and effects before use.

D. identify its color, appearance and properties before use.

Answer Key:

1.B 2.A 3.D 4.C 5.D 6.C 7.D 8.B 9.D 10.C

Performance task

The learner selects one household product or environmental material and identifies one chemical compound it contains. The learner classifies the compound as ionic or covalent, describes one relevant property, and explains how this property supports the product's use. The expected output is a short narrative paragraph that clearly presents the product, compound name, classification, property, and its practical application in everyday life. Sentence frame for performance task:

The product/material I chose is ____. One compound it contains is ____. This compound is ____ because ____. One relevant property is ____. This property helps explain why the product/material is used for ____.'

	Link for suggested rubric *https://docs.google.com/document/d/1zWBGMD7n5BIPVfdkb-LF9XXh-8rRC3jR/edit?usp=sharing&ouid=105286949008851356769&rtpof=true&sd=true*
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part did they find most difficult? 4. How many learners require enrichment or additional academic challenges? How many of them need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used the Copilot and Grammarly to improve the grammar and consistency of the instructions in the different instructional options and in the annotations. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.

Learning Title/Topic:	**Chemical Bonding and Compounds** • **Introduce chemical bonding** • **Show how ionic and covalent bonding form** • **Comparison between ionic and covalent bonding**	**Lesson Exemplar:**	14

I. OBJECTIVES	
A. Content Standard	*The learners learn that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.*
B. Performance Standard	*By the end of the quarter*, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and investigate to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners understand that matter is made of atoms, recognize the role of electrons in chemical interactions, and can describe simple observable properties such as solubility and electrical conductivity.
	The learners identify that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• Chang, Raymond, and Kenneth A. Goldsby. *Chemistry*. 12th ed. New York: McGraw-Hill Education, 2016. • Brown, Theodore L., H. Eugene LeMay Jr., Bruce E. Bursten, Catherine Murphy, and Patrick Woodward. *Chemistry: The Central Science*. 14th ed. Boston: Pearson Education, 2018. • Khan Academy. "Ionic and Covalent Bonds." Accessed May 6, 2026. https://www.khanacademy.org/science/ap-chemistry-beta/x2eef969c74e0d802:bonding. LibreTexts Chemistry. "Ionic and Covalent Bonding." Accessed May 6, 2026.

III. CONTENT *(*Sequencing *Content)*	***Chemical Bonding and Compounds*** • Introduce chemical bonding • Show how ionic and covalent bonding form • Comparison between ionic and covalent bonding	
IV. OBJECTIVES *(*Setting *Clear Objectives and Analyzing the Tasks)*	1. Describe ionic bonding as the electrostatic attraction between oppositely charged ions that forms after electrons are transferred from one atom to another. 2. Explain covalent bonding as a chemical bond formed when atoms share one or more pairs of electrons. 3. Compare ionic and covalent bonding in terms of electron involvement (transfer vs. sharing), the structures formed, and the resulting properties of substances.	
V. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1. Same or Different	
	The teacher shows pairs of familiar substances such as sugar vs. cooking oil, vinegar vs. baking soda, metal spoon vs. plastic spoon. Learners think individually, then discuss in pairs Process Question: Based on your everyday use or known behavior in water, which of these substances do you think would dissolve or conduct electricity, and which would not?	Targeted Objectives: Objectives 1 and 3. IDF 3Rs: Relevance and responsiveness. 2C–2I–1R Approach: Constructivist and Interactive. Pedagogical Strategy: Guided discussion with concept classification. Accept all responses without correction. Prompt learners to focus on observable properties, not definitions.
	Option 2. What's Holding It Together?	
	Teacher asks: "What do you think holds atoms together in substances like salt or water?" Learners respond by raising hands, writing short responses on mini cards or voting (force, attraction, sharing-electrons, etc.,)	Targeted objectives 1 and 2, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive in nature. Use learner responses to identify whether learners confuse electron transfer with electron sharing. Delay formal correction until after all ideas are surfaced, then clarify the difference using one ionic and one covalent example.

	Option 3. Electrons: Share or Give?	
	The teacher poses a scenario, "If two atoms come together, do you think electrons are transferred (given and received), shared, or are you unsure?" Learners respond verbally by choosing one.	Targeted objectives 1 and 2, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive in nature. Corrective Clarification: If learners confuse the two, explain that ionic bonding involves electron transfer that produces oppositely charged ions, while covalent bonding involves electron sharing that commonly forms molecules.
	A.2. Establishing the Purpose of the Lesson	
	Option 1. Situation Sorting-"What Do You Notice?"	
	The teacher says, "Today we will explain how electrons are transferred or shared, identify whether bonding is ionic or covalent, and connect bonding type to the structure and properties of substances". Learners will work in groups. They are given cards with everyday situations, such as salt dissolving in water, sugar dissolving in water, water molecules staying together in liquid water, plastic not dissolving in water. Instead of matching lesson targets, learners sort the situation cards into groups based on observed or expected behavior. Groups provide three short sentences for a brief explanation.	Targeted objectives 1 and 2, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive in nature. Inclusive Support: Provide sentence frames, picture-supported cards, and pair-check opportunities for learners who need language or processing support.
	Option 2. Purpose Station	
	Three short "stations" are set up: **Station 1 (Observation):** Pictures of salt, sugar, water, plastic • What differences do you notice? **Station 2 (Inference):** Same pictures from station 1. Learners predict how each substance might behave in real-life situations	Targeted objectives 1, 2, and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion. The teacher elicits learner observations and predictions at each station, recognizes common patterns in responses, and uses these ideas to formulate and state

	Task: Learners choose or discuss responses such as: • Would this substance mix well with water or not? • Which substances might affect electricity in water, and which might not? **Station 3 (Purpose):** • Task: Write one question you expect today's lesson to answer. Groups rotate briefly, then teacher synthesizes responses to state the lesson's purpose.	the lesson purpose serving as a transition to the formal discussion of ionic and covalent bonding. Expected Output: Learners record brief observations of differences among the substances, make simple predictions about how they behave in water or electricity, and write one question they expect the lesson to answer. Access link to Annex B for picture for the activity https://tinyurl.com/CHEM-Q2-L1-2
	Option 3. Quick Conference	
	Teacher presents the lesson focus: Say, "Today, we will examine how electrons form bonds and affect properties of substances." Learners choose one of three goal statements to discuss in triads: • I want to understand the difference between ionic and covalent bonding. • I want to understand how electrons affect properties like conductivity. • I want to be able to explain real-life examples using bonding ideas.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion. The teacher moves around the room, monitors participation, prompts deeper thinking when needed, and notes common ideas. Learners are expected to actively participate in triad discussions and produce a shared verbal explanation
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1. Electron Story Cards	
	Groups receive picture or story cards showing an atom giving electrons to another atom (one gives, one receives); atoms sharing electrons. Learners identify which card represents ionic and which represents covalent bonding. The teacher formalizes the definition using learner responses. Expected output is a verbal or written justification.	Suggested visual: A two-panel diagram showing (1) sodium transferring an electron to chlorine to form Na^+ and Cl^- and (2) two hydrogen atoms sharing electrons with oxygen in H_2O. Use the diagram to ask learners how electron behavior differs in the two cases. Link for the picture of ionic and covalent bonding iStock. "Ionic vs Covalent Bonds." Vector illustration, n.d. https://www.istockphoto.com/vector/ionic-vs-covalent-bonds-gm1301181932-393288502.

Commented [CJP1]: How about receiving?

Option 2 Guided Comparison Table

The class work in groups to complete a comparison table with the teacher

Feature	Ionic Bonding	Covalent Bonding
Electron involvement		
Structure formed		
Conductivity		

Process Questions:

1. What happens to the electron in this picture—does it move away from one atom or stay between atoms?
2. Do the particles form look like charged ions or neutral molecules?
3. Which type of particles could move freely in water and allow electricity to flow? Why?

Targeted objectives 1, 2 and 3, applying IDF 3 Rs.

Ask guiding questions rather than giving answers outright. Emphasize cause–effect between electron behavior and properties.

For conductivity for Ionic bonding, ionic compounds do not conduct electricity as solids, but they conduct when molten or dissolved in water because ions can move. Most molecular covalent substances do not conduct electricity because they do not produce mobile charged particles.

Link for the comparison table

https://tinyurl.com/CHEM-Q2-L1-2

Option 3. Example- Concept Matching

Learners match specific substances such as sodium chloride (ionic), water (covalent), polyethylene plastic (covalent), potassium chloride fertilizer (ionic), and ammonium nitrate fertilizer (ionic) with the correct bonding type. They state the electron behavior involved in each match.

Teacher's Note:

The teacher elicits learners' matches between substances and bond types, recognizes correct identification of electron transfer or sharing, and uses these responses to reinforce the distinction between ionic and covalent bonding.

B.2. Discussing New Concept

Option 1. Explain the Bond (Small-Group Task)

Learners work in small groups to construct explanations of ionic and covalent bonding using provided prompts. Each group uses illustration cards for ionic/covalent bonds. They examine the illustration assigned to their group and complete the prompts.

Teacher's Note:

The teacher provides illustration cards, guides group discussions, and circulates to check understanding and clarify how electron transfer and electron sharing lead to different structures.

	• *In this type of bonding, electrons are _____.* • *This type of bonding is called _____ bonding.* • *The particles formed are _____ (ions / molecules).*	Teacher Support: Draw a simple particle-level diagram for NaCl and H2O to show how ionic and covalent bonding differ in representation.).
	Option 2. Electron Pathway Sorting (Hands-On Task)	
	Learners work in groups to arrange cards showing electron transfer and electron sharing with ionic bonding and covalent bonding to model how electrons behave in each type of bond. They explain their arrangement to another group and revise it as needed based on class discussion.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs. The teacher guides learners in arranging the cards and facilitates peer explanation and uses class discussion to clarify and refine understanding. Expected Output: Correct card arrangement with a brief explanation or short oral report.
	Option 3. Complete the Concept Flow	
	Using the task sheet, learners complete the concept flow by filling in how electron behavior leads to a specific type of bonding, the structure formed, and the resulting properties. Use examples discussed in class to guide your answers. *Learners complete a partially finished concept flow.* *Task Sheet* *Electron behavior* → *Type of bonding* → *Structure* → *Properties*	Teacher's Note Sample partial concept flow → Electrons are _____from one atom to another. → This forms _____ bonding. → The particles formed are _____ . → The substance usually _____ electricity when dissolved in water. **Expected Output:** A correctly completed concept flow linking electron behavior to bonding type, structure formed, and observable properties
	B.3. Developing Mastery	
	Option 1. Bonding Decision Task	
	Learners are given short real-life substance scenarios such as salt solution (sodium chloride dissolves in water); sugar solution (sucrose dissolved in water); liquid water (water molecules interacting with each other); plastic material (plastic container or plastic spoon). In groups, learners decide for each scenario: • Whether the substance involves ionic or covalent bonding	This activity targets Objectives 1-3 through a constructivist and interactive guided discussion that supports relevance and responsiveness. Formative Check: Ask learners to classify NaCl, H2O MgO, and CO2 as ionic or covalent and identify whether electrons are transferred or shared.

	• Whether electrons are transferred or shared • One resulting structure or observable property (e.g., ions in solution, neutral molecules, conductivity behavior)	Reinforcement: For learners needing support, use a two-column sorting task with sentence frame: " This is ionic because… ' and "This is covalent …".
	Option 2. Explain- Reflect- Refine	
	Each group writes one short explanation of ionic bonding and one of covalent bonding using guiding phrases: • Ionic bonding involves… • Covalent bonding involves… Groups exchange explanations with another group. Based on feedback or class discussion, groups revise their explanations.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs. The teacher facilitates the activity by guiding learners as they articulate and exchange explanations of ionic and covalent bonding. Expected Output: One brief explanation each for ionic and covalent bonding, showing correct use of guiding phrases and improved through peer discussion.
	Option 3 Concept Check Reflection	
	Learners work individually to complete the following prompts in their notebook. 1. One key difference between ionic and covalent bonding is _____. 2. One property that results from ionic bonding is _____. 3. Electron sharing results in substances that _____.	Teacher's Note: Expected sample responses: 1. …that ionic bonding involves the transfer of electrons, while covalent bonding involves the sharing of electrons. 2. …the ability to conduct electricity when dissolved in water. 3. …form neutral molecules and usually do not conduct electricity.
C. Demonstrating Knowledge and Skills	**C.1. Finding Practical Application**	
	Option 1. Bonding in Everyday Situations	
	Learners are grouped and given every day or industrial situations, such as cooking with salt and sugar, using tap water vs. distilled water, plastic containers, electrolyte drinks or ionic salt solutions. Each group identifies the 1.) The type of bonding involved (ionic or covalent) 2.) Whether electrons are transferred or shared 3.) One observable property (e.g., conductivity in solution, solubility in water, non-conductive	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion. Teacher's Note:

	nature of plastics) that supports their classification. A short oral report or written summary per group.	Clarify that distilled water conducts very poorly, while tap water and electrolyte solutions conduct better mainly because they contain dissolved ions.
	Option 2. Substance Card Scenarios	
	Learners work in small groups. Each group is given scenario cards used at home, in the environment, or in industry. • An electrolyte solution in a car battery (sulfuric acid in water) that allows electricity to flow between the battery terminals • A sweet substance that dissolves in water but does not conduct electricity • A lightweight material used for packaging food and drinks For each scenario, the group identifies: • The type of bonding involved (ionic or covalent); • How electrons behave (transferred or shared); and • One observable property that supports their classification.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion. Safety Note: Use only teacher-approved household samples or labels. Do not taste substances, open batteries, or handle unknown chemicals during the activity. Learners are expected to give correct identification of bonding type, electron behavior, and supporting property for each scenario.
	Option 3. Explain It to Others	
	Learners work in pairs. Learner imagines explaining the concept to a younger learner, or a family member at home. They prepare a short explanation answering the following questions: • How electrons behave in ionic vs. covalent bonding? • Why substances behave differently because of this?	Targeted objectives 1, 2 and 3, applying IDF 3 Rs. The teacher elicits learners' explanations of electron behavior, recognizes clear comparisons between ionic and covalent bonding, and uses their responses to reinforce why these differences lead to different substance properties. Learner's output can be a short-spoken explanation or a short-written paragraph

	C.2. Making Generalization	
	Option 1. Complete the Generalization	
	Learners will complete teacher- provided statements based on the lesson. Sample Generalization Statements: • Ionic bonding occurs when electrons are __ from one atom to another. • Covalent bonding occurs when electrons are __ between atoms. • Electron transfer results in the formation of __, while electron sharing forms ____. • Because of these differences, ionic and covalent compounds have different ____ and ____.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive. Guided concept classification using observable properties, followed by teacher clarification of electron transfer and ionic lattice formation. Expected Output: Correctly completed statements showing understanding of how electron behavior distinguishes ionic and covalent bonding and explains differences in their properties.
	Option 2. Key Takeaway Trio	
	Individually or in pairs, learners write three key takeaways from the lesson, guided by prompts: One thing I learned about ionic bonding is _____. One thing I learned about covalent bonding is _____. One way bonding affects the properties of substances is_____.	Teacher's Note: The teacher elicits learners' written takeaways, recognizes accurate summaries of ionic and covalent bonding, and uses these reflections to consolidate how bonding influences the properties of substances.
	Option 3. "Finish the Thought" (Choral / Oral Generalization)	
	The teacher begins statements aloud; learners complete them orally: 1. Chemical bonding involves the _____of electrons. 2. _____ occurs specifically after electrons are transferred from one atom to another. 3. ____ is defined as a chemical bond formed when atoms share one or more pairs of electrons 4. The way electrons behave affects the __and __of substances.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive. Readiness Check: Give learners three quick prompts before the evaluation: (1) NaCl – ionic or covalent? (2) H2O – transferred or shared electrons? (3) Which type is more likely to conduct when dissolved? Proceed to C.3 only after reviewing the answers.

	C.3. Evaluating Learning	
	Option 1. Identify and Explain	
	Learners answer the following: 1. Identify whether the bonding in each substance is ionic or covalent: Salt (NaCl) Water (H_2O) Sugar ($C_{12}H_{22}O_{11}$) 2. State whether electrons are transferred or shared in each case. 3. Briefly explain one property of each substance that supports your answer.	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive. The teacher guides learners in identifying bonding types and electron behavior and reinforces correct connections to properties.
	Option 2. Bonding Comparison	
	Learners complete a comparison organizer individually by answering the following questions: 1. How are electrons involved in ionic bonding? 2. How are electrons involved in covalent bonding? 3. How does this difference affect the structure and properties of substances? 4. Why does electron transfer or sharing lead to a different kind of particle, and how does that help explain the property observed? 5. Why does the presence of mobile ions help explain electrical conductivity in solution, while shared electrons in molecules usually do not?	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive. The teacher facilitates the individual completion of the comparison organizer, monitors learner responses, and provides clarification to ensure accurate comparison of ionic and covalent bonding in terms of electron involvement, structure, and properties.
	Option 3. Concept Mastery Exit Slip	
	Learners answer the following questions individually. 1. Ionic bonding involves the _____ of electrons. 2. Covalent bonding involves the _____ of electrons.	The teacher facilitates the individual completion of the items, reviews learner responses to check understanding, and provides immediate feedback to

	3. One way bonding affects the properties of substances is ____.	reinforce key ideas on electron transfer, electron sharing, and their effects on substance properties
	C.4. Additional Activities	
	Option 1. Reinforcement: "Bonding in My Home"	
	Learners list three specific substances found at home. For each substance, they complete the table below using only the guide provided. • Name of substance. • Type of bonding (ionic or covalent). • Electron behavior (electrons are transferred or shared) • One observable property (conducts electricity when dissolved in water; dissolves in water but does not conduct electricity; does not dissolve in water and does not conduct electricity; exists as a hard crystalline solid; exists as a molecular substance (liquid or soft solid)	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion The teacher guides learners in identifying household substances and determining their bonding type, electron behavior, and observable properties, while monitoring responses to reinforce accurate application of ionic and covalent bonding concepts.
	Option 2. Enrichment: " Bonding Gallery Walk"	
	Learners work in assigned group. Each group will create a mini poster or chart that compares one ionic compound and one covalent compound commonly found at home, in the environment, or in industry. Poster must clearly include the following information for each compound: • Type of bonding (ionic or covalent) • Electron behavior (electrons are transferred or shared) • Structure formed (ions or molecules) • One observable property that is directly related to the bonding type (e.g., electrical conductivity in solution, solubility, physical state) Posters are displayed for peer viewing	Targeted objectives 1, 2 and 3, applying IDF 3 Rs of relevance and responsiveness. The approach is both constructivist and interactive through guided discussion The teacher facilitates the creation of mini posters by guiding learners to accurately present ionic and covalent compounds, monitors group work for correct identification of electron behavior, structure, and properties, and leads a gallery walk to reinforce understanding through peer learning. For Visual and peer-learning enrichment task Link for possible rubric: https://tinyurl.com/CHEM-Q2-L1-2

<table>
<tr><td></td><td colspan="2">Option 3. Remediation: “Bonding Errors: Spot and Correct”</td></tr>
<tr><td></td><td>Learners work individually or in pairs. They are given a short set of incorrect statements about chemical bonding. Their task is to:
1. Identify what is incorrect in each statement.
2. Rewrite the statement correctly, using proper scientific terms.
Sample Statements :
Ionic bonding happens when electrons are shared between atoms.
Covalent compounds form ions that conduct electricity in water.
Electron transfer results in the formation of molecules.
Covalent bonding usually involves metals and nonmetals.</td><td>Targeted objectives 1, 2, and 3, apply IDF 3 Rs of relevance and responsiveness.

The teacher facilitates the activity by guiding learners to identify misconceptions in the given statements and rewrite them correctly using proper scientific terms. Learner responses are monitored and clarified through feedback to reinforce accurate understanding of ionic and covalent bonding.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Multiple Choice: Choose the best answer.
1. Which statement best describes ionic bonding?
A. Neutrons are lost during bonding. C. Electrons are shared equally between atoms.
B. Protons are exchanged between atoms. D. Electrons are transferred from one atom to another.
2. How do atoms form a covalent bond?
A. Atoms form a covalent bond by sharing electrons. C. Atoms form a covalent bond by gaining and losing electrons.
B. Atoms form a covalent bond by transferring electrons. D. Atoms form a covalent bond by breaking into charged particles.
3. Which pair correctly matches the bonding type and particle formed?
A. Ionic bonding – neutral molecules C. Covalent bonding – free cation
B. Ionic bonding – ions arranged in a lattice D. Covalent bonding -ions in lattice
4. A substance dissolves in water and conducts electricity in solution. Which type of bonding is most likely present?
A. Ionic bonding is present because molecules stay neutral. C. Covalent bonding is present because molecules move freely
B. Ionic bonding is present because ions carry electric charge D. Covalent bonding is present because electrons are shared .</td></tr>
</table>

	5. Which observation is most consistent with a molecular covalent substance such as sugar? A. It conducts electricity when dissolved C. It has a high melting point and forms a rigid lattice. B. It forms charged particles in solution D. It dissolves in water but does not conduct electricity 6. Salt (NaCl) and sugar both dissolve in water, but only salt conducts electricity. Which explanation is best? A. Both are covalent compounds. C. Sugar is ionic, while salt is covalent. B. Salt is ionic, while sugar is covalent D. Sugar conducts electricity better than salt 7. If electrons are shared between atoms in molecular substance, which result is most expected? A. Formation of ions and a high melting point. B. Formation of metals and free-moving electrons. C. Formation of molecules and low electrical conductivity D. Formation of ions and electrical conductivity in solution. 8. A compound is composed only of nonmetal atoms and exists as discrete particles. Which conclusion is most reasonable? A. It must contain metal ions C. It most likely forms an ionic lattice. B. It most likely has covalent bonding D. It must conduct electricity in water. 9. Why do ionic compounds usually have different properties from covalent compounds? A. They differ only in color and size C. They contain different numbers of atoms. B. They react differently with all substances. D. They differ in how electrons are transferred or shared. 10. Which statement best explains how chemical bonding affects the properties of substances? A. Only covalent bonds affect substance properties. B. All bonds result in the same physical properties. C. Bonding determines only the appearance of substances. D. Electron behavior influences structure, which affects properties. ***Answer Key*** ***1. D 2. A 3. B 4. B 5. D 6. B 7. C 8. B 9. D 10. D*** **Performance Task:** Using teacher-approved samples, labels, or a provided data table, learners classify two substances as more likely ionic or covalent and justify their answer using electron behavior, structure, and observable properties. They present their explanation either in a short-written paragraph or through a brief oral presentation, clearly stating the bonding type and the evidence used to justify their conclusion.

	Performance Task Rubric Criteria: (1) correctly identifies bonding type; (2) correctly explains electron behavior; (3) links structure to at least one observable property; (4) uses safe, teacher-approved evidence; (5) communicates the explanation clearly.
VII. REFLECTION *(*Feedback *and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Copilot and Grammarly to improve the clarity, grammar, and consistency of selected instructional options and annotations. The author(s) reviewed, revised, and finalized all content and take full responsibility for the finished LE.

Learning Title/Topic:	Chemical Bonding and Compounds	Lesson Exemplar:	15

I. OBJECTIVES	
A. Content Standard	The learners learn that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and investigate to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners are expected to distinguish elements, compounds, atoms, molecules, and ions; interpret simple chemical formulas; identify common metals and nonmetals using the periodic table; and explain that compounds form through electron transfer or sharing.
	In this lesson, the learners name and write formulas of ionic and covalent compounds using IUPAC nomenclature.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	1. Brown, Theodore L., *et al*. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018. 2. Chang, Raymond and Kenneth A. Goldsby. Chemistry. 12th ed. New York: McGraw-Hill, 2016. **Materials:** ion cards, formula cards, prefix chart, projector, worksheets, manila paper, markers, and sample household labels.
III. CONTENT *(Sequencing Content)*	**Chemical Bonding and Compounds**
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Name and write the formula of ionic compounds formed by representative metals and nonmetals using IUPAC nomenclature. 2. Name and write the formula of covalent compounds formed by representative nonmetals using IUPAC nomenclature.

V. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1: *"Quick Classify"*	
	1. The teacher will divide the class into groups and will provide a set of cards with written chemical symbol/formula (e.g. Li+, He, O_3, CO_2, Na^+, Cl^-, Mg^{2+}, H_2O, Ca) and a blank classification table. 2. The group of learners will be tasked to classify each card into: Atom, Molecule, or Ion by sticking it into the classification table provided by the teacher. 3. The group will be tasked to post their answers on the board and state their reasoning for the classification they have made.	The activity targets Learning Objectives 1 and 2 and the IDF principles of relevance and responsiveness by using prior knowledge. It employs the 2C-2I-1R strategy through collaborative group work. The method is guided inquiry with cooperative learning. *Note to the Teachers:* Let learners discuss first in groups before sharing and require brief justification.
	Option 2: *"Rapid Card Response"*	
	The activity is a color-coded classification game where learners use cards to identify whether a chemical symbol or formula represents an atom, molecule, or ion. Learners raise the appropriate colored card—● red for atom, ◍ yellow for molecule, and ◍ green for ion—after the teacher flashes different chemical symbols or formulas. Some learners will then explain how they determined their answers. ***(See Annex A for the detailed activity sheet)***	This targets Objectives 1 and 2 and reflects the IDF through relevance and responsiveness by engaging learners in real-time classification. It applies the 2C-2I-1R framework, specifically the Interactive Learning component, as learners connect representations to chemical concepts. The pedagogy used is interactive questioning with guided inquiry. *Note to the Teachers:* Revisit charge and basic particle differences if learners find it difficult to classify.
	Option 3: *"Sorting Challenge"*	
	1. The teacher will provide learners with a list of chemical symbols / formulae (e.g. Li^+, He, O_3, CO_2, Na^+, Cl^-, Mg^{2+}, H_2O, Ca). 2. The learners will create a simple classification table in their notebook or in a piece of paper with three columns labeled:	The activity targets Learning Objectives 1 and 2 and reflects the IDF guiding principles of relevance and responsiveness by using prior knowledge to classify chemical symbols/formulas. It applies the 2C-2I-1R approaches, specifically independent learning, as learners individually organize and explain representations. The pedagogical method used is Guided Inquiry. *Note to the Teachers:* Let learners complete the task first before class discussion and require brief explanations.

	<table><tr><th>ATOM</th><th>MOLECULE</th><th>ION</th></tr><tr><td></td><td></td><td></td></tr></table> 3. The learner will sort and write each chemical symbol in the classification table and provide a short explanation (1-2 sentence/s) reasoning why it belongs to that category.	
	A.2. Establishing the Purpose of the Lesson	
	Option 1: *"Build the Compound"*	
	1. The teacher will group the learners and provide them with cards containing chemical symbols/formulas (e.g. Li^+, O_3, CO_2, Na^+, Cl^-, Mg^{2+}, H_2O). 2. The learners will match cations and anions to form as many ionic compounds as possible and identify covalent compounds formed by non-metal elements from the given cards. 3. The learners will present their answers to the class and explain the differences between ionic and covalent compounds based on the tasks they completed	The activity targets Objectives 1 and 2 and reflects the IDF principles of relevance and responsiveness by engaging learners in constructing ionic and covalent compounds. It uses the 2C-2I-1R Constructivist approach and applies guided inquiry with cooperative learning. *Note to the Teachers:* Allow groups to complete the task before presenting and require learners to explain how they distinguished ionic from covalent.
	Option 2: *"Thumbs up, Thumbs down"*	
	1. The teacher will flash pairs of chemical symbols and learners will respond by showing thumbs up if the combination can form a stable compound and thumbs down if it cannot. Examples include Cl^- + Cl^- ***(See Annex B for examples)*** 2. The teacher will ask follow-up questions focusing on charge balancing and correct chemical formulas. 3. Selected learners will explain their answers by identifying whether the charges are balanced and whether the combination can form a stable compound.	The activity targets Learning Objectives 1 and 2 and reflects the IDF principles of relevance and responsiveness by engaging learners in evaluating chemical combinations. It applies the 2C-2I-1R approach through interactive, integrated learning using guided questioning and formative assessment. *Note to the Teachers:* Use thumbs-up/thumbs-down responses first, then ask follow-up questions on charge balancing.

<table>
<tr><td></td><td colspan="2">Option 3: “Justify the Match”</td></tr>
<tr><td></td><td>1. The teacher will provide each group (or individual learners) with a set of paired chemical symbols, such as:
• $Cl^- + Cl^-$ • 1 C atom + 1 O atom • $Na^+ + Na^+$
• $Na^+ + Cl^-$ • $Na^+ + O^{2-}$ • 1 H atom + 2 O atom
<table>
<tr><th>Combination</th><th>Possible or Not Possible?</th><th>Chemical Formula (if Possible)</th><th>Reason</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>
2. For each pair, the learners will complete the table (See Annex C for the detailed expected response):</td><td>The activity targets Learning Objectives 1 and 2. It reflects the IDF guiding principles of relevance and responsiveness by engaging learners in analyzing chemical symbol pairings. It applies the 2C-2I-1R approaches, specifically independent learning with Integration, as learners evaluate combinations and explain chemical behavior using charge principles. The pedagogical method used is guided inquiry.

Note to the Teachers: Let learners answer the table first before discussion and require brief reasoning on charge interactions and compound formation.</td></tr>
<tr><td rowspan="6">4. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: “Kitchen Chemistry”</td></tr>
<tr><td>1. The teacher will show learners labels or images of common kitchen substances and connect them to chemical compounds’ table. See Annex B for sample images.
2. The learners will be tasked to identify and explain whether the compound presented on the label/image is ionic or covalent compound.</td><td>This targets Objectives 1 and 2 by linking chemical concepts to real-life examples. It applies Constructivist, Integrative, and Interactive learning.
Note to the Teachers: Let learners observe first and briefly justify their classifications.</td></tr>
<tr><td colspan="2">Option 2: “Presenting Actual Chemical Substance”</td></tr>
<tr><td>1. The teacher presents safe household products with labels showing substances and uses, such as NaCl in saline, sucrose as sugar, $CaCO_3$ in antacids, and H_2O_2 as disinfectant.
2. Learners identify each substance’s chemical name and formula, then classify it as ionic or covalent.
3. Learners justify their classifications using label information.</td><td>The activity targets Objectives 1 and 2 by connecting chemical nomenclature and classification to household substances. It reflects relevance and responsiveness and applies Constructivist, Integrative, and Real-world learning through guided inquiry.
Note to the Teachers: Let learners examine labels first, then justify the formula, name, and classification.</td></tr>
</table>

	Option 3: *"Chemical Hunt"*	
	1. The teacher will hide pictures with description of different household items in the classroom, and the learners will be tasked to find and collect all of it within 3 minutes. Example ***(See other examples in Annex D):*** • Sodium chloride (NaCl) – table salt used for seasoning 2. The learners who are able to hunt a household item will present its use or purpose to class one at a time. 3. The learners will be tasked to obtain the correct formula and the name of each household item that was presented then categorize it as ionic or covalent compound.	The activity targets Objectives 1 and 2 through a scavenger hunt on compound identification and classification. It reflects relevance and responsiveness and applies Collaboration with Real-world engagement through experiential learning and gamification. *Note to the Teachers:* Set safety and time limits and require learners to explain each compound's use and classification.
	B.2. Discussing New Concept	
	Option 1: "*Rotating Learning Station"*	
	1. The teacher will set up different stations where the learners will be tasked to rotate in order to discover the IUPAC nomenclature for writing and naming ionic and covalent compounds. *(See Annex E for the detailed activity sheet.)* Station 1: Naming Ionic Compounds Station 2: Naming Covalent Compounds Station 3: Writing Formulas from Names Station 4: Rule Comparison Station **Learner Task:** Classify and explain the rule used in naming the compound. • MgO • CaF_2 • P_2O_5 • SO_2	The activity targets Objectives 1 and 2 through station-based compound classification and naming-rule explanation. reflects relevance and responsiveness and applies Constructivist learning through guided inquiry and teacher facilitation. *Note to the Teachers:* Ensure group rotation, task completion, and brief justification of naming rules during sharing.
	Option 2: *"IUPAC Naming and Writing Practice"*	
	The teacher will provide the summary sheet on the rules of IUPAC Nomenclature to the learners. The learners (individually) will be referring to it to answer their practice writing and naming. ***(See Annex F for the detailed activity sheet and practice set)***	The activity targets Objectives 1 and 2 through station-based compound classification and naming-rule explanation. It reflects relevance and responsiveness and applies Constructivist learning through guided inquiry and teacher facilitation.

		Note to the Teachers: Ensure group rotation, task completion, and brief justification of naming rules during sharing.
	Option 3: "*Think-Pair-Share*"	
	The teacher will assign the learners to pair with one another. **THINK:** Using a summary list on the rules of IUPAC Nomenclature, the learners will independently analyze and answer: • Na_2O • CO • $MgCl_2$ • N_2O_5 1. Identify if each compound is ionic or covalent. 2. Write the correct chemical name. 3. Briefly explain the rule used. **PAIR:** The learners will pair up to do the following task: • Compare answers • Correct mistakes together • Check naming and formulas • Agree on final answers **SHARE:** Each pair of learners shares the following: • 1 compound they solved • The rule they used • 1 difficulty they encountered	The activity targets Learning Objectives 1 and 2. It reflects the IDF guiding principles of relevance and responsiveness by applying IUPAC naming rules in classifying and naming compounds. It applies the 2C-2I-1R approaches, specifically Constructivist, Collaborative, and Integrative learning with Reflection, as learners work individually, in pairs, and share insights. The pedagogical method used is Think-Pair-Share with guided inquiry and teacher facilitation. *Note to the Teachers:* Ensure independent thinking first, then pair discussion, and require justification and reflection during sharing.
	B.3. Developing Mastery	
	Option 1: *"Error Correction Task"*	
	1. The learners will be tasked to identify the error on the given chemical formulas. Sample examples below: Na_2Cl ✗ MgCl ✗ Monocarbon monoxide ✗ Dicarbon monoxide✗ 2. The learners will accomplish the following task: • Identify what is wrong • Correct it • State the rule used	The activity targets Objectives 1 and 2 through error correction in compound naming and classification. It reflects relevance and responsiveness, applies Reflective and Integrative learning through error analysis and guided inquiry. *Note to the Teachers:* Let learners correct errors first, then require justification of corrections and rules used.

<table>
<tr><td></td><td colspan="2">Option 2: “I Do, We Do, You Do”</td></tr>
<tr><td></td><td>1. The teacher will show an example for a specific IUPAC rule in naming ionic and covalent compound.
2. The teacher and learners work together in answering a given chemical formula to its name and its name to chemical formula.
3. The learners will start to work alone on the following tasks:
Name compounds: $CaCl_2$, SO_3, Al_2O_3
Write formulas: carbon monoxide, potassium bromide, dinitrogen tetroxide</td><td>The activity targets Learning Objectives 1 and 2 and reflects IDF principles of relevance and responsiveness by scaffolding IUPAC naming through examples and guided practice. It applies the 2C-2I-1R Constructivist approach as learners progress from guided to independent work. The pedagogical method used is explicit instruction.
Note to the Teachers: Model one example first, then allow independent work and require learners to state the rule used during checking.</td></tr>
<tr><td></td><td colspan="2">Option 3: “Mastery Table”</td></tr>
<tr><td></td><td>The teacher will let the learners follow the IUPAC Rules to complete the table by giving pairs of chemical symbols. (See Annex G for the detailed mastery table):
<table>
<tr><th>Combination</th><th>Chemical Formula</th><th>IUPAC Name</th><th>IUPAC Rule Used</th></tr>
<tr><td>Mg^{2+} + Cl^-</td><td>$MgCl_2$</td><td>magnesium chloride</td><td>Ionic rule: metal + nonmetal; criss-cross method; no prefixes</td></tr>
</table></td><td>The activity targets Objectives 1 and 2 by applying IUPAC rules to form formulas and names from ion pairings. It reflects relevance and responsiveness and applies Independent learning with Integration through mastery-based seatwork.
Note to the Teachers: Let learners complete the table first, then require the IUPAC rule for each entry.</td></tr>
<tr><td rowspan="3">5. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: “Simulation Activity”</td></tr>
<tr><td>1. The learners will act as assistants in a hospital lab identifying compounds used in basic treatments and cleaning solutions.
Safety Note: Learners will work with printed labels, images, or teacher-prepared cards only. No learner will handle laboratory acids, compressed gases, or medical chemicals during this activity. See Annex H for the sample scenario.</td><td>The activity targets Learning Objectives 1 and 2 and reflects IDF principles of relevance and responsiveness by linking IUPAC nomenclature and classification to hospital and medical applications. It applies the 2C-2I-1R approach (integrative, real-world learning) through contextualized guided inquiry.
Note to the Teachers: Use printed or simulated materials only and require learners to justify both the name and classification.</td></tr>
</table>

	2. The learners will be tasked to write the **correct IUPAC name** and identify if it is **ionic or covalent**.	
	Option 2: "*Design Your Own Real-Life Product*"	
	Scenario: "Create a Safe and Effective Chemical Product" You are part of a learner innovation team tasked to design a simple real-life product (e.g., cleaning solution, sports drink or air freshener). *See ANNEX I for rubric for grading.* Learner's Task: 1. Choose a product to design. 2. Select at least 3 chemical compounds that will be used in your product. 3. For each compound: o Write the correct chemical name; o Write the chemical formula; and o Identify if it is ionic or covalent 4. Explain why each compound is suitable for your product.	The activity targets Learning Objectives 1 and 2. It reflects the IDF guiding principles of relevance and responsiveness by engaging learners in designing a real-life product using IUPAC naming and classification. It applies the 2C-2I-1R approaches, specifically Constructivist, Collaborative, and Integrative learning with Real-world application, as learners select, name, and classify compounds. The pedagogical method used is project-based learning with guided inquiry and teacher facilitation. *Note to the Teachers:* Let learners plan collaboratively first before presentation and require justification of choices, names, formulas, and classifications.
	Option 3: "*Chemical Emergency Room Simulation*"	
	Simulation Task: You are a lab safety responder A school laboratory experienced a minor spill incident. Several unlabeled chemical containers were found in the area, and you must help identify them correctly before they are safely stored again. See Annex J for the learners' task.	The activity targets Objectives 1 and 2 through a simulated lab safety scenario. It reflects relevance and responsiveness and applies Integrative learning with Real-world problem-solving through guided inquiry. *Note to the Teachers:* Let groups discuss first, then require justification of classification and naming.
	C.2. Making Generalization	
	Option 1: *"Spot the Rule Behind the Name"*	
	The goal of this activity is to aid the learners generalize IUPAC naming patterns.	The activity targets Objectives 1 and 2 by helping learners generalize IUPAC naming patterns. It reflects relevance and responsiveness and

	1. The learners will be given a set of compound names and formulas. Instead of just naming them, they must identify the rule used in each case. Sample compounds: • NaCl – sodium chloride • N_2O_5 – dinitrogen pentoxide • CO_2 – carbon dioxide • Fe_2O_3 – iron(III) oxide	applies Reflective learning with Integration through guided inquiry. *Note to the Teachers:* Let learners analyze first, then require the IUPAC rule for each compound.
	Option 2: *"3-2-1 Exit Ticket: IUPAC Naming Check"*	
	Before leaving the class, the learners will be tasked to complete the following: **3 Things I Learned** Example: Write three key takeaways about IUPAC naming rules. **2 Things I Can Do Now** Example: "I can name ionic compounds correctly using charges." **1 Question I Still Have** Instruction: Write one question or confusion you still have about.	The activity targets Learning Objectives 1 and 2. It reflects the IDF guiding principles of relevance and responsiveness by consolidating understanding of IUPAC rules. It applies the 2C-2I-1R approaches, specifically Reflective learning with Integration, as learners summarize key learnings. The pedagogical method used is reflective journaling. *Note to the Teachers:* Let learners complete the reflection individually before submission and use responses to address misconceptions.
	Option 3: *"Complete the Sentence"*	
	Instructions: Complete the following statements using your understanding of ionic and covalent compound naming. 1. Ionic compounds are named by first identifying the **metal (cation)**, followed by the **nonmetal (anion)** with "-ide" ending. 2. Covalent compounds use prefixes such as mono-, di-, tri-, **tetra-** to show the number of atoms. 3. The reason ionic compounds do not use prefixes is because the **charges** of ions already determine the ratio of elements in the compound. 4. A compound is covalent when it is formed between **nonmetals**.	The activity targets Learning Objectives 1 and 2. It reflects the IDF guiding principles of relevance and responsiveness by reinforcing ionic and covalent naming through structured completion of concepts. It applies the 2C-2I-1R approaches, specifically Constructivist and Independent learning with Integration, as learners consolidate IUPAC rules. The pedagogical method used is guided completion with formative assessment and teacher facilitation. *Note to the Teachers:* Let learners answer first before checking as a class and use each item to address misconceptions.

	5. IUPAC naming is important because it ensures a universal and systematic way of **naming compounds** for clear communication. 6. When writing formulas, the positive ion is written **before** the negative ion.	
	C.3. Evaluating Learning	
	Option 1: *"Name and Formula Accuracy Check"*	
	PART A: Name the following chemical compounds using IUPAC nomenclature: 1. Na_2O 2. CO_2 3. $MgCl_2$ 4. N_2O_4 5. Al_2S_3 **PART B.** Write the correct chemical formulas. 6. Calcium chloride 7. Sulfur trioxide 8. Lithium oxide 9. Carbon monoxide 10. Iron (III) oxide	The activity targets Learning Objectives 1 and 2 and reflects IDF principles of relevance and responsiveness by practicing chemical formula translation. It applies the 2C-2I-1R approach (independent, integrative learning) through guided practice and formative assessment. *Note to the Teachers:* Let learners answer independently first before discussion, then ask them to explain the specific IUPAC rule used for selected items.
	Option 2: *"Compound Detective"*	
	Sample Case: A learner found unknown compounds labeled only by their descriptions: 1. Formed from magnesium and chlorine 2. Formed from nitrogen and two oxygen atoms 3. A table salt substitute made of sodium and chlorine Learners will identify each compound by writing its chemical formula, IUPAC name, and classification as ionic or covalent.	The activity targets Objectives 1 and 2 through real-life case analysis. It reflects relevance and responsiveness and applies Integrative and Real-world learning through guided inquiry and case-based learning. *Note to the Teachers:* Let learners work first, then require justification of formula derivation and classification during reporting.
	Option 3: "Mini Naming Lab"	
	The learners will be given a mixed set of compound cards (teacher-prepared). They should be able to: • Sort compounds into **ionic and covalent groups** • Write correct **names and formulas**	The activity targets Learning Objectives 1 and 2 and reflects IDF principles of relevance and responsiveness by engaging learners in sorting and naming compounds using IUPAC rules. It applies the 2C-2I-1R Constructivist

	• Explain briefly how they applied IUPAC rules **Output:** A completed "Compound Classification and Naming Sheet" ***(See Annex K for the sample compounds and expected responses on the Compound Classification and Naming Sheet)***	approach through guided inquiry and cooperative learning. *Note to the Teachers:* Let learners complete the sorting activity first before checking answers, then require brief explanations of the IUPAC rules used.
	C.4. Additional Activities	
	Option 1: *"Chemistry Challenge: Decode the Unknowns"*	
	The learners will be tasked to solve higher-level compound puzzles involving mixed naming situations. **Instructions:** 1. Identify whether each compound is ionic or covalent. 2. Write the correct IUPAC name. 3. Write the correct chemical formula. 4. Explain the rules used in naming each compound. **Challenging Items:** • $FeCl_3$ • P_2O_5 • NH_4Cl • SO_2 • Cu_2O	The activity targets Objectives 1 and 2 through higher-order problem-solving. It reflects relevance and responsiveness and applies the Constructivist approach through guided inquiry, classification, and IUPAC rule application. *Note to the Teachers:* Let learners work first, then require clear justification of classifications and naming rules during discussion.
	Option 2: "Guided Naming Practice Sheet"	
	The learners will be tasked to complete a structured worksheet with step-by-step guidance. **Part A: Fill in the Missing Step** Example: Compound: CO_2 • Step 1: Identify elements → Carbon and Oxygen • Step 2: Type of compound → _____ • Step 3: Use prefixes? → _____ • Final name: _____	The activity targets Learning Objectives 1 and 2 and reflects the IDF guiding principles of relevance and responsiveness by scaffolding learners' understanding of IUPAC naming. It applies the 2C-2I-1R approaches, specifically Independent learning with Integration, as learners progressively complete naming steps and match formulas to correct compound names. The pedagogical method used is guided practice with structured worksheet activities. *Note to the Teachers:* Let learners complete the worksheet independently first before class discussion and use each item to clarify misconceptions on ionic vs covalent naming rules.

<table>
<tr><td rowspan="3"></td><td>Part B: Match Column A to Column B
Match formulas to correct names:
A — B
NaCl — Magnesium oxide
N_2O_4 — Sodium chloride
MgO — Carbon monoxide
CO — Dinitrogen tetroxide</td><td></td></tr>
<tr><td colspan="2">Option 3: “Step-by-Step Naming Helper”</td></tr>
<tr><td>The teacher will provide a guided flowchart worksheet to the learners.
Flowchart Guide:
1. Is it metal + nonmetal? → Ionic
2. Is it nonmetal + nonmetal? → Covalent
3. Ionic → Name metal first + anion (-ide)
4. Covalent → Use prefixes (mono-, di-, tri-)
Practice Items:
• NaBr • CO • Al_2O_3 • N_2O</td><td>The activity targets Learning Objectives 1 and 2 and reflects IDF principles of relevance and responsiveness by scaffolding learners’ understanding of IUPAC naming. It applies the 2C-2I-1R Constructivist approach through structured, step-by-step worksheet-based learning.
Note to the Teachers: Let learners follow the flowchart first before discussion, then require them to explain each step used in arriving at the correct classification and name.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">PART I. NAMING COMPOUNDS AND FORMULA WRITING
1. Read each item carefully.
2. Write the correct name or chemical formula as required.
3. Use proper IUPAC nomenclature.
4. Show clear understanding of ionic and covalent compounds.

A. Naming Ionic Compounds
1. NaCl
2. MgO
3. $CaCl_2$
4. Al_2O_3
5. KBr

B. Writing Formulas of Ionic Compounds
6. Sodium sulfide
7. Calcium fluoride
8. Aluminum nitride
9. Potassium oxide
10. Magnesium chloride

C. Naming Covalent Compounds
11. CO_2
12. N_2O
13. SO_3
14. PCl_3
15. CO

D. Writing Formulas of Covalent Compounds
16. Carbon tetrachloride
17. Dinitrogen monoxide
18. Sulfur dioxide
19. Diphosphorus pentoxide
20. Nitrogen trichloride</td></tr>
</table>

	PART II. COMPOUND NAMING GUIDE Instructions: Prepare a one-page "Compound Naming Guide" for a returning classmate. Include: (1) three correctly named ionic compounds, (2) three correctly named covalent compounds, (3) one short rule summary for each type, and (4) two solved examples showing how you determined the correct name or formula. ***(See Annex L for rubric for grading)***
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot in order to improve sentence organization, generate draft activity ideas, and refine the clarity of instructions and Google Gemini AI for sample images used. The author(s) reviewed and finalized the writing of the content and take full responsibility for the final version.

Learning Title/Topic:	Chemical Bonding and Compounds	Lesson Exemplar:	16

I. OBJECTIVES	
A. Content Standard	The learners learn that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and investigate to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners are expected to draw and describe the Atomic Structure, explain Electron Configuration, and relate Chemical Bonding to the formation of ionic and covalent compounds.
	In this lesson, the learners draw Lewis structures of ionic and covalent compounds applying the Octet Rule.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	1.Brown, Theodore L., et al. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018. 2. Chang, Raymond and Kenneth A. Goldsby. Chemistry. 12th ed. New York: McGraw-Hill, 2016. Materials: Periodic table, valence electron chart, and representative element cards, Mini whiteboards, markers, bond strips, colored counters, and manila paper, Printed or digital Lewis-structure activity sheets, Household product labels/images for application tasks.
III. CONTENT *(Sequencing Content)*	Chemical Bonding and Compounds
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Explain how the Octet Rule governs electron transfer or sharing and its exception. 2. Draw the Lewis Structure of Ions from the representative elements. 3. Construct the Lewis Structure of Ionic Compounds by modelling electron transfer between metals and non-metals from the representative elements. 4. Construct the Lewis Structure of Molecular Covalent Compounds by applying electron-sharing of non-metals from the representative elements.

V. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1: "Shell Game" – Electron Arrangement Recall	
	This activity will activate knowledge of electron shells/energy levels and diagnose misconceptions about electron distribution. 1. The teacher will show a simple Bohr diagram of **Carbon (6 electrons)** and prompt the learners to spot the mistake on the model. ***(See Annex A to view the Bohr Diagram Model of Carbon)*** 2. The learners will determine the maximum number of electrons that each principal energy level can accommodate using the $2n^2$ relationship. The teacher will clarify that this relationship indicates shell capacity and does not describe the actual order in which electrons fill orbitals in multi-electron atoms.	This targets Objectives 1 and 2 and reflects IDF by linking atomic structure to visual models. It applies the 2C–2I–1R approaches, specifically the Constructivist and Inquiry-Based Learning approaches, by using guided discovery and activating learners' prior knowledge. *Note to the Teachers:* Use responses to correct misconceptions about electron distribution before introducing bonding concepts.
	Option 2: "Who Am I?" – Element Identity Puzzle	
	This activity will activate prior knowledge about atomic structure by connecting electron arrangement to element identity. 1. The teacher will present clues about an unknown atom. Example: ● "I have 11 electrons." ● "My outer shell has 1 electron." 2. The learners will be tasked to determine the element and draw its Bohr model on mini whiteboards or paper. 3. Volunteer learners will explain how the number of protons and electrons helped identify the element. 4. The teacher will clarify misconceptions related to valence electrons and shell capacity.	This targets Objectives 1 and 2 and demonstrates IDF relevance by linking electron arrangement to element identity through clue-based atomic structure interpretation. It applies the 2C–2I–1R approaches, specifically the Constructivist and Inquiry-Based Learning approaches, by using guided discovery and activating learners' prior knowledge. *Note to the Teachers:* Address misconceptions on valence electrons, atomic number, shell filling, and equal protons and electrons in neutral atoms before reinforcing correct Bohr model construction.
	Option 3: "Build-an-Atom" – Interactive Particle Modeling	
	1. The teacher will group the learners and provide colored counters or paper cutouts representing protons, neutrons, and electrons. (The teacher can also use colored	This targets Objectives 1 and 2 by using manipulatives to support a concrete understanding of atomic structure. It applies Constructivist and Inquiry-based learning through

	magnets to represent the subatomic particles and small whiteboard) 2. The learners will be tasked to build assigned atoms by placing the correct number of particles in the nucleus and electron shells. 3. The groups will present their models and describe how electrons are distributed across energy levels. 4. The teacher will guide learners in checking whether the models follow the $2n^2$ rule and proper atomic structure.	hands-on modeling with guided verification using the $2n^2$ rule for electron distribution. *Note to the Teachers:* Check student outputs for correct particle placement and address misconceptions on electron arrangement in energy levels and their limits.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: "Stable or Unstable?"	
	The teacher will be displaying three Bohr Models on the board. Then, the teacher will ask and let the learners answer the following questions: ● "Which atom/s do you think is already stable? ● Which atoms still need to become stable? ● If the atom/s is/are unstable, how will it become stable? ***(see Annex B for the Bohr Model and Sample responses)***	This targets Objectives 1 and 3 and demonstrates IDF relevance by linking Bohr models to atomic stability and ionic bonding through guided questioning. It applies the 2C–2I–1R approaches, specifically the Constructivist and Inquiry-Based Learning approaches, by using guided discovery and activating learners' prior knowledge. *Note to the Teachers:* Reinforce the Octet Rule and address misconceptions about stability and electron transfer in ionic bonding.
	Option 2: "Complete the Shell!"	
	1. The teacher will distribute incomplete Bohr Models or electron shell diagrams to the learners. Then, the teacher will prompt: ● "How many more electrons does this atom need to become stable?" ● "Would it be easier for the atom to gain, lose, or share electrons?" ● "What will happen to the outer shell after bonding?" 2. The learners will be tasked to complete the outer shells by drawing arrows or adding electrons. The teacher will guide the discussion toward the idea that atoms tend to gain, lose, or share electrons to achieve a stable outer shell of 8	This activity targets Objectives 1 and 3 and demonstrates IDF relevance by using incomplete Bohr models to help learners understand atomic stability through electron gain, loss, or sharing. The activity makes use of the 2C–2I–1R approaches, specifically the Constructivist and Inquiry-Based Learning approaches. The pedagogical strategy employs guided questioning and visual completion tasks to help learners apply the Octet Rule. *Note to the Teachers:* Monitor learners' reasoning and correct misconceptions about stable electron configurations.

	electrons according to the Octet Rule, which mainly applies to representative elements.	
	Option 3: "Find My Partner!"	
	1. The teacher will display atoms with incomplete outer shells (e.g., sodium, chlorine, oxygen, hydrogen) and ask which atoms need, can lose, or can share electrons to become stable, and which could pair up for a full outer shell. 2. Learners will match atoms with bonding partners and explain whether they gain, lose, or share electrons, while the teacher guides discussion toward the Octet Rule and stability through full outer shells.	This targets Objectives 1 and 3 and demonstrates IDF relevance by using visual atom matching to explain how atoms combine to achieve stability. It applies the 2C–2I–1R approaches, particularly the Constructivist and Inquiry-Based Learning approaches, by using guided questioning and visual completion tasks that enable learners to apply the Octet Rule. *Note to the Teachers:* Reinforce correct atom pairing and address misconceptions about stable electron configurations.
B. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1: "Draw the Dots!" – Lewis Structures of Ions	
	1. The teacher will demonstrate drawing Lewis structures of representative elements by placing valence electron dots around element symbols. Example: 2. The teacher will ask how many valence electrons the atom has, whether it will gain or lose electrons to become stable, and how its Lewis structure changes after ion formation. 3. earners will draw Lewis structures of selected ions by adding or removing dots and writing correct charges, with teacher guidance. 4. he teacher will explain that most elements follow the Octet Rule (8 valence electrons), while exceptions like hydrogen follow the duet rule (2 electrons).	This targets Objectives 1 and 2 and demonstrates IDF relevance by linking Lewis structures to ion formation and stability through guided visual modeling. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning, using teacher-led demonstration followed by guided practice in Lewis structure drawing and charge identification. *Note to the Teachers:* Check correct electron gain/loss representation, clarify octet rule exceptions such as hydrogen, and relate Lewis structures to applications in real-life.
	Option 2: "Complete the Lewis Structure!"	
	1. The teacher will present incomplete Lewis structures (e.g., O^-, H, B) and ask how many electrons are missing, where they should be placed, and whether the Octet Rule or an exception applies.	This targets Objectives 1 and 2 by linking electron arrangement to element identity through clue-based atomic structure.

	2. The learners will be tasked to complete the Lewis structures by correctly placing valence electrons, brackets, and ionic charges. 3. The teacher will explain that Lewis structures show stability through electron gain, loss, or sharing, including exceptions such as hydrogen (duet rule), boron (incomplete octet), and expanded octets.	*Note to the Teachers:* Address misconceptions on valence electrons, atomic number, shell filling, and neutral atoms before Bohr model construction.
	Option 3: "Octet or Exception?" – Lewis Structure Challenge	
	1. The teacher will demonstrate how to draw Lewis structures of selected atoms and ions. 2. Learners will draw Lewis structures of given atoms/ions (e.g. Na^+, Cl^-, H, B, P) with teacher guidance. 3. Learners will analyze whether the structures follow the Octet Rule or represent exceptions, with the teacher emphasizing that Lewis structures show valence electrons and predict stability, but not all atoms require 8 electrons.	This targets Objectives 1 and 2 by using guided Lewis structure drawing to distinguish Octet Rule patterns from exceptions. It applies Constructivist and Inquiry-based learning through modeling, guided practice, and structured analysis. *Note to the Teachers:* Check ion depiction and reinforce Octet Rule exceptions, especially hydrogen and boron.
	B.2. Discussing New Concept	
	Option 1: "Four Corners of Bonding" – Ionic and Covalent Lewis Structures	
	(See Annex C for the detailed activity sheet) 1. The teacher will assign each wall or corner of the classroom with a specific bonding task. 2. The learners will be grouped into teams, will rotate through the four corners and complete the assigned tasks in each station. 3. The teacher will conclude the activity by emphasizing that Lewis Structures help visualize how atoms achieve stability through either electron transfer or electron-sharing, while also explaining Octet Rule exceptions such as Hydrogen following the duet rule and expanded octets in some larger atoms.	This targets Objectives 3 and 4 through station-based Lewis structure modeling and bonding comparison. *Note to the Teachers:* Monitor Lewis structures and correct misconceptions on ionic/covalent bonding and Octet Rule exceptions.
	Option 2: "Bond Builders Challenge" – Collaborative Model Construction	
	1. The class will be divided into groups and given bonding kits (element cards, valence electrons, bond strips/markers, and paper/whiteboards).	This activity targets Objectives 3 and 4 and demonstrates IDF relevance by using cooperative model construction to visualize electron transfer and sharing in Lewis Structures of ionic and covalent compounds. It applies the 2C–2I–1R

	2. Each group will draw compound cards (ionic or covalent examples such as NaCl, MgO, LiF, CH_4, H_2O, O_2). 3. Groups will construct Lewis structures showing electron transfer or sharing and identify whether the compound follows the Octet Rule or an exception. 4. Groups will present and explain how stability is achieved in each compound. 5. The teacher will synthesize the activity by distinguishing ionic and covalent bonding and clarifying Octet Rule exceptions (e.g., hydrogen duet, boron incomplete octet).	approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is cooperative group modeling with structured classification, presentation, and concept synthesis. *Note to the Teachers:* Check group models for correct bonding representation and address misconceptions about ionic vs covalent bonding and Octet Rule exceptions.
	Option 3: "Digital Bond Mapping" – Interactive Lewis Structure Creation	
	1. The teacher will ask learners to bring tablets/laptops (if available) or provide printed templates of incomplete bonding diagrams for compounds such as NaCl, $MgCl_2$, H_2O, CO_2, and NH_3. 2. Learners will complete Lewis structures using digital tools or worksheets and color-code electron transfer (ionic) and electron sharing (covalent). 3. Learners will complete a reflection matrix ***(See Annex D for sample)*** on how atoms achieved stability, whether electrons were transferred or shared, and whether the compound follows the Octet Rule or an exception. 4. The teacher will synthesize the lesson by reinforcing that Lewis structures show valence electrons in bonding and may include Octet Rule exceptions such as duet and expanded octets.	This activity targets Objectives 3 and 4 and demonstrates IDF relevance by using color-coded, technology-assisted modeling to distinguish electron transfer and sharing in Lewis structures. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is guided practice with visual coding and reflection on bonding and stability. *Note to the Teachers:* Check outputs for correct Lewis structures and address misconceptions about bonding types and Octet Rule exceptions.
	B.3. Developing Mastery	
	Option 1: "Build and Defend" – Structured Oral Reasoning Practice	
	1. The teacher will assign each learner a compound (ionic or covalent) such as NaCl, CaF_2, NH_3, or CH_4 to construct its Lewis structure individually. 2. Learners will present a short explanation using sentence frames (e.g., electron transfer/sharing, stability, and Octet Rule application or exceptions). 3. The teacher will provide immediate corrections through micro-explanations and model answers.	This targets Objectives 3 and 4 through Lewis structure construction and explanations of electron transfer or sharing. It applies Constructivist and Inquiry-based approaches *Note to the Teachers:* Address ionic/covalent bonding misconceptions and reinforce the Octet Rule and exceptions.

	(See Annex E for rubric for grading)	
	Option 2: "Timed Bond Construction Sprint" – Rapid Practice with Feedback Cycles	
	1. The teacher will display a compound on the board for short timed intervals (1–2 minutes per item). Examples: Round 1 (Ionic): LiF, $MgCl_2$ Round 2 (Covalent): H_2O, CO_2 Round 3 (Mixed Challenge): NH_3, Na_2O 2. The learners will be tasked to quickly construct the Lewis Structure on mini whiteboards or paper and raise it before time ends 3. After each round, the teacher will reveal the correct structure and conduct immediate formative checks such as: ● "Did the learner correctly show electron transfer or sharing?" ● "Are valence electrons correctly placed?" ● "Is the Octet Rule correctly applied or identified as an exception?"	This activity targets Objectives 3 and 4 and demonstrates IDF relevance by using timed practice to build fluency in Lewis structure construction and distinguishing electron transfer from sharing. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is timed formative assessment with rapid construction and immediate feedback. *Note to the Teachers:* Check for errors in electron placement and bonding type, and reinforce correct application of the Octet Rule and its exceptions.
	Option 3: "Error Detective Lab" – Guided Correction of Lewis Structures	
	1. The teacher will provide learners with a set of pre-drawn Lewis Structures (some correct, some incorrect). The structures will include both ionic and covalent compounds. Examples: NaCl (incorrect charge placement or missing electron transfer) MgO (incorrect valence electron count) H_2O (incorrect bonding or missing lone pairs) CO_2 (incorrect double bond representation) 2. The learners will work individually first to identify and correct the errors, then compare answers in small groups to refine their solutions.	This activity targets Objectives 3 and 4 and demonstrates IDF relevance by using error analysis of Lewis structures to deepen understanding of electron transfer, sharing, and bonding representation. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is guided error analysis with individual correction and collaborative validation. *Note to the Teachers:* Use corrections to address misconceptions in charge placement, electron counting, and Octet Rule application.

	3. The teacher will conduct formative checks by moving around the classroom and using quick prompts such as: ● "Where should the electrons be transferred or shared?" ● "Does each atom follow the Octet Rule?" ● "What is missing in this structure?"	
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1: "Chemistry in Everyday Products Audit" – Real-Life Compound Analysis	
	1. The teacher will present common household products (e.g., NaCl, H_2O, CO_2, NH_3) using labels or images. 2. Learners will act as "product chemists" to classify each substance as ionic or covalent and construct its Lewis structure. 3. Learners will complete a Product Analysis Sheet showing compound type, Lewis structure, electron behavior, and Octet Rule application or exceptions. ***(See Annex F for the template)*** 4. The teacher will conduct formative checks on classification accuracy, Lewis structure correctness, and explanation of bonding type.	This targets Objectives 3 and 4 by linking Lewis structures to real-world products for classifying substances and modeling bonding. It applies Inquiry-based approaches. *Note to the Teachers:* Check classifications and Lewis structures, and correct misconceptions on ionic/covalent bonding and Octet Rule use.
	Option 2: "Chemical Recipe Simulation" – Bonding as Cooking Process	
	1. The teacher will present "chemical recipes" where atoms are treated as ingredients and bonding is the cooking process. **Examples:** ● Na + Cl → NaCl (table salt recipe) ● 2 H + O → H_2O (water recipe) ● C + 2 O → CO_2 (carbonated drink gas recipe) 2. The learners will "follow the recipe" by determining whether electrons are transferred or shared and then construct the Lewis Structures of the resulting compounds. 3. The learners will complete a "Recipe Card" ***(See Annex G)*** containing:	This activity targets Objectives 3 and 4 and demonstrates IDF relevance by using a cooking analogy to explain how atoms form ionic and covalent compounds through electron transfer or sharing. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is analogy-based learning with guided modeling of Lewis structures. *Note to the Teachers:* Check "recipe cards" for understanding of bonding and address misconceptions in electron transfer vs sharing and Lewis structure rules.

	● ingredients (elements) ● bonding process (transfer or sharing) ● final product (compound) ● Lewis Structure representation 4. The teacher will conduct formative checks through quick inspections of recipe cards and spot-check questioning such as verifying electron movement and structure correctness.	
	Option 3: "Molecular Map Quest" – Scenario-Based Navigation Task	
	1. The teacher will present a "Chemistry Map" with different real-world stops. 2. At each stop, the learners will be given different tasks that they need to accomplish 3. The learners will record their answers in a "Travel Log Sheet" that documents their journey through the map. 4. The teacher will conduct formative checks by reviewing travel logs and using quick verification prompts like: ● "Is the structure showing correct electron movement?" ● "Does this compound match ionic or covalent bonding?" **(*See ANNEX H for the MAP and Travel Log Sheet)***	Targets Objectives 3 and 4 and demonstrates IDF relevance through map-based simulation of Lewis structures and bonding via electron transfer or sharing. It applies the 2C–2I–1R approach, specifically Inquiry-based learning, using contextual simulation with task cards and guided questioning. *Note to the Teachers:* Check correct bonding classification and Lewis structures, and address misconceptions on electron movement and the Octet Rule.
	C.2. Making Generalization	
	Option 1: "One-Minute Chemistry Reflection Circle"	
	1. Learners will form small circles and complete guided sentence frames to summarize learning: ● "Ionic bonding happens when…**electrons are transferred from one atom to another, usually between a metal and a nonmetal.**" ● "Covalent bonding happens when…**atoms share electrons to become stable.**" ● "Lewis Structures help us show…**the valence electrons and how atoms are bonded in a compound.**"	This activity targets Objectives 1, 3, and 4 and demonstrates IDF relevance by strengthening understanding of electron transfer, sharing, and Lewis structures through structured peer discussion. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is collaborative sentence framing with guided concept synthesis and peer explanation. *Note to the Teachers:* Ensure participation and use responses to address misconceptions about ionic vs covalent bonding and reinforce the Octet Rule and its exceptions.

	• "Atoms become stable by…**gaining, losing, or sharing electrons to complete their outermost energy level.**" 2. Each learner will contribute one idea while others listen and build on responses to form a complete conceptual summary. 3. The teacher will guide the class to finalize a unified summary emphasizing: • electron transfer vs electron sharing • construction of Lewis Structures • Octet Rule and its exceptions	
	Option 2: "Generalization Ladder – From Atoms to Structures"	
	1. The teacher will present a "generalization ladder" with steps. Sample: Step 1: Atoms have valence electrons Step 2: Atoms become stable through bonding Step 3: Ionic bonding involves electron transfer Step 4: Covalent bonding involves electron sharing Step 5: Lewis Structures represent these interactions 2. The learners will complete the ladder by adding one key idea or explanation per step, reinforcing the progression from atomic structure to bonding representation. 3. The teacher will synthesize responses into a final class generalization: "Lewis Structures show how atoms achieve stability by transferring or sharing electrons based on the Octet Rule, with some exceptions."	This activity targets Objectives 1, 3, and 4 and demonstrates IDF relevance by scaffolding understanding from valence electrons to bonding and Lewis structures through a step-by-step reasoning ladder. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based learning. The pedagogical strategy used is scaffolded concept building with guided progression and class synthesis. *Note to the Teachers:* Use learner responses to check understanding of bonding progression and correct misconceptions before finalizing generalizations on Lewis structures and the Octet Rule.
	Option 3: "Sort–Explain–Conclude Board Task"	
	1. The teacher will display a mixed set of compounds on the board or cards, including: • NaCl, MgO, CaF_2 (ionic) • H_2O, CO_2, NH_3 (covalent)	This activity targets Objectives 1, 3, and 4 and demonstrates IDF relevance by using classification and pattern recognition to distinguish ionic and covalent bonding and Octet Rule exceptions through Lewis structures. It applies the 2C–2I–1R approaches, specifically Constructivist and Inquiry-based

	• H_2, BF_3, PCl_5 (exception cases) 2. The learners will work as a class to sort them into three categories: • Ionic bonding (electron transfer) • Covalent bonding (electron sharing) • Octet Rule exceptions 3. After sorting, learners will complete structured explanations orally or in writing: • what type of bonding is present • how electrons behave (transfer or sharing) • how Lewis Structures represent this behavior 4. The teacher will synthesize the class output into a final generalization statement about Lewis Structures, bonding, and stability.	learning. The pedagogical strategy used is collaborative sorting with guided reasoning and structured synthesis. *Note to the Teachers:* Use learner explanations to assess understanding of bonding patterns and address misconceptions about electron transfer, sharing, and Octet Rule exceptions.
	C.3. Evaluating Learning	
	Option 1: Written Response Test – "Paper-and-Pencil Concept Mastery"	
	Part A: Identification Classify as ionic or covalent: NaCl, H_2O, CO_2, MgO **Part B: Short Explanation** Explain how electrons behave in ionic vs covalent bonding. **Part C: Lewis Structure Drawing** Draw Lewis Structures for: • NaCl • H_2O	This targets Objectives 1, 3, and 4 by assessing bonding classification, electron behavior, and Lewis structure construction. It applies Constructivist and Inquiry-based approaches through mixed-format summative assessment. *Note to the Teachers:* Check classification, electron transfer/sharing explanations, valence electrons, charges, and Lewis structure accuracy.
	Option 2: "Case-Based Chemistry Report" – Real-World Application Assessment	
	1. The teacher will give the learners a scenario: Sample Scenario: "A cleaning product contains ammonia (NH_3) and a disinfectant contains sodium chloride (NaCl). Explain the bonding and structure of each substance." 2. The learners will be tasked to submit a structured report including:	This targets Objectives 3 and 4 by applying Lewis structures to real-world chemical products, focusing on bonding type, electron behavior, and stability. It applies Constructivist and Inquiry-based approaches through scenario-based performance assessment. *Note to the Teachers:* Check compound classification, Lewis structures, electron transfer/sharing explanations, and Octet Rule application or exceptions.

<table>
<tr><td></td><td>

- identification of ionic vs covalent compounds
- Lewis Structures of both compounds
- explanation of electron transfer or sharing
- note on Octet Rule or exceptions

</td><td></td></tr>
<tr><td></td><td colspan="2">Option 3: “Matching Matrix Assessment” – Classification and Structure Linking</td></tr>
<tr><td></td><td>
The learners will be tasked to complete a matrix matching:
<table>
<tr><th>Element Pair</th><th>Bond Type</th><th>Lewis Structure Representation</th></tr>
<tr><td>Na + Cl</td><td></td><td></td></tr>
<tr><td>2 H + O</td><td></td><td></td></tr>
<tr><td>C + 2 O</td><td></td><td></td></tr>
</table>
</td><td>This activity targets Objectives 3 and 4 by analyzing element pairs, bonding types, and Lewis structures through a guided matching matrix. It applies Constructivist and Inquiry-based approaches using concept-mapping assessment.
Note to the Teachers: Check bonding identification, electron transfer or sharing, and accurate Lewis structure representations.</td></tr>
<tr><td></td><td colspan="2">C.4. Additional Activities</td></tr>
<tr><td></td><td colspan="2">Option 1: “Peer Tutoring Pair-Up”</td></tr>
<tr><td></td><td>

1. The learners will be tasked to be in pairs:
   - Tutor (more confident learner)
   - Learner (needs reinforcement)
2. The tutor learner will guide the other learner in constructing Lewis Structures.
Sample compounds:
   - NaCl (ionic)
   - NH_3 (covalent)
3. Roles then switch for a second compound set.

</td><td>This activity targets Objectives 3 and 4 by using peer teaching to reinforce Lewis structures and bonding types through collaborative practice. It applies Constructivist and Inquiry-based approaches using reciprocal peer tutoring.
Note to the Teachers: Monitor pairs for accurate explanations and correct misconceptions in ionic and covalent Lewis structures.</td></tr>
<tr><td></td><td colspan="2">Option 2: “1-2-3 Bonding Drill”</td></tr>
<tr><td></td><td>

1. The learners will be tasked to respond to quick drills in three steps:
   - **Step 1:** Identify bond type (ionic or covalent)
   - **Step 2:** State electron behavior (transfer or sharing)
   - **Step 3:** Draw simple Lewis Structure

</td><td>This activity targets Objectives 3 and 4 by building fluency in bonding identification and Lewis structure construction through rapid drills. It applies Constructivist and Inquiry-based approaches using timed practice with immediate feedback.</td></tr>
</table>

<table>
<tr><td></td><td>Sample Compounds:
• NaCl
• NH_3
• MgO
2. Teacher gives immediate correction after each round.</td><td>Note to the Teachers: Quickly correct errors in bonding classification, electron transfer or sharing, and Lewis structure construction.</td></tr>
<tr><td></td><td colspan="2">Option 3: “Mini Exit Draw”</td></tr>
<tr><td></td><td>1. The learners will be given ONE compound only:
Sample Compounds: NaCl, H_2O, CO_2
2. The teacher will give them the following task:
• Identify bond type
• Draw Lewis Structure</td><td>This activity targets Objectives 3 and 4 by reinforcing bonding types and Lewis structures through independent practice. It applies Constructivist and Inquiry-based approaches using focused skill reinforcement.
Note to the Teachers: Use outputs to diagnose bonding classification and Lewis structure accuracy, then provide targeted correction.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">General Instructions:
1. Read each item carefully.
2. Answer clearly and neatly.
3. Show correct Lewis structures with valence electrons, bonds, and charges.
4. For ionic compounds, show electron transfer; for covalent, show shared electrons.
5. Review your answers before submitting.

Part A: Concepts (6 pts)
1. State the Octet Rule. (2 pts)
2. How is the Octet Rule achieved in:
• ionic bonding (1 pt)
• covalent bonding (1 pt)
3. Give one exception to the Octet Rule and explain briefly. (2 pts)

Part B: Lewis Structures of Ions (8 pts)
Draw Lewis structures of:
• Na^+
• Mg^{2+}
• Cl^-
• O^{2-}
(Show correct valence electrons and charges)

Part C: Ionic Compounds (10 pts)
Draw Lewis structures showing electron transfer for:
• NaCl
• MgO
(Include arrows and final ions with charges)

Part D: Covalent Compounds (10 pts)
Draw Lewis structures for:
• H_2O
• CO_2
(Show shared electrons and lone pairs)</td></tr>
</table>

VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot in order to improve sentence organization, generate draft activity ideas, and refine the clarity of instructions and used Google Gemini AI to generate sample images. The author(s) reviewed and finalized the writing of the content and take full responsibility for the final version.

Learning Title/Topic:	**Investigating the Properties of Ionic and Covalent Compounds**	**Lesson Exemplar:**	17

I. OBJECTIVES	
A. Content Standard	The learners learn that chemical bonding involves the transfer or sharing of electrons and determines the structure and properties of substances.
B. Performance Standard	Learners conduct experiments to differentiate the properties of ionic and covalent compounds.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners recall basic properties of matter and the idea that atoms can bond through electron transfer or electron sharing. They are also able to classify these as physical and chemical properties.
	In this lesson, the learners conduct experiments to differentiate the properties of ionic and covalent compounds such as solubility, melting and boiling points, and electrical conductivity.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	References: Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. 2018. Chemistry: The Central Science. 14th ed. New York: Pearson. Chemistry LibreTexts. 2025. "7.2: Contrasting Ionic Compounds and Covalent Compounds." December 20, 2025. Flowers, Paul, Klaus Theopold, Richard Langley, and William R. Robinson. 2019. Chemistry 2e. Houston, TX: OpenStax. OpenStax. 2023. Organic Chemistry. Houston, TX: OpenStax. PhET Interactive Simulations. n.d. "Sugar and Salt Solutions." University of Colorado Boulder. Materials: Table salt, sugar, sodium bicarbonate (baking soda), ethanol, distilled water, paraffin wax, conductivity tester, beakers, droppers, data table and safety goggles.
III. CONTENT *(Sequencing Content)*	Investigating the Properties of Ionic and Covalent Compounds ● Properties of Ionic and Covalent compounds ● Testing the Properties of Ionic and Covalent compounds ● Classification of Ionic and Covalent compounds based on its properties

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">At the end of the lesson, the learners will be able to:
1. describe common properties of ionic and covalent compounds;
2. compare the solubility and conductivity behavior of selected ionic and covalent substances using teacher-approved observations or experimental data; and
3. classify substances as ionic or covalent and justify each classification using at least two observed properties.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Eliciting Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1: Think-Pair-Share</td></tr>
<tr><td>Directions:
1. Ask learners to recall prior knowledge using guide questions about everyday ionic and covalent compounds and how properties indicate bonding type, and whether bond type can be identified through physical or chemical properties.
2. Have learners pair up with a seatmate to share their insights.
3. Record key terms and concepts on the board to connect to the new lesson.</td><td>This option targets Objective 1 and uses inquiry-based, collaborative learning to activate prior knowledge on chemical bonding, check understanding, and scaffold the next lesson on properties of ionic and covalent bonds through guided discussion.
Note: Record misconceptions that arise during partner discussions and use them to guide the next explanation.</td></tr>
<tr><td colspan="2">Option 2: Ionic and Covalent Organization Chart</td></tr>
<tr><td>Directions:
1. Present a table of two columns on the board.<table><tr><th>Ionic compounds</th><th>Covalent compounds</th></tr><tr><td></td><td></td></tr></table>2. Provide meta-cards with pictures and names of common compounds (e.g., table salt, sugar, baking soda, paraffin wax).
3. A volunteer learner classifies each compound as ionic or covalent and explains their reasoning.
4. Learners are asked what factors they considered in sorting the compounds.
5. Identify key concepts from responses and link them to the new lesson.</td><td>This option targets Objective 1 and uses inquiry-based guided discussion to activate prior knowledge, classify compounds as ionic or covalent, and scaffold understanding.
Note: Record misconceptions from learners' responses and use them to guide the next discussion. Expected responses may include: ionic compounds involve electron transfer and are typically hard, brittle, water-soluble, and conductive in solution, while covalent compounds involve electron sharing and are generally soft, insoluble, and poor conductors.</td></tr>
</table>

	Option 3: Bonding Mingle Game: Ionic & Covalent	
	Directions: 1. Provide each learner with a card containing representative elements. 2. The task is for the learners to find and bond with one or more peers to form a compound whenever the teacher reveals an ionic or covalent card. 3. Then, ask the learners of the compound they have formed and justify whether it is ionic or covalent.	This option targets Objective 1 and uses a collaborative game to retrieve prior knowledge by letting learners act as atoms to form compounds, reinforcing understanding of bonding types and their properties. Note: The teacher should prepare multiple cards to represent atoms of each element, especially for compounds with multiple atoms such as NaCl, CO_2, and NH_4.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Decoding a Mysterious Compound	
	Directions: 1. Present a challenge of identifying an unknown compound using a set of properties such as texture (hard, brittle, waxy, soft), crystalline structure, state at room temperature, solubility, melting point, etc. 2. Given the list of properties of matter, ask about the characteristics of the unknown compound and provide their guess on what compound it is. 3. Process their response and lead to the discussion of ionic and covalent compounds.	This option targets Objective 2 and uses inquiry-based learning to identify unknown compounds from given clues. It supports constructivist learning as learners build understanding by analyzing and decoding information. Note: If learners use only one property to classify a substance, ask for additional evidence. Remind them that at least two or three properties are needed to identify whether a substance is ionic or covalent.
	Option 2: Comparing and Contrasting Sugar and Salt	
	Directions: 1. Show a sample of sugar and salt in class and ask whether they can classify them as ionic or covalent compounds. 2. Lead the learners in making a group Venn diagram to compare the two samples based on their prior observations about its properties and its relation to their classification as ionic or covalent compound.	This option targets Objective 2 and uses guided inquiry-based learning to help learners compare ionic and covalent compounds through a Venn diagram. Note: If learners lack experience with melting, boiling, or conductivity tests, the teacher may provide demonstrations and address

	3. Focus on identifying the two properties that provide the strongest evidence for their classification, and why they are more reliable than appearance alone.	misconceptions such as all dissolved substances conducting electricity, salt conducting in solid form, sugar forming ions in water, or all white crystals having the same bonding type.
	Option 3: Agree/Disagree Poll	
	Directions: 1. Conduct a short Agree/Disagree Poll sample statements about ionic and covalent compounds. 2. Process the responses, identify common misconceptions, and/or highlight points to consider in linking the new lesson.	This option targets Objective 2 by activating prior ideas, sparking curiosity, and identifying misconceptions through constructivist learning. **Note to Teacher:** Use a short poll to begin discussion, then let learners revisit and correct misconceptions after the lesson.
2. Instituting New Knowledge	***B.1. Presenting Examples***	
	Option 1: Learning Stations	
	Directions: 1. Divide the class into small groups rotating through three stations to investigate properties of substances like salt, sugar, ethanol, distilled water, and paraffin wax. 2. Stations include: A- Solubility Test, B- Property Data Analysis, and C-Electrical Conductivity Test 3. Stations include solubility testing, property data analysis, and electrical conductivity testing. 4. Learners record observations and classify each substance as ionic or covalent based on properties. They also compare results, identify patterns, and explain how bonding relates to properties. 5. Each group presents a summary of findings.	This option targets Objectives 2 and 3 and uses inquiry-based learning to classify bond types based on compound properties. Anchored on experiential learning, it promotes firsthand observation, active learning, collaboration, and scientific inference. Note: The teacher should prepare all materials and equipment in advance and emphasize safety precautions, including proper disposal and care with fire and electrical hazards. The list of compounds may also be modified to be contextualized, localized, or indigenized based on the community.

	Option 2: Virtual PhET simulation	
	Directions: 1. Using online resources such as PhET simulation, provide a virtual platform for exploring the properties of ionic and covalent compounds: https://bit.ly/3Rjn8wY. 2. Let the learners explore and perform the virtual experiment and answer the guide questions that follow: • *What differences did you observe between salt and sugar in the simulation?* • *How does the simulation explain the solubility, melting points and conductivity of salt and sugar?* • *How does the simulation show the difference between ionic and covalent compounds?*	This option targets Objectives 2 and 3 which demonstrates inquiry-based learning to discover how properties of compounds can be used to classify bond types. With the help of technology, learners will experience interactive simulation to explore and test variables in the virtual platform. *Note*: The teacher can ensure smooth delivery of the virtual simulation by providing cyber ethical norms and classroom management strategies. For efficient execution, secure a reliable internet connection.
	Option 3: Analyze the Evidence: Ionic or Covalent?	
	Instead of performing the experiment themselves, learners are provided with experimental results, observation tables, videos, graphs, or sample data sets about different substances. They analyze the evidence to determine whether the compounds are ionic or covalent. Directions: 1. Present a graph showing the trend of solubility of compounds. 2. Ask the learners to analyze and infer the type of bonding based on the patterns in properties. Guide Questions: • *Based on the solubility curves, which substances appear to have high solubility in water? What can you infer about their possible bonding type—ionic or covalent?* • *How does the solubility behavior shown in the graph help you differentiate ionic compounds from covalent compounds? Cite examples from the graph to support your answer.*	This option targets Objectives 2–3 by using inquiry-based learning to help learners classify bond types from compound properties. When materials are limited, teachers may provide data sets, experimental results, or graphs for analysis. The activity develops data literacy, conceptual understanding, and higher-order thinking as learners interpret evidence and explain patterns. **Note to Teacher:** Use quality-assured or research-based materials as sources of data for learners.

<table>
<tr><td></td><td>Provide learners with experimental results, observation tables, videos, graphs, or sample data about different substances. Ask them to analyze the evidence and infer whether the compounds are ionic or covalent.
Directions: Present a solubility graph and guide learners to identify patterns that may indicate bonding type.
Guide Questions:
1. Which substances show high solubility in water, and what does this suggest about their bonding type?
2. How can solubility patterns help distinguish ionic from covalent compounds? Use evidence from the graph.</td><td></td></tr>
<tr><td></td><td colspan="2">B.2. Discussing New Concept</td></tr>
<tr><td></td><td colspan="2">Option 1: CER (Claims, Evidence, Reasoning)</td></tr>
<tr><td></td><td>Directions:<table><tr><th>Claims</th><th>Evidence</th><th>Reasoning</th></tr><tr><td></td><td></td><td></td></tr></table>1. Groups will synthesize their observations using a Claims, Evidence, and Reasoning (CER) graphic organizer.
2. Each group must provide at least five claims with corresponding evidence and reasoning from their experiment.
3. A representative will present the group output in class.
Guide question: How do the experimental results support your claim about whether the substance is ionic or covalent?</td><td>This option targets Objectives 2 and 3 and uses inquiry-based learning to classify bond types based on compound properties. The CER strategy promotes critical thinking and scientific literacy through collaborative discussion and evidence-based reasoning.
Note: The teacher may revisit prior misconceptions and use them to refine reasoning, correct understanding, and develop higher-order thinking skills.</td></tr>
<tr><td></td><td colspan="2">Option 2: FGD on Solubility, Melting point and Conductivity</td></tr>
<tr><td></td><td>Directions:
1. Divide the class into three groups and provide a table of properties of the identified compounds.
2. Each group will interpret the data based on solubility, melting point, and conductivity.</td><td>This option targets Objectives 2 and 3 and uses inquiry-based learning to classify bond types through compound properties. Through FGD, learners compare observations with expected</td></tr>
</table>

	3. Learners will compare these results with their experimental observations. 4. Groups will present insights guided by questions on solubility, bonding type, and similarities or differences in observations and their possible causes.	results, build explanations, and correct misconceptions collaboratively. Note: The teacher should carefully process results to address misconceptions such as confusing melting with decomposition, assuming all dissolved substances conduct electricity, or thinking solubility depends only on particle size.
	Option 3: Video Analysis	
	Directions: 1. Present a video clip about the properties of ionic and covalent compounds via YouTube link: https://bit.ly/4fy8vzD. 2. After watching the video, facilitate the guide questions: ● *How do you compare the solubility, melting points and ability to conduct electricity between ionic and covalent compounds?* ● *Which of your experimental observations (solubility, conductivity, melting behavior) matched the properties described in the video?*	This option targets Objectives 2 and 3 and uses inquiry-based learning to help learners classify bond types through compound properties. Multimedia and video clips enhance engagement and strengthen conceptual understanding through visual observation. Note: The teacher may provide guide questions before the video and apply effective classroom management to maximize technology use during the lesson.
	B.3. Developing Mastery	
	Option 1: Concept Mapping	
	Directions: 1. Provide an activity sheet for learners to concept map their understanding of the topic. 2. instruct the learners to use the following terms: *Ionic compounds, covalent compounds, high melting point, low melting point, soluble in water, insoluble in water, conductor in a solution, non-conductors.*	This option targets Objectives 1-3 and which is anchored on Constructivist theory where learners connect how properties of compounds can be used to classify bond types and build from what they know about the topic. Concept mapping is a visual learning strategy that serves as a knowledge organization tool for higher-order thinking scaffold.

<table>
<tr><td></td><td colspan="2">Option 2: Comic Strips making</td></tr>
<tr><td></td><td>Directions:
1. Provide a 4–6 panel comic strip template for learners to illustrate the properties of ionic and covalent compounds.
2. Emphasize the scoring rubric focusing on scientific accuracy and creativity in storytelling.
3. Use the attached rubric as a guide to help learners meet both content and creativity requirements.</td><td>This option targets Objectives 1-3 and which is anchored on Constructivist theory and Expressive Arts-Based Learning for better visual scientific literacy. This will allow learners to express their conceptual understanding through an engaging and creative multimodal approach.</td></tr>
<tr><td></td><td colspan="2">Option 3: Creating Infographics</td></tr>
<tr><td></td><td>Directions:
1. Instruct the learners to create single page infographics summarizing their conceptual understanding of the lesson.
2. Focus on the guide question: How does the type of bonding in a compound affect its observable properties?
3. Use the sample rubric from the attachment to help students focus on both the scientific accuracy of the bonds and the creativity of their output.</td><td>This option targets Objectives 1-3 and which is anchored on Constructivist theory and Expressive Arts-Based Learning for better visual scientific literacy. This will allow learners to organize, simplify, and communicate complex scientific ideas visually and logically through an engaging and creative multimodal approach.</td></tr>
<tr><td>3. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td></td><td colspan="2">Option 1: Power of Salt and Sugar</td></tr>
<tr><td></td><td>Directions:
Given the properties of table salt and table sugar, prompt these guide questions to elicit the practical uses of these compounds in daily living:
● How do the structures and properties of salt and sugar influence their different roles in food preservation?
● What other practical uses of salt and sugar can be directly linked to their bonding type (ionic vs. covalent)?</td><td>This option targets Objectives 1–3 by using constructivist, inquiry-based, and contextualized learning to connect compound properties with real-life situations.
Note to Teacher: Guide learners to explain compound behavior using solubility, particle type, structure, and interaction with water, not labels alone.</td></tr>
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<table>
<tr><td></td><td colspan="2">Option 2: Space Exploration</td></tr>
<tr><td></td><td>Directions:
1. Learners act as members of an interplanetary research team collecting unknown substances (Samples A, B, and C) from a newly discovered planet.
2. They determine whether each sample is ionic or covalent based on observable properties before safe transport to Earth.
3. In groups, learners design a “Space Investigation Protocol” outlining tests, materials, safety measures, procedures, and data recording methods.
4. Groups present and justify how their protocol will help identify the type of bonding in each substance.</td><td>This option targets Objectives 1-3 and which is anchored on Problem-based Learning. The use of Space Exploration context and the task of designing their plan increases authenticity and engagement through role immersion.
This will also prepare learners for the actual investigation and promote collaboration and procedural thinking.
Note: The teacher must prepare ahead the unknown compounds and ensure the scientific coherence and accuracy of the given unknown properties.</td></tr>
<tr><td></td><td colspan="2">Option 3: Skit-making</td></tr>
<tr><td></td><td>Directions:
1. Divide the class into small groups to prepare a 3–5 minute skit showing their understanding of the lesson.
2. Each group must present how the substances were tested, the results obtained, and how the classification for each sample was decided.
3. Use the attached sample rubric as the basis for scoring.</td><td>This option targets Objectives 1–3 and is anchored on active learning to promote deep conceptual understanding while developing collaboration and communication skills through meaningful, concrete application of concepts.
Note: The teacher must present a scoring rubric to guide learner assessment based on set criteria.</td></tr>
<tr><td></td><td colspan="2">C.2. Making Generalization</td></tr>
<tr><td></td><td colspan="2">Option 1: Exit Slips</td></tr>
<tr><td></td><td>Directions:
1. Provide an exit slip containing the table below:
<table><tr><th>Name of Compound</th><th>Bond type</th><th>Real-life application</th></tr><tr><td>Ex. Calcium carbonate</td><td>Ionic</td><td>Used in chalk, toothpaste and antacids</td></tr></table></td><td>This option targets Objectives 1–3 and uses formative assessment to provide focused feedback on learner understanding. Anchored on reflective learning, it allows learners to organize ideas, synthesize learning, and identify gaps in understanding.</td></tr>
</table>

<table>
<tr><td></td><td>2. Ask the learners of common substances, its bond type and real-life practical application.</td><td>Note: The teacher should identify misconceptions, especially on solubility and conductivity, and provide follow-up activities to address them.</td></tr>
<tr><td></td><td colspan="2">Option 2: 3-2-1 Statements</td></tr>
<tr><td></td><td>Directions:
1. Provide sheets of paper containing the 3-2-1 columns.
2. The learners will be asked to reflect on the topic about the properties of ionic and covalent compounds and write 3 things that they have learned, 2 interesting facts that are worthy to share, and 1 question that still needs to be answered.
<table><tr><th>3 things you have learned</th><th>2 interesting facts</th><th>1 question</th></tr><tr><td></td><td></td><td></td></tr></table></td><td>This option targets Objectives 1-3 and which demonstrates assessment of student understanding by encouraging structured reflection, identifying key learnings, and revealing remaining questions or misconceptions after the lesson. Anchored on Reflective Learning, learners are given the opportunity to organize their reflections, establish checkpoints, and help the teacher identify both mastery and misconceptions quickly.</td></tr>
<tr><td></td><td colspan="2">Option 3: Formative Checkpoint</td></tr>
<tr><td></td><td>Directions:
1. Encourage learners in pairs to create a 1-minute explanation of one sample of compound using two properties and one concluding statement.
2. Focus on proper classification using two properties and one limitation statement regarding the use of properties of compounds in classifying bond type.</td><td>This option targets Objectives 1-3 and which demonstrates concept generalization strategy to differentiate between ionic and covalent compounds based on observed properties, allowing the teacher to assess conceptual understanding and identify misconceptions before the final performance task as the summative assessment.</td></tr>
<tr><td></td><td colspan="2">C.3. Evaluating Learning</td></tr>
<tr><td></td><td colspan="2">Option 1: Classifying Compounds</td></tr>
<tr><td></td><td>Directions:
1. Provide a set of compounds with corresponding properties.
2. The learners will classify it whether ionic or covalent compounds and provide justification based on the identified properties.</td><td>This option targets Objectives 1–3 and uses performance-based assessment to develop higher-order thinking, requiring learners to classify substances and justify their answers using scientific evidence on bonding and properties.</td></tr>
</table>

	A. Carbon dioxide (CO_2) • Gas at room temperature • Does not conduct electricity • Low boiling point	Covalent – exists as molecules with weak intermolecular forces	Note: Require learners to support each classification with at least two properties; answers based on only one clue (e.g., solubility or melting point) should not be accepted.
	Option 2: Multiple Choice Short Quiz		
	Directions: 1. Access the sample multiple choice questions from https://bit.ly/49dIUbs or construct a set of questions similar to the given sample. 2. Administer the quiz to reinforce memory, uncover learning gaps, and provide quick feedback on learners' understanding of key concepts.		This option targets Objectives 1-3 and which demonstrates Inquiry-based Assessment to support MCQs as a cognitive assessment tool to evaluate learners' understanding of key concepts such as bonding, solubility, and conductivity, and to identify misconceptions in an efficient and structured manner."
	Option 3: Reflection Essay		
	In 5–7 sentences, explain how the properties of a substance (such as solubility, melting/boiling point, conductivity, texture, and other observable characteristics) help you determine whether it is an ionic or covalent compound.		This option targets Objectives 1-3 and which demonstrates Constructivist Learning Approach to encourage learners to synthesize their experiences and explain the relationship between chemical bonding and observable properties using higher-order thinking skills.
	C.4. Additional Activities		
	Option 1: Case analysis		
	Directions: 1. The learners can predict the properties of other unknown or unfamiliar compounds based on bonding type. Upon the approval of the teacher, learners can explore the properties to determine its bond classification. 2. Ask them to submit a report on their case analysis containing: Title, Prediction, Observations, Explanations, and Conclusion.		This option targets Objectives 1–3 by applying inquiry-based and constructivist learning to classify unknown compounds. **Note to Teacher:** Collect a case analysis report showing the sample name, properties used, and final ionic or covalent classification.

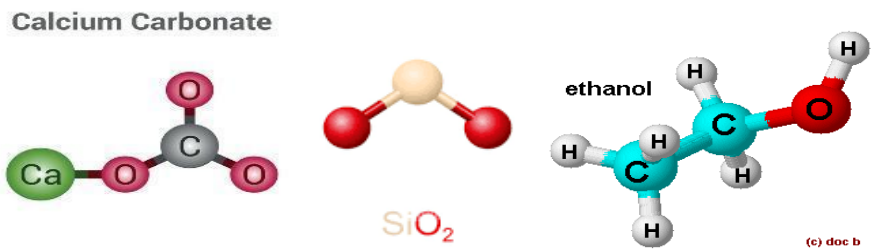
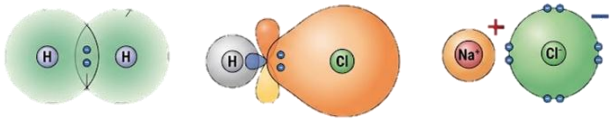
<table>
<tr><td rowspan="4"></td><td colspan="2">Option 2: Local Expert Interview</td></tr>
<tr><td>Directions:
1. The class will identify a local expert from the community to invite for an interview about the significance of identifying the properties of common compounds.
2. The interview can be submitted in multiple formats (written verbatim, audio or video presentation).</td><td>This option targets Objectives 1–3 and uses inquiry-based learning to extend conceptual understanding to real-life applications and community relevance.
Note: The teacher must emphasize ethical considerations in conducting interviews and using multimedia for educational purposes.</td></tr>
<tr><td colspan="2">Option 3: Additional Videos for Enhancement</td></tr>
<tr><td>The class can be encouraged to watch a video clip of a laboratory experiment from YouTube: https://bit.ly/4uWbGWl.
The teacher can instruct the learners to submit a short video review.</td><td>This option targets Objectives 1-3 and which demonstrates Inquiry-based Learning Approaches to further establish their conceptual understanding using the video clip.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Performance Task: Comparative Compound Investigation Video
In groups, learners investigate one ionic compound and one covalent compound using teacher-approved data or teacher-supervised tests on solubility and conductivity. In a short video format, they present observations, classify each substance and compare their properties, justify the classification using evidence, and explain one limitation of the investigation. Use the rubric for scientific accuracy, evidence use, clarity, and safety compliance.
Note to teacher:
● Use teacher-approved materials and safe procedures. Avoid tasting, direct smelling, open flames, and unsupervised tests at home. If unsafe, use verified class data instead.
● Remind learners to use respectful language, avoid posting outputs without permission, and seek approval before recording others. Alternative outputs such as narrated slides, posters, or oral defense may be accepted if video production is difficult.
● Since the task is performance-based, assessment will focus on rubric criteria and formative activities. Sample scoring rubrics are attached.</td></tr>
</table>

VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used ChatGPT to organize lesson ideas and improve language clarity. The author(s) reviewed, revised, and finalized the content and take full responsibility for this LE.

Learning Title/Topic:	Determining Polarity through Electronegativity	Lesson Exemplar:	18

I. OBJECTIVES	
A. Content Standard	The learners learn that differences in electronegativity influence bond polarity;
B. Performance Standard	Learners predict polarity based on electronegativity.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners recall the different types of chemical bonding—ionic, covalent, and metallic—and can distinguish the properties of compounds formed by ionic and covalent bonding.
	In this lesson, the learners explain how electronegativity differences determine bond polarity.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	References: Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, Patrick Woodward, and Matthew Stoltzfus. Chemistry: The Central Science. 14th ed. Pearson, 2018. Chang, Raymond, and Kenneth A. Goldsby. Chemistry. 12th ed. New York: McGraw-Hill Education, 2016. University of Colorado Boulder. "Molecule Polarity." PhET Interactive Simulations. Accessed for instructional review. Materials: periodic tables, calculators, polarity task cards, bond-polarity worksheets, printed molecule-shape visuals, water/oil/dishwashing-liquid demo materials, projector, and rubric sheets.
III. CONTENT *(Sequencing Content)*	Determining Polarity through Electronegativity ● Electronegativity of Elements ● Polarity of Compounds ● Calculating electronegativity differences ● Predicting polarity using electronegativity differences
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	At the end of the lesson, the learners will be able to: 1. explain the relationship between electronegativity difference and bond polarity to identify nonpolar covalent, polar covalent, and ionic compounds; 2. calculate the electronegativity differences to classify the type of bond polarity among compounds; and 3. predict bond polarity from electronegativity difference and predict molecular polarity by considering both bond polarity and molecular shape when appropriate.

V. PROCEDURES		ANNOTATIONS
A. Activating Prior Knowledge	***A.1. Eliciting Prior Knowledge***	
	Option 1: Electronegativity Recall Game	
	Directions: 1. The teacher will facilitate a recall game where learners identify the electronegativity of selected elements (e.g., H, C, O, Na, Cl) using the periodic table. 2. Learners will bring their periodic tables and recall the trend of electronegativity across periods and groups. Guide Questions: 1. What happens to electronegativity as you move from left to right across the periodic table? Why? 2. Which elements strongly attract electrons during bonding, and which elements attract them weakly?	This option targets Objective 1 by promoting active recall of electronegativity values through an engaging activity anchored on the 3Rs and 2C-2I-1R. Guided prediction and evidence-based classification help learners maximize prior knowledge. Note to Teacher: Address misconceptions through immediate feedback, particularly on the relationship between electronegativity difference, bond polarity, and molecular shape. Ensure effective classroom management during game-based activity. This option targets Objective 1 by using an engaging activity to strengthen recall of electronegativity values and support evidence-based classification. **Note to Teacher:** Give immediate feedback on misconceptions about electronegativity differences, bond polarity, and molecular shape, and ensure good classroom management during the game.
	Option 2: Ionic or Covalent?	
	Directions: 1. The teacher will present pictures of calcium carbonate ($CaCO_3$), silicon dioxide (SiO_2) and ethanol (C_2H_5OH).	This option targets Objective 1 by using inquiry-based active recall to elicit prior knowledge on chemical bonding and bond types. **Note to Teacher:** Recognize correct answers and address misconceptions. Emphasize that calcium carbonate is overall ionic because it contains Ca^{2+} and CO_3^{2-} ions, while carbonate has covalent

	 *https://bit.ly/4a0LfXs* *https://bit.ly/4fwDoo8* *https://bit.ly/4umeBHY* 2. Ask the learners to determine which is ionic and which is covalent compounds. Let them share their reasoning.	bonds. Silicon dioxide is a network of covalent substance.
	Option 3: Thumbs up/ Thumbs down	
	Directions: 1. The teacher will present True or False statements from the previous lesson on properties of ionic and covalent compounds. 2. Upon showing each statement, learners decide to show their thumbs up or down to correspond to their answer.	This option targets Objective 1 by recalling prior knowledge on the properties of ionic and covalent compounds through inquiry-based questioning. **Note to Teacher:** Acknowledge correct responses and address misconceptions before proceeding to the next lesson part.
	A.2. Establishing the Purpose of the Lesson	
	Option 1: Balancing Act!	
	Directions: 1. The teacher will present illustrations of H_2, HCl and NaCl.  *Image generated using Gemini AI* 2. Ask the learners to compare the illustration based on their prior knowledge on ionic and covalent compounds. 3. Encourage them to infer about the structure of each molecule in relation to attraction of electrons upon bonding through these guide questions:	This option targets Objective 1 by using visual representations to recall chemical bonding and show how electron behavior determines bond type and polarity. **Note to Teacher:** Address misconceptions immediately and manage the game-based activity effectively. Emphasize that in NaCl, electrons are transferred, forming ions that attract through electrostatic forces.

	● *Which bonded atoms in the illustrations attract the shared electrons equally, and which attract them unequally?* ● *What visual evidence can you identify supports your answer?*	
	Option 2: Will It Dissolve?" Prediction Activity	
	Directions: 1. Prepare different substances such as water, salt, sugar, ethanol, and paraffin wax. 2. Learners will predict whether each substance will dissolve in water or oil. 3. Conduct the actual mixing demonstration and let learners compare their predictions with the observed results. 4. Essential Question: *Why do some substances dissolves in water while others do not? How about in oil?*	This option targets Objective 1 by promoting active retrieval of concepts on chemical bonding and bond types. Anchored on the Inquiry-Based Learning Approach, the activity elicits prior knowledge and strengthens learners' understanding in preparation for the succeeding lesson. Note: The teacher may acknowledge correct responses and address misconceptions immediately.
	Option 3: Water and Oil Mixing Challenge	
	Directions: 1. Prepare the following materials: transparent container, water, cooking oil, food coloring, and dishwashing liquid. 2. Mix water and oil in a clear container. Observe that they do not mix and just separate into layers. 3. Add dishwashing liquid and shake again. 4. Lead the discussion using their observations and the following guide questions: ● *Why don't water and oil mix with each other?* ● *Why did the dishwashing liquid help them mix temporarily?*	This option targets Objective 1 by promoting active retrieval of concepts on chemical bonding and bond types. It maximizes hands-on learning through an inquiry-based approach, using learners' observations and prior knowledge as a springboard for the lesson. Note: The teacher may acknowledge correct responses and address misconceptions. Use only small amounts of household materials, avoid tasting any samples, immediately wipe spills, and ensure that only the teacher handles any demonstration involving glassware equipment.

<table>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: Electronegativity Difference Table of Cl-O-F Compounds</td></tr>
<tr><td>Directions:
1. Divide the class into three groups; each with assigned set of compounds:
Group 1- Chlorine compounds (Cl_2, NaCl, and HCl)
Group 2- Oxygen compounds (O_2, H_2O and MgO)
Group 3- Fluorine compounds (F_2, HF, LiF)
2. Using the periodic table, the learners will determine its electronegativity values and find the difference for each compound and identify the bond type of each compound.
3. Guide the discussion with these questions:
● What relationship do you observe between electronegativity difference and bond character?</td><td>This option targets Objectives 1-2 which present the standard competency on electronegativity and bond type.
Along with the Inquiry-based Learning approach, this activity provides learners the clear grasp to explore the competency.

Note: Use of periodic table is advisable. The teacher can recognize correct answers and address misconceptions.</td></tr>
<tr><td colspan="2">Option 2: Interactive PhET Simulation</td></tr>
<tr><td>Directions:
1. Share the link for the PhET simulation and have them explore and navigate on Molecule Polarity via https://bit.ly/4v056hw.
2. Use these guide questions to process their observations:
● How does changing the atoms in a molecule affect the distribution of electrons and the overall polarity of the molecule?
● What patterns do you observe between electronegativity differences and the shape or polarity (polar or nonpolar) of the molecules in the simulation?
● How does molecular shape influence whether a molecule is polar or nonpolar even if it contains polar bonds?</td><td>This option targets Objectives 1-2 through the use of virtual application (PhET simulation) to provide learners a clear picture of abstract concepts on electronegativity and bond type. Through active engagement, aided by technology, learners can observe and deduce how difference in electronegativity predicts bond type.

Note: Use of periodic table is still advisable. The teacher shall ensure effective classroom management. The teacher can recognize correct answers and address misconceptions. Provide printed screenshots, molecule cards, or teacher-drawn diagrams when devices or internet access are limited.</td></tr>
</table>

Option 3: Video Analysis

Directions:

Present the YouTube video Polar Covalent Bonds Made Easy from https://bit.ly/4wGsqCN, let the learners watch and answer the guide questions that follow:

- *How does electronegativity difference determine whether electrons are shared equally (covalent) or transferred completely (ionic) in a bond?*
- *What pattern do you observe between the type of elements involved and the type of chemical bond formed?*

This option targets Objectives 1–2 by helping learners construct understanding of electronegativity, bond types, and bond polarity through a video-based activity.

Note to Teacher: Use guide questions and feedback to support learning. Emphasize that greater electronegativity difference increases bond polarity and may approach ionic character, showing bonding as a continuum.

B.2. Discussing New Concept

Option 1: Predicting Polarity

Directions:

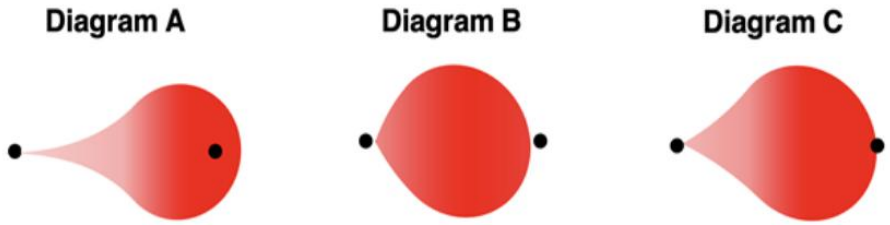
1. Divide the class in small groups and assign a hypothetical molecule with the corresponding electronegativity values.

Group	EN Atom A	EN Atom B	Bond Type/ Polarity
1	1.0	2.0	
2	0.7	3.3	
3	2.5	2.5	

2. Identify whether the bond is nonpolar covalent, polar covalent, or largely ionic based on the given electronegativity values.

This option targets Objectives 2–3 by guiding learners to use electronegativity and bond type to predict compound polarity through inquiry-based reasoning.

Note to Teacher: Allow use of the periodic table. Address misconceptions on polarity, solubility, and molecular symmetry, and emphasize that bond character exists on a continuum based on electronegativity differences.

	Option 2: Matching Polarity	
	Directions: Consider the bonds of C (EN=2.5), N (EN=3.0), and O (EN=3.5) bonding with hydrogen (EN=2.1).Using the diagram below, let the learners identify the correct compound and match the three bonds C-H, N-H, and O-H to each diagram.  Image source: https://bit.ly/49eDEEB	This option targets Objectives 2-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. The use of visuals transforms abstract electronegativity values into meaningful chemical understanding, which is essential for mastering polar covalent bonding and molecular polarity. *Note*: Use of periodic table is advisable. The teacher can recognize correct answers and address misconceptions. Emphasize that bond polarity depends on ΔEN while molecular polarity depends on both bond polarity and molecular geometry.
	Option 3: Ranking Polarity	
	Directions: 1. Present six Fluorine compounds (F-F, H-F, C-F, K-F, O-F, N-F). 2. Let the learners rank the following bonds in order of increasing ionic characteristics (from least ionic to most ionic).	This option targets Objectives 2-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. The use of ranking polarity distinguishes gradual transition from covalent to ionic character and understands that bonding is a continuum, not a strict classification
	B.3. Developing Mastery	
	Option 1: Classification Relay Game	
	Directions: 1. In small groups, learners will compute and classify the compounds as ionic, polar covalent or non-polar covalent in the form or relay game. 2. The fastest team to accurately decode the electronegativity values and the bond classification wins the game.	This option targets Objectives 2–3 by enabling learners to relate electronegativity, bond type, and compound polarity. Anchored on gamification and cooperative learning, the activity integrates cognitive, social, and motivational learning principles, helping learners confidently apply electronegativity-based classification across different situations.

<table>
<tr><td rowspan="4"></td><td colspan="2">Option 2: Practice Drill</td></tr>
<tr><td>Directions:
The teacher will present the set of compounds as shown below and learners will predict what type of bond is present between the following pairs of atoms by determining their electronegativity difference.
1. Ca and Cl 2. Cl and Cl 3. H and Cl
4. S and O 5. C and N</td><td>This option targets Objectives 2-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. It promotes conceptual understanding, analytical thinking, and scientific reasoning, ensuring that learners can apply the skill to new and unfamiliar chemical pairs—not just recall definitions.</td></tr>
<tr><td colspan="2">Option 3: Problem-solving stations</td></tr>
<tr><td>Directions:
In small groups, the learners will be accomplishing the task per station:
Station A- compute for EN values
Station B- predict for polarity
Station C- identify the bond type</td><td>This option targets Objectives 2–3 by allowing learners to relate electronegativity, bond type, and compound polarity. Through a station rotation activity, learners develop competency by treating bonding not as a one-step task but as a logical scientific process, leading to deeper understanding and long-term mastery.</td></tr>
<tr><td rowspan="3">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1: The Dual Identity of Dishwashing Liquids</td></tr>
<tr><td>Directions:
1. Assign the class to read the article: Is dishwashing liquid polar or nonpolar? from https://bit.ly/42NIFQH
2. Then, learners will answer the guide questions:
● Why does dishwashing liquid mix with water and help remove oil and grease from surfaces?
● What does this behavior reveal about the molecular structure of dishwashing liquid in terms of its polar and nonpolar parts?</td><td>This option targets Objectives 2-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. This activity strengthens competency as it builds deep conceptual understanding of polar and nonpolar regions in molecules, preparing learners to confidently apply electronegativity and bonding concepts in both academic and practical contexts.</td></tr>
</table>

	Option 2: News Analysis: Oil Spill in Manila Bay (2024)	
	Directions: 1. Present a news article on the effect of Oil Spill in Manila Bay to the environment, livelihood and public health from https://bit.ly/4wI17Ig. 2. Lead their analysis using the guide questions: *How might the polarity of oil and water, based on differences in electronegativity, explain why oil from spills does not easily mix with seawater and instead spreads across the surface of Manila Bay?* *Crude oil is composed largely of nonpolar hydrocarbons, while water is polar. How does this polarity difference help explain why oil spreads on water instead of mixing with it?*	This option targets Objectives 2-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. It transforms chemistry learning into a real-world, interdisciplinary understanding of science, environment, and society, ensuring deep conceptual mastery and long-term retention.
	Option 3: The Chemistry of Vitamins	
	Directions: 1. Using the infographics comparing the polarity of vitamins and its effects to human body from https://bit.ly/4v4eGAf. 2. Lead the discussion using these guide questions: ● *How does the presence of electronegative atoms in vitamin structures affect their polarity and solubility in water or fat?* ● *Based on the functional groups shown in the structures, how can you classify vitamins as water-soluble or fat-soluble, and what does this reveal about their molecular polarity?*	This option targets Objectives 1-3 which allows learners to relate electronegativity, bond type and the polarity of the compound in real-life, allowing them learners to analyze how the molecular polarity of vitamins is influenced by electronegativity, and how this directly affects their biological function in the human body. Note: However, vitamin solubility depends on the overall balance of polar and nonpolar regions in the whole molecule, not simply on the presence of one electronegative atom or one polar bond.
	C.2. Making Generalization	
	Option 1: Quick Sort Cards	
	Directions: 1. The teacher will prepare mini cards of compounds to be posted on the board e.g. H_2, HCl, NaCl, CO_2, CH_4 2. Let the learners sort them into ionic, polar covalent or non-polar covalent.	This option targets Objectives 1-3 which allows learners to relate electronegativity, bond type and the polarity of the compound, providing quick demonstration of understanding the concept and provision of timely and relevant feedback.

	Option 2: Formative Checkpoint Drill	
	Directions: Give all learners HCl, CO_2, and H_2O. Ask them to compute ΔEN, classify each bond, and decide whether the whole molecule is polar or nonpolar, with one-sentence reasons.	This option targets Objectives 1-3 which allows learners to practice on the competency acquired on computing for the ΔEN and use it to classify the bond and polarity. This activity prepares the learners for the evaluation part and summative assessment.
	Option 3: Traffic Light Reflection	
	Directions: 1. Using the colors from the traffic light, encourage learners to reflect on their level of understanding as: ● Green- I can predict polarity confidently ● Yellow- I have learned but need more practice ● Red- I am still confused 2. Based on their responses, teacher can make follow-up questions for yellow and red colors.	This option targets Objectives 1-3 which allows learners to reflect on their level of understanding of the topic. This will provide inputs for the Note: In cases of more yellow and red responses, teachers need to make necessary intervention/ remediation.
	C.3. Evaluating Learning	
	Option 1: Multiple Choice Short Quiz	
	Directions: 1. Access the sample multiple choice questions from https://bit.ly/4dUCWyJ or construct a set of questions similar to the given sample. 2. Administer the quiz to reinforce memory, uncover learning gaps, and provide quick feedback on learners' understanding of key concepts.	This option targets Objectives 1-3 which allows learners to demonstrate higher-order thinking skills in relation to the conceptual understanding of the lesson. Note: The teacher may use MCQs as a cognitive tool and the attached sample items as reference.
	Option 2: True or False	
	Directions: 1. Prepare 5-10 statements for the True or False type of assessment. 2. See attached sample statements from the annex.	This option targets Objectives 1-3 which allows learners to demonstrate conceptual understanding on the topic.

Option 3: Supply what's missing

Directions: Complete the table.

Compound	Electronegativity Values	ΔEN	Bond Type	Molecular/ Bond Polarity
H–Cl	H = 2.1, Cl = 3.0			
Na–Cl	Na = 0.9, Cl = 3.0			
O_2	O = 3.5, O = 3.5			
H_2O (O–H)	H = 2.1, O = 3.5			
CH_4 (C–H)	C = 2.5, H = 2.1			

This option targets Objectives 1-3 which allows learners to exhibit competency on deriving the electronegativity differences and determine the bond type.

C.4. Additional Activities

Option 1: Enrichment: Shape Matters—Why Some Molecules Are Polar or Nonpolar

Directions:

1. Let the learners explore MolView as interactive simulation to visualize molecules in 3D and explain how electronegativity differences + molecular shape determine polarity. https://app.molview.com/
2. Assign compounds for them to build and analyze based on these guide questions:
   - *How does electronegativity difference in each bond affect the direction of electron pull inside the molecule?*
   - *Why do some molecules with polar bonds (like CO_2) become nonpolar when using their 3D shape in MolView?*
   - *How does molecular geometry shown in MolView help explain whether dipoles cancel or not?*

This option targets Objectives 1-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. It promotes deep conceptual understanding, scientific reasoning, and visualization skills, making abstract chemistry concepts more concrete and easier to master.

<table>
<tr><td></td><td colspan="2">Option 2: Reinforcement- Home Investigation</td></tr>
<tr><td></td><td>Directions:
1. Learners list household substances and classify them as ionic, likely polar or nonpolar.
2. Let them present their list in a table shown below:
<table><tr><td>Household substance</td><td>Chemical compound present</td><td>ΔEN values</td><td>Classification</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td><td>This option targets Objectives 1-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. This activity is an essential extension as it transforms the theoretical classroom concept into a practical analytical skill, enabling learners to accurately classify real substances using electronegativity differences and molecular understanding.</td></tr>
<tr><td></td><td colspan="2">Option 3: Additional Videos for Remediation</td></tr>
<tr><td></td><td>Directions:
The teacher can encourage the learners to watch additional video materials for remediation. https://bit.ly/49IVWxM</td><td>This option targets Objectives 1-3 which allows learners to relate electronegativity, bond type and the polarity of the compound. The use of additional videos will help learners improve their conceptual understanding about the topic.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Performance Task: Multimodal Polarity Prediction Challenge
Learners will predict the bond and molecular polarity of compounds using electronegativity differences, and real-time reasoning, presented through multiple interactive formats.
In groups, they can decide on various multimodal approach for their performance output such as but not limited to:
1. Hands-on Flash Card
2. Online Games
3. Interactive Slide Quiz
Every output must include (1) computed ΔEN, (2) bond classification, (3) molecular polarity decision when applicable, and (4) a brief explanation of how shape affects dipole cancellation or reinforcement. For four assigned compounds, compute ΔEN, classify each bond, determine molecular polarity when applicable, and explain your reasoning in complete sentences. If done in groups, add an individual exit response to verify each learner’s understanding.
Note: See attached sample scoring rubric.</td></tr>
</table>

VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was most difficult? 4. How many learners needed enrichment or additional challenge? How many learners needed remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	Generative AI disclosure: In preparing this Learning Exemplar, the author(s) used ChatGPT for language refinement and Gemini for one illustrative draft image. All content and final material selections were reviewed and finalized by the author(s).

Learning Title/Topic:	Molecular Polarity based on bond polarity, VSEPR and Molecular Geometry	Lesson Exemplar:	19

I. OBJECTIVES	
A. Content Standard	The learners learn that molecular geometry determines the shape of molecules and affects their polarity.
B. Performance Standard	By the end of the quarter, learners write names and formulas, particularly compounds commonly used in everyday life, industries, and the environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners should already understand valence electrons, the octet rule, basic Lewis structure construction, electron domains, common VSEPR geometries, electronegativity, and bond polarity
	The learners predict molecular polarity based on VSEPR theory and molecular geometry.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• Brown, Theodore L., H. Eugene LeMay Jr., Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. Chemistry: The Central Science. 15th ed. Boston: Pearson, 2023. • Department of Education. The Department of Education Manual of Style. Department Order No. 30, s. 2019. Pasig City: Department of Education, 2019. • OpenStax. Chemistry 2e. 2nd ed. Houston, TX: OpenStax, Rice University, 2019. • PhET Interactive Simulations. “Molecule Polarity.” University of Colorado Boulder. Accessed May 7, 2026. • PhET Interactive Simulations. “Molecule Shapes.” University of Colorado Boulder. Accessed May 7, 2026. Annex Link: https://tinyurl.com/CHEM-Q2-LE7-ANNEX
III. CONTENT *(Sequencing Content)*	Molecular Polarity based on bond polarity, VSEPR and Molecular Geometry
IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Determine the molecular geometry of simple molecules using Lewis structures and VSEPR theory. 2. Represent molecular geometries using labeled diagrams or models. 3. Explain whether a molecule is polar or nonpolar by analyzing symmetry and bond dipoles. 4. Predict the overall polarity of a molecule using bond polarity and molecular geometry.

<table>
<tr><th colspan="2">V. PROCEDURES</th><th>ANNOTATIONS</th></tr>
<tr><td rowspan="6">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1. Modified KWL chart</td></tr>
<tr><td>Learners complete a KWL Chart. In the What I Know column, divide into three parts: Absolutely Certain: facts and concepts they are confident about, supported by prior learning; Somewhat Sure: ideas they think are true but need clarification; Uncertain: assumptions or incomplete knowledge needing investigation. In the What I Want to Know column, learners list questions or scenarios specifically about molecular polarity.</td><td>The targeted objectives include 1–4. The IDF guiding principle is relevance (surfacing prior knowledge). The 2C-2I-1R approach is Constructivist because learners will self-assess and prepare for deeper exploration.
Note to teacher: Encourage honest entries in all columns; use misconceptions later for discussion.</td></tr>
<tr><td colspan="2">Option 2. Quick Recall Quiz</td></tr>
<tr><td>Learners take a short quiz to check their prior knowledge on predicting molecular polarity using VSEPR and molecular geometry. The quiz may be done on paper or with digital tools.
Sample Questions:
1. What makes a bond polar? Give at least one example.
2. If a molecule has polar bonds but is symmetrical, what is its overall polarity?
3. What is the difference between bond polarity and molecular polarity?</td><td>The targeted objectives include 1–3. The IDF guiding principle is relevance (checking key concepts). The 2C-2I-1R approach is both Constructivist and Inquiry-based because learners recall, apply, and reason through diagnostic questions.
Note to teacher: Use quiz results to guide pacing and highlight areas needing reinforcement.</td></tr>
<tr><td colspan="2">Option 3. Brainstorming Web</td></tr>
<tr><td>Learners create a concept web on the board to connect terms: electronegativity, dipole, Lewis structure, bond, molecule, shape, polarity. Groups expand the web by adding relationships and examples.</td><td>The targeted objectives include 1–4. The IDF guiding principle is reflectiveness (visualizing links). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners map concepts and build connections.
Note to teacher: Prompt learners to add examples and connections; use a web to transition into new content.</td></tr>
</table>

	A.2. Establishing the Purpose of the Lesson	
	Option 1: Concept Unpacking	
	The teacher writes **"MOLECULAR POLARITY"** on the board and unpacks the terms: *Molecular* = relating to molecules (atoms bonded together). *Polarity* = uneven electron distribution creating partial positive (δ^+) and partial negative (δ^-) regions. Discuss with the learners: *How does molecular shape affect the distribution of charges and overall polarity?* Suggest this real-world guiding question: *Why does water dissolve salt, but oil doesn't?* The teacher concludes with the lesson's purpose.	The targeted objectives include 1–4. The IDF guiding principles are relevance (defining molecular polarity), responsiveness (linking to real-world questions), and reflectiveness (connecting shape and charge distribution). The 2C□2I□1R approach is both Constructivist and Inquiry□based because learners unpack definitions and relate them to everyday phenomena. *Note to teacher*: Use everyday examples (solubility, boiling points) to show why polarity matters.
	Option 2: Prediction Challenge	
	• The teacher shows images of a water droplet on a leaf (beading up) and oil floating on water. (*See Annex link for the images)* • Here are some discussion questions that can be asked: *1. Both are liquids, but why do they behave differently?* *2. Could the shape of their molecules be the reason?* • The teacher concludes with the lesson's purpose.	The targeted objectives include 1–3. The IDF guiding principle is relevance (comparing water and oil behavior). The 2C□2I□1R approach is Constructivist because learners use visual inquiry to connect their observations with geometry. *Note to teacher:* Use images to spark curiosity; guide learners to connect observations to molecular geometry.
	Option 3: Question to Ponder	
	• The teacher provides quick recall on previous lesson on bond polarity using electronegativity difference and correct assigning of charges in a molecule being + and -. (*See Annex link for support images for the quick recall)* • Display the question: *"If H_2O and CO_2 both contain polar bonds, why is water polar while carbon dioxide is nonpolar?"* • Let learners discuss in pairs before sharing their thoughts in class. • The teacher concludes with the lesson's purpose.	The targeted objectives include 1–3. The IDF guiding principle is relevance (revisiting bond polarity). The 2C□2I□1R approach is Inquiry based because learners explain and share insights before teacher clarification. *Note to teacher:* Let learners share initial thoughts before clarifying their understanding of geometry and dipole cancellation.

<table>
<tr><td rowspan="8">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1: Card Sorting Task</td></tr>
<tr><td>In small groups, learners are given "mystery molecules" (Lewis structures only: $BeCl_2$, BCl_3, CH_4, NH_3, H_2O). They will predict geometry and justify their reasoning using their prior knowledge of VSEPR rules. The teacher circulates to check understanding and address misconceptions.</td><td>The targeted objectives include 1 and 3. The IDF guiding principle is relevance (applying VSEPR rules to new molecules). The 2C-2I-1R approach is Inquiry-based because learners predict geometries.
Note to teacher: Check their reasoning; highlight correct use of VSEPR rules and symmetry. Additional mystery molecules can be added.</td></tr>
<tr><td colspan="2">Option 2: Geometry Prediction Challenge:</td></tr>
<tr><td>Provide cards with Lewis structures of molecules (e.g., CO_2, NH_3, H_2O, CH_4, BF_3, SO_2).
Learners sort them into geometry categories: linear, bent, trigonal planar, tetrahedral, trigonal pyramidal.
For each category, learners identify: Number of bonding pairs, Number of lone pairs, Electron domain geometry, Molecular geometry
Groups present their sorted cards and justify their classifications. (See Annex link for the acceptable answers)</td><td>The targeted objectives include 1–2. The IDF guiding principles are relevance (linking Lewis structures to geometry), responsiveness (engaging learners in classification), and reflectiveness (justifying reasoning). The 2C-2I-1R approach is both Constructivist and Inquiry-based because learners actively sort, identify features, and explain their classifications.
Note to teacher: Encourage justification for each category; use misconceptions (e.g., lone pairs vs bonding pairs) for later clarification.</td></tr>
<tr><td colspan="2">Option 3: Spot the Difference</td></tr>
<tr><td>Display images of H_2O and CO_2 molecular geometries. (See Annex link for the images)
Learners identify differences in shape, lone pairs, and symmetry.</td><td>The targeted objectives include 2–3. The IDF guiding principle is reflectiveness (linking geometry to polarity). The 2C□2I□1R approach is Constructivist because learners analyze visual differences and connect them to polarity
Note to teacher: Use H_2O vs CO_2 comparison to reinforce how lone pairs and symmetry affect polarity.</td></tr>
</table>

	B.2. Discussing New Concept	
	Option 1: Guided Prediction Activity: Tracing Polarity Pathways	
	• Learners predict the polarity of a molecule based on VSEPR Theory and Molecular Geometry using a Molecular Polarity Guide Map. (*See Annex link)* • Let learners begin the activity by reviewing the guide map with the teacher, who explains each step in predicting molecular polarity. • In small groups, they analyze sample molecules like H_2O, CO_2, NH_3, and CH_4 using a guided worksheet that mirrors the map. The teacher facilitates reasoning and clarifies misconceptions, then groups share their predictions with the class for comparison.	The targeted objectives include 1, 3, and 4. The IDF guiding principles are relevance (using guide map to structure reasoning), responsiveness (group analysis), and reflectiveness (sharing predictions). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners predict polarity step by step and refine ideas through comparison. *Note to teacher:* Facilitate reasoning with the guide map; clarify misconceptions during group sharing. Use a labeled guide map that shows the sequence of Lewis structure → molecular geometry → bond dipoles → overall polarity.
	Option 2: Guided Model Exploration- Shapes in Our Hands	
	• Learners start with pre-constructed molecular models (H_2O, CO_2, NH_3, CH_4). The teacher guides them to identify electron domains, bond angles, and overall geometry. The teacher demonstrates how to add dipole arrows to the models to show polarity. Learners handle the models, observe symmetry, and discuss whether dipoles cancel or reinforce, connecting shapes to polarity predictions. **Key Discussion Points:** — Molecules with polar bonds can still be nonpolar if symmetrical. Lone pairs create asymmetry, often leading to polarity. — The 3D shape is critical. 2D drawings can be misleading.	The targeted objectives include 1–4. The IDF guiding principles are relevance (using models to visualize geometry), responsiveness (adding dipole arrows), and reflectiveness (connecting symmetry to polarity). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners manipulate models, observe dipoles, and reason for polarity. *Note to teacher:* Stress that 3D shapes matter; highlight how lone pairs create asymmetry leading to polarity.

	Option 3: Explicit Teaching	
	Direct instruction using a structured presentation: 1. Review VSEPR theory and electron domain geometries 2. Present the all-basic molecular geometries with examples (linear, bent, trigonal planar, tetrahedral, trigonal pyramidal, T-shaped, and octahedral) 3. Explain the relationship between electronegativity and bond polarity 4. Demonstrate vector addition of bond dipoles 5. Provide the "symmetry rule" for predicting molecular polarity 6. Work through 3-4 examples together as a class	The targeted objectives include 1–4. The IDF guiding principles are relevance (structured presentation of VSEPR and polarity), responsiveness (step-by-step explanation), and reflectiveness (working through examples). The 2C□2I□1R approach is both Constructivist and Inquiry□based because learners build understanding through direct instruction and guided practice. *Note to teacher:* Provide clear rules (symmetry, vector addition) and reinforce with multiple examples.
	B.3. Developing Mastery	
	Option 1: Faded Prediction Activity- Molecule Detective Challenge	
	• Continue the Guided Prediction Activity from B.2 Option 1. • Learners individually apply the same process to new molecules (BF_3, SO_2, PCl_3, XeF_2) without the guide map. • For each molecule, they need to: — Draw or build a labeled sketch/model showing central atom, bonding pairs, lone pairs, electron domain geometry, and molecular geometry. — Complete a blank worksheet. • Pair up to cross check and justify answers.	without scaffolds and refine through peer review. *Note to teacher:* Remind learners that central atoms beyond Period 2 can expand octets; use peer checks to surface errors.
	Option 2: Independent Model Construction- Build and Predict Challenge	
	• Continue the Guided Prediction Activity from B.2 Option 2. • Learners receive molecular formulas (BF_3, SO_2, PCl_3, XeF_2, CH_2Cl_2). • For each molecule, they: 1) Predict geometry using VSEPR theory. 2) Construct models with kits or improvised materials. 3) Analyze dipole interactions to decide if polar or nonpolar. 4) Submit a labeled sketch/model showing central atom, bonding pairs, lone pairs, electron-domain	The targeted objectives include 1–4. The IDF guiding principles are relevance (building models from formulas), responsiveness (analyzing dipoles), and reflectiveness (comparing peer results). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners construct models, predict polarity, and justify reasoning.

	geometry, and molecular geometry. And 5) Compare results with peers, justify reasoning, and reflect on how geometry influences polarity.	*Note to teacher:* Ensure learners connect geometry to polarity; encourage reflection on how shape influences dipole cancellation.
	Option 3: Digital Simulation Exploration	
	Using the PhET "Molecule Shapes" simulation, learners will: 1) build molecules and observe real-time geometry changes; 2) add lone pairs and observe how geometry shifts; 3) overlay electronegativity values to see bond dipoles; and 4) toggle "molecular dipole" visualization to check their predictions Guide Questions for Exploration 1. How does adding lone pairs change the geometry? 2. Which shapes show dipoles that cancel, and which reinforce? 3. Does the molecular dipole visualization match your prediction? Why? 4. Compare two molecules (e.g., H_2O vs CO_2). How does shape explain their polarity difference?	The targeted objectives include 1–4. The IDF guiding principles are relevance (interactive simulation of geometry and polarity), responsiveness (exploring lone pairs and dipoles), and reflectiveness (comparing predictions with visualization). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners conduct the experiment digitally, test predictions, and reflect outcomes. Note to teacher: Provide learners with questions on lone pairs, symmetry, and dipole reinforcement; emphasize comparing predictions with simulation results.
C. Demonstrating Knowledge and Skills	**C.1. Finding Practical Application**	
	Option 1: Real World Connections	
	• Group Investigation Task: Each group researches and presents on ONE of the following real-world applications of molecular polarity including but not limited to: solubility, cleaning, and biological functions. • Group Presentation: Each group creates a poster or digital slide explaining: 1. The molecules involved and their structures. 2. Why are they polar or nonpolar (using VSEPR and geometry). 3. How does polarity create effects in real-world contexts?	The targeted objectives include 1–4. The IDF guiding principle is relevance (linking polarity to solubility, cleaning, and biological functions). The 2C-2I-1R approach is Constructivist and Inquiry-based because learners explore authentic applications and justify polarity's role in everyday contexts. Note to teacher: Encourage groups to use VSEPR reasoning in posters; highlight how polarity explains practical phenomena.

	Option 2: Solubility Experiment Design	
	Learners design a simple experiment to test solubility: • *Test substances*: salt (ionic), sugar (polar covalent), oil (nonpolar), wax (nonpolar) • *Solvents:* water (polar), rubbing alcohol (polar), vegetable oil (nonpolar) • *Prediction:* Which test substances will be dissolved in each solvent? Why? • Learners connect solubility results to molecular polarity and intermolecular forces.	The targeted objectives include 2–4. The IDF guiding principle is relevance (testing solubility with common substances). The 2C□2I□1R approach is Inquiry based because learners design experiments and explain anomalies. *Note to teacher:* Remind learners that oil and wax are largely nonpolar hydrocarbons; use this to clarify misconceptions.
	Option 3: Molecular Polarity in Everyday Products	
	• Provide learners with a teacher-prepared list of common ingredients (water, ethanol, glycerol, mineral oil, acetone) and ask them to classify each as likely polar or nonpolar based on structure.' • Learners research whether these ingredients are polar or nonpolar and explain how polarity affects the product's function (e.g., why moisturizers contain both water and oil components, why nail polish remover dissolves polish).	The targeted objectives include 2–4. The IDF guiding principle is relevance (classifying common ingredients). The 2C□2I□1R approach is Constructivist and Inquiry based because learners analyze product ingredients, classify polarity, and connect to everyday uses. *Note to teacher:* Guide them to explain why products often combine polar and nonpolar components (e.g., moisturizers, solvents).
	C.2. Making Generalization	
	Option 1: KWL Chart Continuation	
	• Learners use their constructed KWL chart earlier and fill in the last column.	The targeted objectives include 3–4. The IDF guiding principle is reflectiveness (documenting corrected understanding). The approach is Constructivist because learners revisit their chart *Note to teacher:* Review "What I Learned" to identify persistent errors for later clarification.

	Option 2: Guide Map Fill in the Blank	
	• Use the same Guide Map from the Guided Prediction Activity (Tracing Polarity Pathways). • Leave some parts blank for learners to fill in. (*See Annex link for a sample guide map with NH_3)*	The targeted objectives include 1–4. The IDF guiding principle is reflectiveness (checking accuracy of reasoning steps). The 2C□2I□1R approach is Constructivist because learners reconstruct reasoning pathways and validate polarity predictions. *Note to teacher:* Use blanks to scaffold reasoning; emphasize correct identification of lone pairs and dipole cancellation.
	Option 3: Exit Ticket	
	Each student writes 3 generalizations they've learned, with one specific molecule example to support each. The teacher collects reviews for misconceptions.	The targeted objectives include 3–4. The IDF guiding principle is relevance (summarizing key generalizations). The approach is both Constructivist and Inquiry based because learners articulate generalizations with evidence before leaving class. *Note to teacher:* Collect tickets to check learning; use examples to guide the next lesson review.
	C.3. Evaluating Learning	
	Option 1: Polarity Quiz Game	
	• For the following molecular formulas: NH_3, CO_2, CH_2Cl_2, predict if the molecule is polar or nonpolar • Must justify geometry and symmetry analysis. • For each molecule, submit a labeled sketch or model showing the central atom, bonding pairs, lone pairs, electron-domain geometry, and molecular geometry.	The targeted objectives include 1–4. The IDF guiding principle is relevance (testing polarity predictions). The 2C□2I□1R approach is Constructivist because learners predict polarity collaboratively. *Note to teacher:* Ensure learners include labeled sketches; highlight symmetry analysis in justifications.

	Option 2: Structured Problem Set	
	• Part A: Draw Lewis structures for 5 given formulas: H_2O, CO_2, NH_3, CH_4, SO_2 • Part B: Represent each molecule using a labeled 2D or 3D sketch before stating its molecular geometry and polarity. • Part C: Predict polarity with justification	The targeted objectives include 1–4. The IDF principle is relevance (drawing structures). The approach is Constructivist because learners apply VSEPR and reflect on polarity outcomes. *Note to teacher:* Check accuracy of Lewis structures; emphasize link between geometry and polarity.
	Option 3: If-Then Generalization Statements	
	Learners complete and share generalization statements:(*see Annex link for the expected answers)* 1. If a molecule has no lone pairs on the central atom and all surrounding atoms are identical, then..." 2. If bond dipoles are arranged symmetrically, then... 3. If a molecule is polar, then its physical properties will include...	The targeted objectives include 3–4. The IDF guiding principle is relevance (formulating rules). The 2C□2I□1R approach is Constructivist because learners generate conditional reasoning and validate with examples. *Note to teacher:* Encourage precise language in statements; use them to reinforce symmetry and polarity rules. Extra statements may be added.
	C.4. Additional Activities	
	Option 1. The Chemist in Me (Enrichment)	
	• Learners list possible substances that could be applied to solve given problems (e.g. household cleaning, oil spill), acting in the role of chemists. • Learners analyze each substance's molecular geometry using VSEPR theory, then predict its overall polarity. • Learners defend and justify their choices by explaining how the predicted polarity relates to the problem context.	The targeted objectives include 2–4. The IDF guiding principle is relevance (applying polarity to real problems). The 2C□2I□1R approach is Constructivist and Inquiry based because learner's roleplay as chemists, predict polarity, and justify applications. *Note to teacher:* Encourage creativity in substance selection; guide learners to connect polarity to practical solutions.

<table>
<tr><td></td><td colspan="2">Option 2. Polarity Bingo (Reinforcement)</td></tr>
<tr><td></td><td>• Learners create their own BINGO card by putting common compounds in each cell.
• The teacher then draws a random prompt (e.g. under B, cross out all non-polar substances, under G, cross out substances with linear molecular geometry)
• Learners apply VSEPR theory and polarity rules to determine which compounds to cross out, aiming to complete a BINGO line.</td><td>The targeted objectives include 1–3. The IDF guiding principle is responsiveness (applying prompts to classify). The 2C□2I□1R approach is both Constructivist and Inquiry based because learners apply rules interactively and reflect on prompts requiring deeper reasoning.
Note to teacher: Use prompts that combine geometry and polarity; emphasize reflection after the game.</td></tr>
<tr><td></td><td colspan="2">Option 3. Hint Cards (Remediation)</td></tr>
<tr><td></td><td>This is a remediation scaffold activity that can be used to support learners who struggle with predicting molecular polarity. The hint card provides structure and cues so they can reason step by step. (See Annex Link for the Sample Hint Cards)</td><td>The targeted objectives include 1–4. The IDF guiding principle is relevance (scaffolding with structured cues). The 2C□2I□1R approach is Constructivist because learners use sentence frames to articulate polarity reasoning.
Note to teacher: Provide visual cues with hint cards; gradually fade scaffolds as learners gain confidence.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Structured Problem Set
Directions: For each formula, draw the Lewis structure with all valence electrons, bonding pairs, and lone pairs. Use VSEPR theory to identify the molecule’s geometry. Then check the bond dipoles and overall symmetry. Finally, decide if the molecule is polar or nonpolar.
<table>
<tr><th>Molecules</th><th>Lewis Structure</th><th>Molecular Geometry</th><th>Predicted Polarity</th></tr>
<tr><td>CS_2</td><td></td><td></td><td></td></tr>
<tr><td>SeO_2</td><td></td><td></td><td></td></tr>
<tr><td>PCl_3</td><td></td><td></td><td></td></tr>
<tr><td>CCl_4</td><td></td><td></td><td></td></tr>
<tr><td>SO_2</td><td></td><td></td><td></td></tr>
<tr><td>$BeCl_2$</td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>BF_3</td><td></td><td></td><td></td></tr>
<tr><td>CF_4</td><td></td><td></td><td></td></tr>
<tr><td>ClF_3</td><td></td><td></td><td></td></tr>
<tr><td>SF_6</td><td></td><td></td><td></td></tr>
</table>
Pointing System: Each correct answer corresponds to 1 point. Award 1 justification point when the learner consistently explains polarity using the geometry shown, even if an earlier drawing error is present; reserve full credit for fully correct structure, shape, and polarity.
Performance Task: Choose one household substance or product ingredient. Draw or describe its molecular structure, identify its geometry and polarity, and explain one observable property or use that is influenced by its polarity.
</td></tr>
<tr><td>VII. REFLECTION
(Feedback and Continuous Improvement)</td><td>Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery.
1. How many learners successfully demonstrated the learning objectives based on the assessment results?
2. Which activity helped learners understand the lesson the most? Which activity helped the least?
3. Which part of the lesson was easiest for learners? Which part was the most difficult?
4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support?
5. What did the assessment results show about learners' understanding of the lesson?
6. What improvement would you make if you taught this lesson again?</td></tr>
<tr><td>VIII. USE OF GENERATIVE AI</td><td>In preparing this Learning Exemplar (LE), the author used Copilot to structure the sentences cohesively and concisely, and to generate the Polarity Guide Map. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.</td></tr>
</table>

Learning Title/Topic:	Differentiating Intramolecular and Intermolecular Forces Using Diagram	Lesson Exemplar:	20

I. OBJECTIVES	
A. Content Standard	The learners learn that intermolecular forces affect the physical properties and behavior of substances
B. Performance Standard	*By the end of the quarter, learners* write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. *Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.*
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners should come prepared with prior knowledge of the kinetic molecular theory, types of chemical bonds, and the difference between physical and chemical changes, as these concepts provide the foundation for distinguishing intramolecular and intermolecular forces through diagrams.
	The learners use a diagram to differentiate the intermolecular forces and the intramolecular forces.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	OpenStax. Chemistry 2e. Houston: OpenStax, Rice University, 2019. Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018. *Materials:* Printed anticipation guide, Paper clips, Molecular diagrams and molecule cards, Projector or television for multimedia presentation, Chart paper/manila paper, Markers and pens, Optional electrolysis setup: (Low-voltage DC power supply, Beakers, Electrodes, Connecting wires), Safety goggles, Printed rubrics and activity sheets *ANNEX LINK*: https://tinyurl.com/ANNEX-CHEMQ2LE8
III. CONTENT *(Sequencing Content)*	Differentiating Intramolecular and Intermolecular Forces Using Diagram

IV. OBJECTIVES *(Setting Clear Objectives and Analyzing the Tasks)*	1. Represent through diagrams the difference between intramolecular forces and intermolecular forces; 2. Differentiate the two types of forces by analyzing diagrams focusing on relative strength and location. 3. Use the diagram-based distinction between the two forces to explain selected physical properties such as melting point, boiling point, and solubility.	
V. PROCEDURES		**ANNOTATIONS**
A. Activating Prior Knowledge	***A.1. Activating Prior Knowledge***	
	Option 1. Anticipation Guide	
	The learners answer an Anticipation Guide survey. (*See Annex link for sample items for the anticipation guide.* The learners share their responses in pair. The responses of the learners will then be consolidated and will be revisited at the end of the session.	The objectives include 1–3. The IDF principle is relevance, as survey items connect diagrams to real phenomena. The 2C-2I-1R approach is Constructivist and Inquiry-based, as learners refine initial beliefs through evidence. *Note to teacher:* Treat misconceptions as starting points for clarifying intra- and intermolecular forces.
	Option 2. Active Recall	
	Teacher poses a *central question*-What is the difference between the forces that hold atoms together inside a molecule and forces that act between separate molecules? *Learner tasks:* Jot down plausible answers. Jot down curiosity questions related to the central question. Draw a quick sketch of water molecules and mark where they think the forces of interactions are. Learners compare answers and questions, noting similarities and differences.	The targeted objectives include 1–3. The IDF guiding principle is relevance (central question focuses on diagrammatic differences). The 2C□2I□1R approach is Constructivist because learners generate, question, and diagram their own ideas. *Note to teacher:* Use quick sketches diagnostically, as learners' questions reveal gaps and guide discussion toward physical property explanations.
	Option 3. Inside Bonds vs Between Forces	
	The teacher presents an everyday phenomenon *(e.g. salt dissolving in water, ice melting, perfume evaporating, diamond hardness)*. For each phenomenon, learners decide whether it is mainly explained by intramolecular bonds or intermolecular forces. Learners sketch a simple diagram (atoms connected vs.	The objectives include 1–3. The IDF principle is relevance, as real-world phenomena anchor diagrams. The 2C-2I-1R approach is Inquiry-based, as learners analyze cases, sketch diagrams, and reason for bond strength.

	molecules interacting) to represent their choice. Learners compare answers, highlight differences, and surface misconceptions. (*see Annex link for a sample table for learner's response)*	*Note to teacher:* Require diagram-based justifications. Contrast melting as intermolecular and decomposition as intramolecular.
	A.2. Establishing the Purpose of the Lesson	
	Option 1. Paper Clip Chain Analogy	
	Procedure: Learners create a chain of paper clips. (They may use 5 or more paper clips). Learners untangle the chains of paper clips. Learners break a paper clip. *Discussion Questions: (not limited to the following:)* 1. Which is easier: separating chains or breaking clips? 2. What does separating chains represent? 3. What does breaking clips represent? 4. Why is separating chains easier than breaking clips? Give a real-life example.	The objectives include 1–3. The IDF principle is reflectiveness, connecting analogies to real-life examples. The 2C-2I-1R approach is Inquiry-based, as learners use models to compare separation and breaking. *Note to teacher:* Emphasize that separating chains represents intermolecular forces, while breaking clips represents intramolecular bonds.
	Option 2. The One-Million-Peso Investment	
	The teacher presents a *hypothetical question*: "You have PHP 1 million to invest in a startup that claims to have invented a device that boils water by breaking O-H bonds inside water molecules directly. Is this a good investment? Why or why not? Learners write a 3-sentence justification for either supporting or rejecting the investment, justifying their current understanding of forces. (*See Annex link for the scoring rubric)*	The objectives include 1–3. The IDF principle is reflectiveness, focusing on scientific plausibility. The 2C-2I-1R approach is Inquiry-based, as learners apply concepts to decision-making. *Note to teacher:* Emphasize scientific accuracy and connect bond strength, energy, diagrams, and real-world claims
	Option 3. Real-World Phenomenon Hook	
	Show side-by-side images of water boiling in a kettle and water splitting in an electrolysis apparatus. (*See Annex link for the images)* *Ask:* Why does evaporation separate molecules physically, while electrolysis changes water into new substances? *Transition*: The answer lies in which forces are being overcome, namely — intermolecular attractions vs. intramolecular bonds, respectively. Let's use a diagram to see the difference.	The objectives include 1–3. The IDF principle is responsiveness, as learners explain force differences. The 2C-2I-1R approach is Inquiry-based, as learners interpret visuals, classify forces, and reason outcomes. *Note to teacher:* Emphasize that evaporation involves intermolecular forces, while electrolysis involves intramolecular bonds.

<table>
<tr><td rowspan="6">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1. Discrepant Event Video Demonstration</td></tr>
<tr><td>The learners watch two short clips.
Clip 1: Evaporation of Water (Phase change- Physical)
Clip 2: Electrolysis of Water (Chemical Decomposition)
Discussion Question: (See Annex for sample expected answers)
1. Why did heating water change its state, while electrolysis formed new substances?
2. What forces were overcome in each case?</td><td>The objectives include 1–3. The IDF principle is reflectiveness, linking demonstrations to diagram distinctions. The 2C-2I-1R approach is Inquiry-based, as learners observe, compare, and explain force.
Note to teacher: Emphasize that evaporation involves intermolecular forces, while electrolysis involves intramolecular bonds.</td></tr>
<tr><td colspan="2">Option 2. Melting vs Burning Investigation</td></tr>
<tr><td>The teacher presents images or videos of candle melting and candle burning. Learners compare the two processes. Learners identify whether intermolecular or intramolecular forces are primarily involved.
Guide Questions: 1) Which process is a physical change? 2) Which process is a chemical change? 3) What type of force is affected in each process?</td><td>The objectives include 1–3. The IDF principle is relevance, contrasting physical and chemical changes. The 2C-2I-1R approach is Inquiry-based, as learners classify forces and justify using diagrams.
Note to teacher: Emphasize that melting affects intermolecular forces, while burning involves a chemical reaction in which bonds are broken and new bonds are formed.</td></tr>
<tr><td colspan="2">Option 3. Vocabulary Check</td></tr>
<tr><td>Learners shall classify a list of words (within, bonds between atoms, ionic bond, metallic bond, bond molecules, hydrogen bonding, dipole-dipole forces, and van der Waals forces) as either “Intramolecular Force” or “Intermolecular Forces”. (See Annex link for suggested list of words, classification, and definition)
After classifying, learners define and differentiate the two categories in their own words.</td><td>The objectives include 1–3. The IDF principle is relevance, as terms of map to diagram conventions. The 2C-2I-1R approach is Constructivist, as learners classify vocabulary and explain forces.
Note to teacher: Link classification to diagram representation and use learners’ definitions to consolidate understanding.</td></tr>
</table>

B.2. Discussing New Concept

Option 1. Diagram Convention Clinic

The teacher introduces local diagram conventions for lesson purpose through direct instruction with visual example:

Conventional Symbol	Meaning	Corresponding Representation	Visual Examples
Solid line	Strong force, within structural unit	Intramolecular force	O—H, Na^+—Cl^-, C—C
Dashed line (- - -)	Moderate force, between structural unit	Intermolecular forces (dipole-dipole)	H—O···H—O (H-bond)
Dotted Line (….)	Weak force, between structural units	Intermolecular forces (London Dispersion)	Cl_2····Cl_2
Line Thickness	Relative Strength	Thicker = stronger	Ionic bond (thick) vs. H-bond (thin dashed)
Numerical label	Approximate /illustrative energy value.	Both types	Covalent: ~400 kJ/mol; H-bond: ~20 kJ/mol
Distance between units	Inverse relationship with strength	Both Types	Closer = stronger attraction

After introducing the conventions, learners describe a given diagram using the following key points: *(1) What type of force does each line style represent? (2) Where is the force located?*

The objectives include 1–3. The IDF principles are relevance, responsiveness, and reflectiveness, as learners use diagram conventions to interpret forces and connect features to physical properties. The 2C-2I-1R approach is Constructivist and Inquiry-based, as learners decode, apply, and explain diagrams.

Note to teacher: Emphasize that conventions aid clarity, but learners must always check figure keys because diagrams may use different conventions.

	(within or between molecules) (3) What is the relative strength based on the line thickness/distance? (4) What physical property would this effect?	
	Option 2. Diagram Analysis	
	The learners analyze a given diagram. (*See Annex link for a sample diagram for this activity)* Guide Questions: (*Additional questions may be added)* 1. What do the solid and dotted/dashed lines in the diagram represent? 2. How do line thickness and distance between units indicate the relative strength of forces? 3. Which forces act within a molecule, and which act between molecules? 4. Which type of force (intramolecular or intermolecular) generally requires more energy to break?	The objectives include 1–3. The IDF principles are relevance and responsiveness, as learners interpret diagram features and answer guide questions about force strength. The 2C-2I-1R approach is Inquiry-based, as learners classify forces and reason for strength and location. *Note to teacher:* Emphasize that thickness and distance in diagrams should be connected to melting, boiling, and solubility.
	Option 3. Molecular Sorting Challenge	
	Learners are given several molecular diagrams. They sort the diagrams into: *Intramolecular forces only; Intermolecular forces present; Both intermolecular and intramolecular forces.* Learners justify their classification.	The objectives include 1–3. The IDF principle is relevance, as learners sort diagrams into intra- and intermolecular categories. The 2C-2I-1R approach is Inquiry-based, as learners manipulate diagrams and reason for forces. *Note to teacher:* Emphasize justification and explain that intra- and intermolecular forces may coexist in some diagrams.
	B.3. Developing Mastery	
	Option 1. Diagram Representation	
	This option is a continuation of B.2. Option 1. Using the Convention Chart, learners draw diagram of these scenarios: 1. Water molecules showing O-H covalent bonds and hydrogen bonds.	The targeted objectives include 1–3. The IDF guiding principle is reflectiveness (connecting diagram distinctions to phenomena like solubility and melting). The 2C□2I□1R approach is Constructivist because learners construct diagrams, annotate and reason for forces.

	2. Solid iodine (I_2) showing covalent bonds and London dispersion forces. 3. Hydrogen Chloride (HCl) showing ecovalent bonds and Dipole-dipole forces. After drawing, learners provide written descriptions distinguishing the forces by location (within/between), strength (strong/moderate/weak), and effect on properties.	*Note to teacher:* Stress that diagrams must show both intra and inter forces clearly; highlight how written descriptions consolidate understanding.
	Option 2. Drawing Inferences Based on Diagrams	
	Learners are presented with diagrams of the following molecules: Methane, HF, Cl_2. Learners note their inferences (*See Annex link for the diagrams and a sample note table for learners)* Reflection guide: 1) How do line styles help you distinguish between intra- and intermolecular forces? 2) Which molecule shows the strongest overall attraction? 3) How do these forces affect the physical state of each substance?	The objectives include 1–3. The IDF principle is reflectiveness, linking diagram cues to physical states. The approach is Constructivist, as learners analyze diagrams. *Note to teacher:* Emphasize that line styles and distances help learners connect diagrams to physical properties.
	Option 3. Force Battle- Card Game	
	Teacher prepares molecule cards with diagram conventions. Learners play in teams, with each team receiving 5 cards. The remaining cards become the draw pile. Players take turns laying cards. The next player must use a stronger force card or draw. The stronger card wins, and the winner keeps both cards in the score pile. Played cards cannot be reused. The team with the most cards wins. After game discussion questions: *(not limited to the following)* 1. Which cards were hardest to beat? 2. How did diagram conventions help you decide strength? 3. Why do intramolecular forces win over intermolecular forces? 4. How does this game help differentiate between the two forces?	The objectives include 1–3. The IDF principles are relevance, responsiveness, and reflectiveness, as learners compare force strength through cards and diagrams. The approach is Constructivist and Inquiry-based. *Note to teacher*: Emphasize that intramolecular forces are stronger, reinforcing the hierarchy of bond strength.

<table>
<tr><td rowspan="6">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1. CFCs and the Ozone Layer</td></tr>
<tr><td>Learners diagram the process:
Weak London dispersion forces → easy evaporation
Strong C–Cl bonds → broken by UV light
Released Cl· radicals → attack ozone molecules
Learners explain why CFCs were stable near the ground but harmful in the stratosphere.
Discussion Prompt: Why did the same stability that made CFCs useful as refrigerants become a problem when UV radiation broke them apart in the upper atmosphere?</td><td>The objectives include 1–3. The IDF principle is relevance, linking environmental issues to force distinctions. The 2C-2I-1R approach is Inquiry-based, as learners diagram processes and analyze ozone depletion.
Note to teacher: Emphasize that weak IMFs explain volatility, while strong intramolecular bonds break under UV.</td></tr>
<tr><td colspan="2">Option 2. Viscosity Investigation: Motor Oil</td></tr>
<tr><td>Context: Motor oil viscosity depends on intermolecular forces between hydrocarbon chains. Longer chains = have stronger London dispersion forces = accounts for higher viscosity. (See annex for a diagram of an engine oil)
Learner task: Draw diagrams comparing short-chain vs. long-chain hydrocarbons. Explain why multi-grade oils work across temperatures (viscosity index improvers to modify IMFs).</td><td>The objectives include 1–3. The IDF principle is reflectiveness, linking IMFs to coolant choice. The approach is Inquiry-based, as learners compare hydrocarbons and relate IMFs to viscosity.
Note to teacher: Emphasize that longer chains have stronger IMFs, affecting antifreeze and engine performance.</td></tr>
<tr><td colspan="2">Option 3. Biomolecules and Life Processes</td></tr>
<tr><td>Context: DNA strands are held together by hydrogen bonds between base pairs, while the sugar-phosphate backbone is held by covalent bonds.
Learner task: Diagram a DNA segment using solid lines for covalent backbone bonds and dashed lines for A-T and G-C hydrogen bonds.
Discussion: Why can DNA strands separate during replication without breaking the backbone, and how do enzymes help?</td><td>The objectives include 1–3. The IDF principles are relevance, responsiveness, and reflectiveness, connecting DNA replication to force distinctions. The approach is Constructivist and Inquiry-based.
Note to teacher: Emphasize that enzymes separate weak hydrogen bonds while the covalent backbone remains intact.</td></tr>
</table>

	C.2. Making Generalization	
	Option 1. From Anticipation to Justification	
	Revisit the *Anticipation Guide for Activity in A.1 Option 1*. Learners review their Anticipation Guide responses, justify corrections, and use diagrams to clarify the difference between intramolecular and intermolecular forces. After refining and annotating their answers, guide them in forming a class conclusion.	The objectives include 1–3. The IDF principle is reflectiveness, as learners synthesize a generalization. The approach is Constructivist and Inquiry-based. *Note to teacher:* Require diagram-supported corrections and clear generalization.
	Option 2. Recall to Justification with Annotated Diagrams	
	Revisit *the Active Recall Activity in A.1 Option 2.* The teacher re-poses the central question from the Active Recall activity. Learners review their initial notes, redraw a water molecule diagram, and annotate it by labeling solid O-H bonds as intramolecular forces and dotted lines between molecules as intermolecular forces. They add brief notes explaining corrections, then synthesize their ideas into a class conclusion.	The targeted objectives include 1–3. The IDF guiding principle is reflectiveness (writing notes to explain corrections). The 2C□2I□1R approach is Constructivist and Inquiry based because learners redraw, annotate, and reason for force distinctions. *Note to teacher:* Stress that annotations make distinctions visible; highlight how learners' notes consolidate conceptual clarity.
	Option 3. Bond or Attraction- What is it Really?	
	Revisit the recall phenomena activity in A.1 Option 3. Bond or Attraction Learners revisit their prior answer, identify corrections, and explain their reasoning- reinforcing the distinction between intramolecular and intermolecular forces. (*See Annex Link for Sample Learner's Table)* After learners refine and annotate their answers, guide them to synthesize into a conclusion.	The objectives include 1–3. The IDF principle is reflectiveness, as learners synthesize a conclusion. The approach is Constructivist, as learners revise, annotate, and reason for phenomena. *Note to teacher:* Require diagram-supported revisions and connect force distinctions to real-world phenomena.

	C.3. Evaluating Learning	
	Option 1. Diagram Analysis Quiz	
	Learners analyze a given diagram. (*See Annex link for the sample diagram that can be used.* Learners identify the following: 1. Intramolecular forces 2. Intermolecular forces 3. Relative strength 4. Physical property affected	The objectives include 1–3. The IDF principle is responsiveness, as learners analyze force strength and property effects. The approach is Constructivist, as learners interpret diagrams. *Note to teacher:* Require diagram-based justifications and relate force type to melting, boiling, and solubility.
	Option 2. Exit Ticket	
	In 3–5 sentences, the learners: Differentiate intermolecular and intramolecular forces; explain why boiling water does not break O–H bonds; and include a simple labeled diagram.	The objectives include 1–3. The IDF principle is reflectiveness, explaining boiling versus bond breaking. The approach is Inquiry-based, as learners distinguish related phenomena. *Note to teacher:* Emphasize concise explanations and clear labels for intra- and intermolecular forces.
	Option 3. Concept Mapping	
	Learners create a concept map connecting: *Intramolecular forces, Intermolecular forces, Bond strength, Physical properties, Real-life applications.* (*See Annex link for the scoring rubric)*	The objectives include 1–3. The IDF principle is reflectiveness, as learners synthesize ideas into a concept network. The approach is Constructivist, as learners build maps and connect concepts. *Note to teacher:* Emphasize accuracy, completeness, and clear distinction between intra- and intermolecular forces.

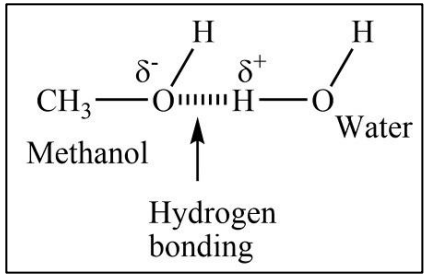
	C.4. Additional Activities	
	Option 1. Peer Teaching: Force Convention Experts	
	Assign groups as "experts" on one convention type (solid lines, dashed lines, dotted lines, thickness, distance). Each group creates a mini-poster explaining their convention with examples. Groups rotate to teach other groups in a jigsaw format.	The objectives include 1–3. The IDF principle is reflectiveness, as peer teaching reinforces understanding. The approach is Constructivist, as learners learn diagram conventions. *Note to teacher:* Emphasize consistent use of conventions and peer teaching to deepen mastery.
	Option 2. Real-World Investigation: Cooking Oil vs Water	
	Question: Why does oil have a higher boiling point than water even though it lacks hydrogen bonding? *Investigation:* Compare molecular structures (triglycerides vs. H_2O), diagram the forces, and explain how London dispersion forces in large molecules can outweigh hydrogen bonding in small molecules.	The objectives include 1–3. The IDF principle is relevance, using real-world boiling point comparisons. The approach is Inquiry-based, as learners investigate structures, diagram forces, and explain boiling and mixing. *Note to teacher*: Emphasize that strong dispersion forces in large molecules may outweigh hydrogen bonding.
	Option 3. Home Observation Task	
	Learners observe household examples involving intermolecular forces (e.g., evaporation, condensation, dissolution) and explain the phenomena using diagrams.	The objectives include 1–3. The IDF principle is relevance, as household phenomena anchor learning. The approach is Inquiry-based, as learners explain real-life IMF examples. *Note to teacher:* Require learners to connect observations to diagrams and use everyday examples to clarify concepts.

VI. ASSESSMENT

(Assessing Learnings)

Diagram Analysis- Methanol-Water Interaction

This diagram shows a methanol (CH_3OH) molecule interacting with a water (H_2O) molecule—relevant to understanding solubility, hydrogen bonding in solutions, and why alcohols mix with water.



Part A: Identification and Conventions

1. What do the solid lines (—) in the diagram represent? Classify the C–O, O–H, and C–H bonds in methanol as polar or nonpolar covalent and justify using electronegativity difference.
2. What does the dotted line (····) between the methanol oxygen and water hydrogen represent? Name the specific type of intermolecular force and explain why it forms between these two molecules (hint: consider electronegativity and partial charges).
3. Why are partial charges (δ+ and δ−) shown on the hydrogen and oxygen atoms? Explain how these charges enable the intermolecular attraction shown.

Part B: Differentiation and Analysis

4. Complete the Comparison Table

Feature	**Intramolecular Force (C—O bond in methanol)**	**Intermolecular Force (methanol-water attraction)**
Location		
Relative strength	~360 kJ/mol	~20 kJ/mol
Energy required to break		
Effect if broken		
Line convention in diagram		

5. Explain why oxygen atoms in water and methanol can participate in hydrogen bonding.
6. Which would require more energy: breaking all C—O and O—H bonds in methanol to decompose it into atoms, OR separating methanol from water molecules in a solution? Justify with numerical comparisons and diagram references.

Assessment alignment guide: Part A1 measures Objective 1; Part A2–A3 measure Objective 2; Part B4–B6 measure Objective 3

See Annex link for answer key and Scoring Rubric

VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot for language polishing and sentence cohesion. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.

Learning Title/Topic:	Types of Intermolecular Forces	Lesson Exemplar:	21

I. OBJECTIVES	
A. Content Standard	The learners learn that intermolecular forces affect the physical properties and behavior of substances.
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. *Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.*
C. Learning Competencies	**Prerequisite Knowledge and Skills**
	Lewis structures and molecular geometry, Polarity of molecules (polar vs. nonpolar), Electronegativity and partial charges, Intramolecular forces (ionic, covalent, metallic bonds)
	The learners describe different types of intermolecular forces, such as London dispersion forces, dipole-dipole forces, and hydrogen bonding;
II. REFERENCES and MATERIALS (Selecting Resources and Material)	• Brown, Theodore L., H. Eugene LeMay Jr., Bruce E. Bursten, Catherine J. Murphy, and Patrick M. Woodward. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018. • Department of Education. General Chemistry 2 Senior High School Module. Manila: Department of Education, 2016. • LabXchange. "Comparing Dipole-Dipole to London Dispersion." Simulation. Harvard University. Accessed May 8, 2026. [https://www.labxchange.org/library/pathway/lx-pathway:d434428e-91c2-4aac-9d4d-9e110fb97734/items/lb:LabXchange:b0a0f22a:lx_simulation:1/57114]. *Materials:* index cards, watch glasses, water, ethanol, acetone, molecular models or cutouts, chart paper, and markers. ANNEX LINK: https://tinyurl.com/ANNEX-CHEMQ2LE9
III. CONTENT (Sequencing Content)	Types of Intermolecular Forces

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Identify the different types of intermolecular forces.
2. Describe how each type of intermolecular force arises based on the interactions between particles.
3. Differentiate the intermolecular forces in terms of their characteristics and relative strength.
4. Classify intermolecular forces present in given molecular situations or representations.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1. IMF Sorting Challenge</td></tr>
<tr><td>• Teacher prepares a set of 10 index cards with molecular formulas and brief descriptions: H_2O (water), CH_4 (methane), HCl (hydrogen chloride), NH_3 (ammonia), CO_2 (carbon dioxide), C_8H_{18} (octane), HF (hydrogen fluoride), C_2H_5OH (ethanol), CH_3Cl (chloromethane), CH_3COOH (acetic acid)
• In pairs, learners sort the cards according to the strongest intermolecular force present in each substance, while remembering that London dispersion forces are present in all molecular substances. Then they write a one-sentence justification for each category.</td><td>This activity targets Objectives 1, 3, and 4 by connecting molecular formulas and electronegativity to prior knowledge through prediction and peer exchange.
Note to Teacher: Remind learners that all molecules have London dispersion forces. Note misconceptions, such as confusing polar bonds with polar molecules, for later discussion.</td></tr>
<tr><td colspan="2">Option 2. Why Does It Happen?</td></tr>
<tr><td>Set up 4 stations around the room, each with a phenomenon card and a guiding question:
<table>
<tr><th>Station</th><th>Phenomenon</th><th>Guiding Question</th></tr>
<tr><td>1</td><td>Water droplets bead up on a waxed car</td><td>Why is it that water droplets do not spread out like oil?</td></tr>
<tr><td>2</td><td>Iodine crystals sublime at room temperature</td><td>Why is it that iodine crystals change into gas without changing into liquid phase?</td></tr>
</table></td><td>This activity targets objectives 1 and 2. It applies to the IDF principles of relevance, responsiveness, and reflectiveness by linking everyday phenomena to molecular attractions. It shows Constructivist and Inquiry-based approaches as learners predict and discuss forces at each station.

Note to teacher: Let learners hypothesize freely, then highlight that all phenomena involve molecular attractions of different types and strengths.</td></tr>
</table>

3	Oil and vinegar separate in salad dressing	Why don't oil and vinegar mix?	
4	Gecko lizards walk on glass ceilings	How do their feet stick without glue?	

Learners rotate through stations, jotting predictions about what forces are involved, and answer: *What do all these phenomena have in common?*

Option 3. Predict-Observe-Explain: Boiling Point Mystery

Teacher presents three substances with their boiling points:

Substance	Molar Mass (g/mol)	Boiling Point (°C)
CH_4 (methane)	16	-161
HCl (hydrogen chloride)	36.5	-85
H_2O (water)	18	100

Learners write individual predictions on: *Why does water (lightest molecule) have the highest boiling point?*

This activity targets Objectives 1–3 by guiding learners to predict trends and explain polarity and hydrogen bonding.

Note to Teacher: Use the boiling point anomaly to spark curiosity and help students connect the unusual trend to polarity and hydrogen bonding.

A.2. Establishing the Purpose of the Lesson

Option 1. Intermolecular Forces: Setting the Stage

Teacher sets the stage with direct representations

- Covalent bonds hold atoms together within a molecule
- London dispersion forces arise from temporary uneven electron distribution
- Dipole–dipole forces result from permanent partial charges in polar molecules
- Hydrogen bonding is a strong dipole–dipole attraction involving H bonded to N, O, or F

The teacher highlights that these forces differ in strength and role, preparing students to explore them further in the lesson.

This activity targets objectives 2 and 3. It applies to the IDF principles of relevance, responsiveness, and reflectiveness by introducing core IMF concepts through direct representations. It shows Constructivist and Inquiry-based approaches as learners process ideas and compare force strengths.

	Discussion Questions: 1. Which intermolecular force is strongest among dispersion, dipole–dipole, and hydrogen bonding? 2. Why might molecules need different types of forces instead of just one? 3. How could the strength of these forces affect everyday properties like boiling points? The teacher introduces the lesson's purpose.	*Note to teacher:* Keep explanations brief; highlight differences in force strength and role to prepare learners for deeper exploration.
	Option 2. The Gecko Foot Mystery	
	Show a 2-minute video of a gecko walking on glass, highlighting how tiny hair-like structures on its feet create many weak intermolecular attractions. Ask learners to discuss in pairs: If each hair produces only weak van der Waals forces, how can millions of hairs support the gecko's weight? Emphasize the key idea: Many weak London dispersion forces can add up to a strong total effect. Then introduce the lesson's purpose.	This activity targets objectives 2 and 3. It applies to the IDF principles of relevance by using a biological example to show how weak forces can add up. It demonstrates Constructivist and Inquiry-based approaches through visual inquiry and collaborative reasoning. *Note to teacher:* Emphasize that many weak London dispersion forces combine to create strong adhesion; use this to bridge toward broader IMF concepts. If the video is unavailable, use printed image sequences to show the same phenomenon.
	Option 3. Personal Experience Poll	
	Poll Questions: 1. Have you ever opened a bottle of alcohol (isopropyl/rubbing alcohol) and noticed it evaporates faster than water? 2. Have you tried to mix oil with water for cooking and seen them separate from each other? 3. Have you noticed that cooking oil is thicker (more viscous) than water? Teacher bridges the lesson purpose with the poll questions.	This activity targets objectives 1, 2, and 3. It applies to the IDF principles of reflectiveness by connecting familiar everyday experiences to IMF concepts. It demonstrates Constructivist and Inquiry-based approaches through experiential reflection and guided discussion. *Note to teacher:* Use student experiences (evaporation, mixing, viscosity) to personalize learning and connect to IMF types.

<table>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1. LabXchange — Comparing Dipole-Dipole to London Dispersion</td></tr>
<tr><td>Learners use a simulation to compare attraction strength by pulling molecule pairs apart.
Investigation 1: London Dispersion Forces
— Use nonpolar molecules, such as noble gases, to show weak temporary attractions. Emphasize that LDF exists in all substances and is the only IMF in nonpolar molecules.
Investigation 2: Dipole-Dipole Forces
— Use polar molecules, such as HCl, to show stronger attraction between δ+ and δ− ends. Emphasize that polar molecules have both dipole-dipole forces and LDF.
Investigation 3: Hydrogen Bonding
— Use water models to show H attraction to O. Emphasize that hydrogen bonding occurs when H is bonded to N, O, or F.</td><td>This activity targets Objectives 1–3 by allowing learners to compare IMF strengths through simulation and guided observation.

Note to Teacher: Emphasize that all molecules have London dispersion forces, while dipole-dipole forces and hydrogen bonding add stronger attractions. Keep explanations brief so learners can focus on observation.

Offline Option: Use printed images or teacher-drawn molecular diagrams if the simulation is unavailable.</td></tr>
<tr><td colspan="2">Option 2. Real-World Video Analysis</td></tr>
<tr><td>Show two video clips:
○ Clip 1: Water strider insect walking on water surface (surface tension due to H-bonding network)
○ Clip 2: Naphthalene mothballs subliming in a closet (LDF only, no dipole)
Pause-and-discuss questions: (not limited to the following)
1. Why can a water strider be supported more easily by water than by many other liquids?
2. Why do mothballs disappear without melting?
(See Annex link for sample answers)</td><td>This activity targets objectives 2 and 3. It is relevant by linking IMFs to everyday and biological phenomena, responsive by prompting learner explanations, and reflective by addressing misconceptions. It applies Constructivist and Inquiry-based approaches through visual comparison and guided discussion.
Note to teacher: Use contrasting clips to show IMF differences; let learners explain first, then clarify misconceptions.</td></tr>
</table>

	Option 3. Teacher Demonstration: Evaporation Race	
	Materials: Three watch glasses, water, ethanol, acetone, stopwatch **Setup:** Place 5 drops of each liquid on separate watch glasses. Start the timer. **Observation:** Let learners record which evaporates fastest (acetone > ethanol > water). **Discussion:** o Acetone: polar, but no H-bonding between molecules (only dipole-dipole + LDF) → evaporates fastest o Ethanol: H-bonding, but only one —OH per molecule → moderate evaporation o Water: extensive H-bonding network (each molecule can H-bond to 4 neighbors) → evaporates slowest.	This activity targets objectives 2 and 3. It is relevant by connecting evaporation rates to IMF strength. It applies Inquiry-based approaches through experimental observation and reasoning. *Note to teacher*: Stress safety precautions; guide learners to connect IMF type and strength to evaporation results. *Safety Note:* Use only small quantities of ethanol and acetone in a well-ventilated area. Keep all liquids away from flames, sparks, and hot surfaces. Require goggles, teacher handling of volatile liquids, and proper disposal according to school laboratory procedures.
	B.2. Discussing New Concept	
	Option 1. IMF Feature Comparison Matrix	
	Teacher presents the IMF Feature Comparison Matrix *(See Annex link)* Key emphasis: 1) *LDF is universal:* Even polar molecules have LDF, but it's often overshadowed by stronger forces. 2) *H-bonding is a subset***:** It's still a dipole-dipole, just an exceptionally strong case. *Key question to ask:* Does the molecule have H bonded to N, O, or F? → *If yes, H-bonding. If polar but no H-N/O/F → Dipole-dipole. If nonpolar → LDF only.*	This activity targets objectives 1–3. The IDF guiding principle applied is relevance by organizing IMF features in a clear matrix. It applies Inquiry-based approaches through guided comparison and conceptual mapping. *Note to teacher:* Stress that LDF is universal; hydrogen bonding is a subset of dipole–dipole, and classification depends on the H–N/O/F rule.
	Option 2. "Force Detective" Card Sort	
	Distribute a set of 15 molecular diagrams/cards to pairs. *(See Annex Link for the Molecular cards)* Learners classify each into LDF, dipole-dipole, or H-bonding. **Teacher check:** Why isn't card 4 hydrogen bonding? What is the rule? *(H must be bonded to N, O, or F—not just any electronegative atom; H–Cl is polar, but hydrogen bonding is absent because H-bonding requires N, O, or F)*	This activity targets Objectives 1, 3, and 4 by using molecular diagrams, classification, and justification to surface misconceptions. *Note to Teacher:* Probe students' reasoning with questions, such as why H–Cl is not hydrogen bonding, and reinforce the use of diagrams in explaining IMF classification.

	Option 3. Molecular Diagram Annotation Clinic	
	Teacher projects three annotated diagrams progressively: Diagram 1: London Dispersion in Cl_2; Diagram 2: Dipole-Dipole in HCl; Diagram 3: Hydrogen Bonding in NH_3 (*see Annex link for the diagrams)* Let learners practice annotating a blank diagram of CH_3OH (methanol) showing all relevant forces.	This activity targets objectives 2–4. The IDF guiding principle is relevant by using visual conventions to show IMF types. It applies Constructivist and Inquiry-based approaches through guided annotation and progressive modeling. *Note to teacher:* Model clear diagram conventions, then have learners annotate methanol diagrams to show all relevant forces.
	B.3. Developing Mastery	
	Option 1. IMF Ranking Challenge	
	Present four substances: **CH_4, HCl, H_2O, C_3H_8 (propane)** **Task 1:** Identify the primary IMF in each. **Task 2:** Rank by predicted boiling point (lowest to highest). **Task 3:** Justify ranking using relative strength and molecular features. **Discussion twist:** Why does HCl (dipole-dipole) have a lower boiling point than C_3H_8 (LDF only) despite having stronger IMF type?	This activity targets objectives 3 and 4. The IDF guiding principles include relevance. It is relevant by linking the IMF type and molecular size to boiling points. It applies Constructivist approach through analytical comparison and guided reasoning. *Note to teacher:* Emphasize that boiling point depends on overall IMF strength and molecular size, not just force type. (*See Annex for answer)*
	Option 2. "Build the Force" Molecular Modeling	
	Using molecular model kits or paper cutouts, learners build: 1. Two CH_4 molecules: show how temporary dipoles create LDF 2. Two HCl molecules: show permanent dipole alignment 3. Two H_2O molecules: show H-bonding with specific angle (≈180° O—H···O) *Written component:* For each model, write three sentences: The force is called ___. It arises because it is ____. It is [stronger/weaker] than ___ because of ____.	This activity targets objectives 2–4. The IDF guiding principles include relevance. It is relevant by using models to visualize IMF interactions. It applies Constructivist approach through hands-on modeling and reflection. *Note to teacher:* Ensure learners connect models to written explanations of IMF origin and relative strength.

	Option 3. IMF Error Analysis	
	The teacher presents five student statements (some correct, some incorrect). Learners identify errors and correct them. 1. Only polar molecules have intermolecular forces 2. Hydrogen bonding occurs whenever hydrogen is present in a molecule. 3. London dispersion forces get stronger as molecules get larger. 4. Dipole-dipole forces are stronger than hydrogen bonds. 5. CO_2 has dipole-dipole forces because C=O bonds are polar *Concluding Questions: (See Annex link for sample answers)* 1. Why do all molecules, even nonpolar ones like CO_2 or noble gases, have London dispersion forces? 2. Rank CH_4, HCl, and H_2O from lowest to highest boiling point. Explain using intermolecular forces.	This activity targets objectives 1–3. The IDF guiding principles include relevance, responsiveness, and reflectiveness. It is relevant by surfacing common misconceptions, responsive by guiding learners to correct errors, and reflective by requiring diagram-based justification. It applies Constructivist and Inquiry-based approaches through diagnostic reasoning and collaborative correction. *Note to teacher:* Use mixed statements to highlight misconceptions; guide learners to precise corrections using diagrams.
C. Demonstrating Knowledge and Skills	**C.1. Finding Practical Application**	
	Option 1. Pharmaceutical Solubility: Why Some Drugs Don't Work	
	Many drugs have both polar and nonpolar parts. For example, ibuprofen has a polar —COOH group and a large nonpolar hydrocarbon region, making it only slightly soluble in water unless specially formulated, such as in salt form. Ask learners to diagram water's H-bonding network, simplified ibuprofen with a benzene ring and —COOH group, and how —COOH can H-bond with water while the benzene ring cannot. *Conclusion:* Ibuprofen can be taken as a pill because its small polar region allows limited interaction with water, while formulations help improve its absorption. The large nonpolar region limits solubility.	This activity targets objectives 2 and 4. The IDF guiding principles include relevance, responsiveness, and reflectiveness. It is relevant by connecting IMF concepts to drug solubility, responsive by using diagrams to show polar and nonpolar regions, and reflective by explaining why special formulations are needed. It applies Constructivist and Inquiry-based approaches through applied case analysis. *Note to teacher*: Guide learners to diagram polar vs. nonpolar regions and connect solubility limits to pharmaceutical design.

<table>
<tr><td></td><td colspan="2">Option 2. Climate Science: Water Vapor and Heat Storage</td></tr>
<tr><td></td><td>Compare water and ethanol.<table><tr><td></td><td>Water</td><td>Ethanol</td></tr><tr><td>H-bonds per molecule</td><td>4</td><td>~2</td></tr><tr><td>H-bond network</td><td>3D, extensive</td><td>Broken up by ethyl groups</td></tr><tr><td>Latent heat of vaporization</td><td>2260 J/g</td><td>~840 J/g</td></tr></table>Why is the gap? Ethanol's bulky ethyl group (–C_2H_5) wedges between molecules, blocking hydrogen bonds. Water is a small, bent, and strongly polar molecule. Each H_2O molecule can donate two hydrogen bonds and accept two, allowing an extensive three-dimensional network in liquid water.
Learner Task: Calculate energy to vaporize 1 g of each liquid. Find the ratio. Explain why ethanol needs less energy even though both have -OH groups.
Climate Connection: Because water has a much stronger and more extensive hydrogen-bond network than ethanol, it absorbs more energy per gram during evaporation. This helps explain why water is an effective thermal buffer in Earth systems.</td><td>This activity targets objectives 2 and 3. The IDF guiding principles include relevance, responsiveness, and reflectiveness. It is relevant by linking hydrogen bonding to climate science, responsive by engaging learners in quantitative comparison, and reflective by showing water's role as a thermal buffer. It applies Constructivist and Inquiry-based approaches through calculation and guided discussion.

Note to teacher: Emphasize water's extensive hydrogen-bond network and its impact on heat storage.</td></tr>
<tr><td></td><td colspan="2">Option 3. Materials Science: Gecko Tape and Spider Silk</td></tr>
<tr><td></td><td>Context: Scientists developed "gecko tape" using carbon nanotubes to mimic van der Waals forces.
Learner task: Diagram how millions of tiny hairs create cumulative LDF.
Extension: Compare it to spider silk, which uses H-bonding between protein chains for strength AND flexibility.</td><td>This activity targets objectives 2–4. The IDF guiding principles include relevance. It is relevant by connecting IMF types to advanced materials. It applies Constructivist and Inquiry-based approaches through comparative diagramming and application.</td></tr>
</table>

<table>
<tr><td></td><td>Engineering question: Why can't we use H-bonding for gecko tape? (H-bonding requires specific donor/acceptor pairs; LDF is universal and works on any surface)</td><td>Note to teacher: Highlight cumulative weak forces in gecko adhesion and specific hydrogen bonding in spider silk.</td></tr>
<tr><td></td><td colspan="2">C.2. Making Generalization</td></tr>
<tr><td></td><td colspan="2">Option 1. IMF Generalization Flowchart</td></tr>
<tr><td></td><td>Learners create a decision flowchart in their notebooks: See Annex link for a sample flowchart) and write a 2-3 sentence generalization statement.</td><td>This activity targets objectives 1–3. It is relevant by consolidating IMF rules in a flowchart and reflective by encouraging class-wide generalization. It applies Constructivist approach through guided synthesis.
Note to teacher: Ensure learners include all IMF types and strength orders in their flowcharts.</td></tr>
<tr><td></td><td colspan="2">Option 2. Three-Column" Generalization</td></tr>
<tr><td></td><td>Learners complete a three-column summary:<table><tr><th>What I Used to Think</th><th>What I Know Now</th><th>How Can I prove It?</th></tr><tr><td>(based on Learner responses in Activating Prior Knowledge Activities)</td><td>(Corrected Understanding)</td><td>(Diagram or evidence from Lesson)</td></tr></table>Learners write 2-3 - sentence generalization.</td><td>This activity targets objectives 1–3. The IDF guiding principles include reflectiveness. It is reflective by requiring diagram evidence. It applies Constructivist and Inquiry-based approaches through reflective correction.
Note to teacher: Prompt learners to provide diagrammatic evidence in the “How Can I Prove It?” column.</td></tr>
<tr><td></td><td colspan="2">Option 3. Generalization Through Analogy</td></tr>
<tr><td></td><td>Learners create their own analogy for the three IMF types:
LDF: Like people bumping in a crowded hallway (random, temporary, everyone does it)
Dipole-dipole: Like two magnets aligning (permanent attraction, specific orientation)</td><td>This activity targets objectives 1–3. The IDF guiding principles include reflectiveness. It is reflective by ensuring accuracy in representation. It applies a Constructivist approach through analogy creation and peer review.
Note to teacher: Facilitate peer evaluation to ensure analogies correctly represent IMF characteristics.</td></tr>
</table>

	H-bonding: Like Velcro strips (strong, specific matching parts, directional) Learners write 2-3- sentence generalization. Share best analogies with the class; vote on most accurate and memorable.	Remind learners that all analogies have limits to avoid misconceptions (especially magnet and Velcro comparisons).
	C.3. Evaluating Learning	
	Option 1. IMF Classification Test	
	Identify the primary intermolecular force present in each substance, and provide justification for choice: CH_3CH_2OH (ethanol), CH_3OCH_3 (dimethyl ether), $CH_3CH_2CH_3$ (propane), HF (hydrogen fluoride), CO_2 (carbon dioxide), NH_3 (ammonia) *Additional Assessment Task:* Compare CH_4, HCl, and H_2O in terms of dominant intermolecular forces and explain how those forces influence boiling point. Use polarity and molecular structure as evidence. (*See Annex for a sample answer)*	This activity targets objectives 1–4. The IDF guiding principles include relevance. It is relevant by requiring learners to classify IMFs in given substances. It applies Inquiry-based approach through diagnostic classification and reasoning. *Note to teacher:* Remind learners that all molecules have LDF; guide them to use polarity and structure in justification
	Option 2. IMF Infographic	
	Create an infographic poster for the three types of intermolecular forces. *Requirements:* • Visual diagram for each force type (showing molecules and force arrows) • One real-world example for each • Relative strength comparison (use a scale or bar graph) • "Quick check" question for the reader to test understanding *(See Annex link for the scoring rubric)*	This activity targets objectives 1–3. The IDF guiding principles include relevance. It is relevant by consolidating IMF concepts into visual form. It applies Constructivist approach through creative synthesis. *Note to teacher:* Ensure posters include diagrams, examples, and strength comparisons; use rubric for scoring.
	Option 3. Short Multiple Choice	
	Read each item carefully and select the best answer. 1. Which substance has ONLY London dispersion forces? A. H_2O B. NH_3 *C. CH_4 (correct) D.* HF	This activity targets objectives 1–3. The IDF guiding principles include relevance. It is relevant to test IMF knowledge. It applies Constructivist and Inquiry-based approaches through guided assessment.

	2. Which best explains why H_2O has a higher boiling point than H_2S. A. H_2S is a larger molecule B. Water has more electrons C. Both have the same intermolecular forces *D. Water forms hydrogen bonds; H_2S does not (correct)*	*Note to teacher:* Use MCQs to quickly check understanding; discuss reasoning behind correct answers. *(See Annex for additional sample items)*
	C.4. Additional Activities	
	Option 1. IMF in Food Chemistry: Fats vs. Oils (Enrichment)	
	Investigation: Let the learners draw diagram fatty acid molecules: o Saturated: straight chains pack closely → stronger LDF → solid o Unsaturated: kinked chains (cis double bonds) can't pack well → weaker LDF → liquid *Health connection***:** Why does hydrogenation of oils (adding H to double bonds) create trans fats that are worse for health? *(Trans fats straighten chains, increasing LDF and melting point; body enzymes evolved for cis configuration)*	This activity targets objectives 2 and 4. It is relevant by linking IMFs to fats and oils, responsive by diagramming molecular packing, and reflective by connecting to health implications. It applies Constructivist and Inquiry-based approaches through applied case analysis. *Note to teacher*: Highlight how cis vs. trans configurations affect LDF and health outcomes.
	Option 2. Virtual Lab: Boiling Point Prediction (Enrichment/Investigation)	
	Using ChemCollective or similar virtual lab: o Learners select 5 unknown substances, measure boiling points o Predict IMF type based on molecular structure o Compare predicted vs. actual boiling points o Account for anomalies (e.g., HF and H_2O both exhibit hydrogen bonding, but water forms a more extensive three-dimensional hydrogen-bond network. That broader network helps explain why water has a higher boiling point.	This activity targets objectives 2–4. It is relevant by simulating boiling point experiments and reflective by explaining anomalies. It applies Constructivist and Inquiry-based approaches through virtual experimentation. *Note to teacher:* Assist learners in explaining anomalies like water's extensive H-bond network. You may add a structured recording table (Predicted IMF → Predicted BP → Actual BP → Explanation) to guide learners.

Option 3. Peer Quiz Creation (Reinforcement/Review)

- In pairs, learners write 5 quiz questions (3 multiple choices, 2 short answers) about IMF types.
- Trade quizzes with another pair.
- After taking the quiz, provide feedback on question quality and accuracy.
- The teacher selects the best questions for a future review game.

This activity targets objectives 1–3. It is relevant by engaging learners in question creation. It applies Constructivist approach through collaborative assessment.

Note to Teacher: Provide sample stems or Bloom's taxonomy prompts, such as "Explain why…" or "Compare…," and use peer review to improve accuracy and clarity.

VI. ASSESSMENT
(Assessing Learnings)

IMF Classification Test

Part A. For each substance below, identify the *primary intermolecular force and explain your reasoning* using molecular structure. Consider: polarity, electronegativity differences, molecular geometry, and whether hydrogen is bonded directly to N, O, or F.

No.	Substance	Structural Feature	Structure	Primary IMF	Justification
1	CH_3OH (methanol)	Contains —OH group; polar molecule			
2	$CH_3CH_2OCH_2CH_3$ (diethyl ether)	Polar C—O bonds, but no H bonded to O			
3	$CH_3CH_2CH_2CH_3$ (butane)	Nonpolar hydrocarbon; larger than propane			
4	H_2O (water)	H bonded to O; bent shape; two H-bond donors and acceptors			
5	CCl_4 (carbon tetrachloride)	Tetrahedral; polar C—Cl bonds but nonpolar molecule overall			
6	CH_3NH_2 (methylamine)	H bonded to N; polar; trigonal pyramidal			
7	CH_3COCH_3 (acetone)	Polar C=O bond; no H bonded to O; trigonal planar around C=O			
8	CH_3CH_2F (fluoroethane)	Polar C—F bond; H bonded to C, not F			

<table>
<tr><td></td><td>
<table>
<tr><td>9</td><td>Ne (neon)</td><td>Monatomic; no bonds; spherical electron cloud</td><td></td><td></td><td></td></tr>
<tr><td>10</td><td>CH_3COOH (acetic acid)</td><td>Contains —COOH group; H bonded to O; can form dimers via H-bonding</td><td></td><td></td><td></td></tr>
</table>
Scoring Note: Award 1 point for correct primary IMF classification and 1 point for scientifically accurate structural justification for each item. Scoring for justification: Scoring guide for justification: 1 point for correct force identification; 1 point for correct use of structure-based evidence such as polarity, geometry, or H bonded to N/O/F. Maximum score: 20 points.
Part B. Application Output: Create a one-page comparison chart for three substances of your choice. For each, identify the dominant intermolecular force, explain one physical property affected by that force, and justify your answer using molecular structure.
</td></tr>
<tr><td>VII. REFLECTION
(Feedback and Continuous Improvement)</td><td>Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery.
1. How many learners successfully demonstrated the learning objectives based on the assessment results?
2. Which activity helped learners understand the lesson the most? Which activity helped the least?
3. Which part of the lesson was easiest for learners? Which part was the most difficult?
4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support?
5. What did the assessment results show about learners' understanding of the lesson?
6. What improvement would you make if you taught this lesson again?</td></tr>
<tr><td>VIII. USE OF GENERATIVE AI</td><td>In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot for language polishing and sentence cohesion. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.</td></tr>
</table>

Learning Title/Topic:	Intermolecular Forces and Properties of Substances	Lesson Exemplar:	22

I. OBJECTIVES	
A. Content Standard	The learners learn that intermolecular forces affect the physical properties and behavior of substances.
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners are expected to recall that matter is made of particles, that substances can exist as solids, liquids, and gases, and that particles attract one another to different degrees. They should also be able to observe simple changes in liquids, compare properties, record data, and interpret short scientific explanations.
	Explain the effect of intermolecular forces on liquid properties such as surface tension, vapor pressure, boiling point, and melting point.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	1. Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, Patrick M. Woodward, and Matthew W. Stoltzfus. 2018. Chemistry: The Central Science. 14th ed. New York: Pearson. 2. Flowers, Paul, Klaus Theopold, Richard Langley, and William R. Robinson. 2019. Chemistry 2e. Houston, TX: OpenStax. 3. Study.com. "Effect of Intermolecular Forces on Physical Properties." *Study.com Education*. Accessed May 7, 2026. 4. Scribd. "Intermolecular Forces and Substance Properties." *Scribd Presentation*. Accessed May 7, 2026. 5. OpenStax. 2019. Chemistry 2e. Houston, TX: OpenStax. **Materials** 1-peso coin, dropper, distilled water, 70% isopropyl alcohol solution, dish soap, paper clips, clear containers, glass slide, printed data table, and activity sheets.
III. CONTENT *(Sequencing Content)*	Intermolecular Forces and Properties of Substances

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Describe how the strength of intermolecular forces affects surface tension, vapor pressure, boiling point, and melting point.
2. Compare substances using evidence to infer relative intermolecular-force strength.
3. Interpret simple tables, graphs, or demonstration results involving evaporation, surface tension, boiling point, and melting point.
4. Cite and explain one practical application of intermolecular forces in daily life, industry, or the environment.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1 "The Penny Challenge" (Individual/Group)</td></tr>
<tr><td>Instruct students to do the following:
1. Predict how many drops of water can fit on a single 1-peso coin before spilling.
2. Test the coin using water, then repeat using 70% isopropyl alcohol.
3. Record the number of drops for each liquid.
4. Submit one evidence-based conclusion comparing the two results.
See Annex A for full activity sheet for tasks
https://tinyurl.com/2vx5da9r</td><td>This activity supports Learning Objectives 1–3 by engaging students in a simple, inquiry-based test of surface tension and intermolecular force strength.
Note to Teacher: Probe predictions first, recognize common misconceptions, and use observed evidence before formal explanation.</td></tr>
<tr><td colspan="2">Option 2 Think–Pair–Share: Everyday Scenarios</td></tr>
<tr><td>Scenario Question: Why does water bead on a waxy leaf but spread on a paper towel? Use cohesion, adhesion, surface tension, and the nature of the surface.
Student Instructions:
1. Think: Record what happens (beads vs. spreads).
2. Pair: Share ideas using “attraction,” connect to cohesion, adhesion, and surface tension.
3. Share: Present your partner’s best explanation to the class.
See Annex B for full activity sheet for tasks
https://tinyurl.com/2vx5da9r</td><td>This activity addresses Learning Objectives 1–4 by guiding students to observe, compare, and explain water behavior on different surfaces using cohesion, adhesion, and surface tension.
Note to Teacher: Encourage students to predict and explain using the word “attraction”.</td></tr>
</table>

	Option 3 Concept Mapping: "Sticky Attractions"	
	Directions: Write **ATTRACTION** in the center of the board. Ask students to brainstorm everyday examples that are hard to pull apart (**Strong Attractions**) and easy to separate (**Weak Attractions**). Examples: • Strong: Magnets, Velcro, Glue, Static Cling • Weak: Wet paper, Sand	This activity supports **Learning Objectives 1–2** by helping students categorize everyday examples into strong vs. weak attractions and justify their reasoning. **Note to Teacher:** Guide students to connect familiar "sticky" examples with strong IMF, and "easy-to-pull-apart".
	A.2. Establishing the Purpose of the Lesson	
	Option 1 (Short Answer/Group Activity)	
	After activation of prior knowledge, ask students why molecular attraction matters in daily life. Have them explain the role of **intermolecular forces** in: • **Medical** • **Waterproofing** • **Cooking**	This activity supports **Learning Objectives 1–4** by prompting students to connect everyday situations in medicine, waterproofing, and cooking to intermolecular forces. **Note to Teacher** Encourage students to connect each scenario (medical, waterproofing, cooking) to IMF concepts using simple language.
	Option 2 Brainstorming Activity: *Product Designers at Work*	
	Task: Students act as product designers, solving everyday problems using knowledge of how molecules "stick together." **Scenarios:** ○ **Glue underwater** ○ **Smudge-free phone screen** ○ **Instant-dry paint** ○ **Cooling vest** *See Annex C for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	This activity supports Learning Objectives 1–4 by helping students apply intermolecular force concepts to real-world product design through evidence-based reasoning and practical examples. **Note to Teacher:** Guide students to connect product ideas to IMF concepts

<table>
<tr><td></td><td colspan="2">Option 3 Video Analysis: Liquids in Action</td></tr>
<tr><td></td><td>Procedure:
Play a short video showing water striders, alcohol or perfume evaporating, boiling water vs. oil, and ice melting.
Guide Questions:
Ask students to:
• Identify the property shown in each scene.
• Describe how the liquid behaves.
• Compare IMF strength, such as water vs. alcohol.
• Connect the examples to daily life, such as cooking, cleaning, and the environment.
See Annex D for full activity sheet for tasks
https://tinyurl.com/2vx5da9r</td><td>Note to Teacher
Use the clip (or screenshots/sketches) to highlight surface tension, vapor pressure, boiling point, and melting point. Probe student predictions first, then connect their observations to IMF strength, emphasizing evidence-based reasoning. Keep explanations concise and focus on linking everyday phenomena to molecular attractions.</td></tr>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1 The race of the Liquids</td></tr>
<tr><td>Procedure:
Show three transparent bottles of water, cooking oil, and pancake syrup or honey. Tilt them at the same time and ask students to predict which liquid will reach the bottom first.
Guide Questions:
1. What happened when the bottles were tilted?
2. What liquid property is shown? Use viscosity in your answer.
3. Rank the liquids from lowest to highest viscosity.
See Annex E for full activity sheet for tasks
https://tinyurl.com/2vx5da9r</td><td>This activity supports Learning Objectives 1–4 by scaffolding student reasoning from identification to application. It helps learners observe liquid properties, compare IMF strength, interpret demonstration results, and connect concepts to everyday life, and reinforcing evidence-based explanations.
Teacher note: Use familiar materials to make invisible molecular ideas visible through direct observation and evidence-based explanation.</td></tr>
<tr><td colspan="2">Option 2 "The Great Evaporation Mystery" (Demonstration)</td></tr>
<tr><td>Procedure: Place a drop of water on one hand (or a glass slide) and a drop of 70% isopropyl alcohol on the other. Have students observe which one disappears first and describe the cooling sensation.</td><td>This activity supports Learning Objectives 1–3 by helping students observe evaporation; compare IMF strength in water and alcohol; and explain evidence using scientific terms.</td></tr>
</table>

	Guide Questions (Sequenced): 1. What happened to the drops? 2. Which property of liquids does this demonstrate? 3. Which substance has higher vapor pressure—water or alcohol? How do you know from your observations? *See Annex F for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	**Note to Teacher:** Emphasize that alcohol evaporates faster because it has weaker IMFs than water. Link evaporation to cooling, observe safety precautions, and ensure proper handling of materials.
	Option 3 "Paper Clip Magic" (Challenge)	
	Procedure: Show the class a bowl of water. Ask a volunteer to carefully place a metal paper clip on the surface so it floats. Then add a single drop of dish soap and observe what happens. **Guide Questions (Sequenced):** 1. Observation: What happened before and after soap was added? 2. Property: Which liquid property is shown? (surface tension) *See Annex G for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	This activity supports **Learning Objectives 1–3** by engaging students in direct observation of surface tension and its reduction by soap. **Note to Teacher** Use familiar materials to make invisible molecular ideas visible through direct observation and evidence-based explanation.
	B.2. Discussing New Concept	
	Option 1 DISCUSSING THE CONCEPT	
	Liquid Properties and Intermolecular Forces Intermolecular forces affect key liquid properties: **Surface Tension:** Strong IMFs pull molecules together, forming droplets. **Vapor Pressure:** Strong IMFs resist evaporation, lowering vapor pressure. **Boiling Point:** Strong IMFs need more heat, raising boiling points. **Melting Point:** Strong IMFs need more energy, raising melting points. *See Annex H for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	**Note to Teacher** Present each property (surface tension, vapor pressure, boiling point, melting point) with clear examples and connect them directly to IMF strength. Encourage students to compare water and alcohol to highlight differences, then guide them to interpret how stronger or weaker attractions explain everyday behaviors of liquids. Keep explanations concise and evidence-based.

<table>
<tr><td></td><td colspan="2">Option 2 Guided Discussion – The Liquid as a Group of Friends</td></tr>
<tr><td></td><td>Attraction: Weak IMFs = strangers, strong IMFs = best friends.
Surface Tension: Best friends stick close; outsiders can't break in.
Vapor Pressure: Weak bonds = people leave easily (high VP); strong bonds = people stay (low VP).
Melting/Boiling Point: Strong bonds need more heat to break apart. See Annex I for full activity sheet for tasks
https://tinyurl.com/2vx5da9r</td><td>This activity supports Learning Objectives 1–3 by explicitly linking surface tension, vapor pressure, boiling point, and melting point to the strength of intermolecular forces.
Note to Teacher
Use the friendship analogy to simplify IMF concepts, helping students visualize cohesion, vapor pressure, and boiling/melting points.</td></tr>
<tr><td></td><td colspan="2">Option 3 Structured Comparison Discussion</td></tr>
<tr><td></td><td>Chart (Teacher-led):
<table><tr><th>Liquid</th><th>Surface Tension</th><th>Evaporation Rate</th><th>Boiling Point</th></tr><tr><td>Water</td><td>High</td><td>Moderate</td><td>100 °C</td></tr><tr><td>70% isopropyl Alcohol</td><td>Low</td><td>Fast</td><td>78 °C</td></tr><tr><td>Oil</td><td>Moderate</td><td>Slow</td><td>>200 °C</td></tr></table>Student Task:
Compare the three liquids using the chart.
Infer which has stronger intermolecular forces:
Strong intermolecular forces → high surface tension, slow evaporation, high boiling point.
Justify with evidence from demonstrations.</td><td>This activity supports Learning Objectives 1–3 by guiding students to compare water, alcohol, and oil using a chart and relate IMF strength to surface tension, evaporation rate, and boiling point.
Note to Teacher: Guide students to infer IMF strength from the chart, ask questions that probe their reasoning, correct misconceptions, and ensure conclusions are evidence-based.</td></tr>
</table>

B.3. Developing Mastery

Option 1 Guided Practice Activity

Liquid	Boiling Point	Evaporation Speed
A	78°C	Fast
B	100°C	Slow
C	56°C	Very Fast

Task:

Learners analyze data charts comparing evaporation rate, boiling point, and surface-tension evidence for three liquids, then justify which one has the strongest intermolecular forces.

Guide Questions:

1. Based on the boiling points, which liquid has the strongest intermolecular forces?
2. Why does Liquid C evaporate faster than Liquid B? (Use the term "molecular attraction" in your answer).

This activity supports Learning Objectives 1–3 by asking students to interpret boiling point and evaporation data, rank IMF strength, and justify their answers using evidence.

Note to Teacher: Guide students to infer IMF strength from boiling points and evaporation rates, then connect their findings to practical choices, such as selecting a coolant.

Option 2 **Worksheet: Matching & Explanation – Intermolecular Forces in Action**

Directions: Match each property in **Column A** with the correct everyday scenario in **Column B**. Then, complete the explanation using the sentence starter provided.

Column A – Liquid Properties

1. Surface Tension
2. Vapor Pressure

This activity supports Learning Objectives 1–3 by helping students connect liquid properties to everyday scenarios and explain them using IMF language.

	3. Boiling Point 4. Melting Point **Column B – Everyday Scenarios** A. Water striders walk on water B. Perfume spreads quickly in air C. Cooking pasta in boiling water vs. frying in oil D. Salt lowers ice's melting point on roads *See Annex J for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	**Note to Teacher:** Guide students in matching each property to the correct scenario and writing clear, evidence-based one-sentence explanations linked to molecular attractions.
	Option 3 **Mini-Scenario Analysis**	
	Directions: Read each scenario carefully. Write **2–3 sentences** explaining: 1. The **observed effect** (what happens). 2. The **specific IMF concept** involved. 3. Whether the intermolecular forces are **strong or weak**, and how that explains the behavior. **Scenarios:** 1. Oil and water remain in separate layers instead of mixing well. 2. Salt melts ice on the road. 3. Perfume scent spreads quickly. *See Annex K for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	This activity supports Learning Objectives 1–3 by prompting students to connect everyday scenarios to specific IMF concepts. The scaffolded sentence starter ensures consistency in cognitive demand, guiding learners to describe observed effects, identify IMF strength, and justify behaviors with evidence-based explanations. **Note to Teacher** Encourage students to write concise explanations linking each scenario to IMF strength using terms like "molecular attraction."

<table>
<tr><td rowspan="8">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1 Activity: The Scientist's Solution</td></tr>
<tr><td>Students choose one real-world problem and explain it using intermolecular forces (IMFs):
A. Oil Spill: Why does oil float and clump on water? How can the soap break it?
B. High-Altitude Cooking: Why does water boil at a lower temperature on mountains?
C. Self-Cleaning Window: How can water bead up and roll off glass?</td><td>This activity supports Learning Objectives 1–4 by having students apply IMF concepts to real-world problems through collaborative, evidence-based explanations.
Note to Teacher: Ask students to identify the specific property involved, such as surface tension, vapor pressure, boiling point, or melting point, before explaining the example.</td></tr>
<tr><td colspan="2">Option 2 Mini Research Hunt</td></tr>
<tr><td>Task: Assign students to quickly research (or recall) one practical use of intermolecular forces in industries (food, medicine, environment).
• Examples:
o Salt in ice cream making (melting point of depression).
o Hydrogen bonding in DNA stability.
o Surface tension in insecticides spreading on leaves.
• Activity: Students share findings in 2–3 sentences.</td><td>This activity supports Learning Objective 4 by extending classroom learning to industrial, medical, and environmental contexts.
Note to Teacher
Encourage students to connect their findings to IMF concepts.</td></tr>
<tr><td colspan="2">Option 3 Matching Type Activity: Intermolecular Forces in Action</td></tr>
<tr><td>Directions: Match each Liquid Property in Column A with the correct Practical Application in Column B. Write the letter of the correct answer.
Column A – Liquid Properties
1. Surface Tension
2. Vapor Pressure
3. Boiling Point</td><td>This activity supports Learning Objectives 1–3 by reinforcing recognition of liquid properties and their practical applications. The matching format strengthens recall, while the explicit link to IMF concepts ensures students connect theory to real-world scenarios. It also provides a quick formative check for understanding before moving into deeper explanation tasks.</td></tr>
</table>

	4. Melting Point **Column B – Practical Applications** A. Perfume spreads quickly in air B. Salt lowers ice's melting point on roads C. Water striders walk on water; detergents break tension D. Cooking pasta in boiling water vs. frying in oil	**Note to Teacher** Guide students to match each property with the correct scenario and write one-sentence explanations using IMF concepts. Reinforce clarity by highlighting how each property directly explains the everyday application.
	C.2. Making Generalization	
	Option 1 **Activity:** "The Intermolecular Forces Connection Map"	
	Direction: The teacher guides the students in completing a summary on the board. Students must fill in the blanks to create a general rule for how liquids behave. **General Rule:** "The stronger the Intermolecular Forces (IMFs) in a liquid…" …the higher the Surface Tension (it beads more). …the higher the Boiling Points (it needs more heat). …the higher the Melting (it needs more heat). …the lower the Vapor Pressure (it evaporates slower).	This activity supports Learning Objectives 1–3 by helping students synthesize a general rule about how IMF strength affects liquid properties. The fill-in-the-blank format scaffolds recall and reasoning, while the closing question encourages predictive thinking and application to new scenarios. **Note to Teacher** Guide students to complete the general rule on the board, then use the closing question to check understanding.
	Option 2	
	Exit Ticket Task: Before leaving class, students answer: • What is one property of liquids affected by intermolecular forces? • Give one real-life example where this property matters.	This activity supports Learning Objectives 1 and 4 by prompting students to recall one liquid property influenced by IMFs **Note to Teacher** Use the exit ticket to quickly gauge student understanding.

	Option 3	
	One-Minute Paper • Task: Ask students to write a short paragraph answering: *How do intermolecular forces explain the behavior of liquids in everyday life?*	This activity supports Learning Objectives 1–4 by asking students to summarize IMF concepts in their own words. **Note to Teacher:** Use the one-minute paper to check whether students can explain IMF concepts and connect them to everyday liquid behaviors.
	C.3. Evaluating Learning	
	Option 1	
	Performance Task: "The Intermolecular Forces Infographic" **Instruct students**: to create a poster or infographic titled "The Molecular Grip: How Intermolecular Forces Shape Our World." Their output should explain how the strength of intermolecular forces affects surface tension, vapor pressure, boiling point, and melting point. Ask them to use one specific substance and include one real-life application. *See Annex L for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	This activity supports **Learning Objectives 1–4** by requiring students to synthesize IMF concepts into a visual product. **Note to Teacher** Assign students to design an infographic that visually explains how IMF strength affects liquid properties, using one named substance and one real-life application.
	Option 2	
	Data Interpretation Task • Format: Provide a simple table of boiling points and vapor pressures for substances (e.g., water, ethanol, acetone). • Task: Students answer: o *Which substance has the strongest* intermolecular forces*?* o *Which evaporates fastest?* o *How does* intermolecular forces *strength affect the boiling point?*	This activity supports Learning Objectives 1–3 by requiring students to interpret numerical data (boiling points and vapor pressures) and connect them to IMF strength. **Note to Teacher** Provide a simple table of boiling points and vapor pressures, then guide students to infer IMF strength and evaporation behavior.

	Option 3	
	Administer a 5–10-item multiple-choice quiz to assess students' recall of key concepts on intermolecular forces and related properties. For example, ask: Which property explains why water striders can walk on water? a. Vapor pressure b. Surface tension c. Boiling point d. Melting point. *See Annex M for full activity sheet for tasks* *https://tinyurl.com/2vx5da9r*	This activity supports Learning Objectives 1–3 by checking recall of key liquid properties influenced by intermolecular forces. Use 5–10 short multiple-choice items to check recall of key IMF concepts. Keep questions straightforward and ensure distractors highlight common misconceptions for effective formative assessment.
	C.4. Additional Activities	
	Option 1 Enrichment (For advanced learners)	
	Activity: Mini Research Presentation • Task students to research one industrial or environmental application of intermolecular forces (e.g., salt in ice cream making, detergents in cleaning, hydrogen bonding in DNA). • Present findings in a short oral report or infographic.	This activity supports Learning Objective 4 by extending learning beyond the classroom and connecting IMF concepts to industrial and environmental applications. **Note to Teacher** Encourage advanced learners to explore deeper industrial or environmental applications of IMFs
	Option 2	
	Remediation (For learners needing extra support) Activity: Concept Sorting Cards • Give students cards with terms (surface tension, vapor pressure, boiling point, melting point) and cards with simple definitions/examples. • Students sort and pair them correctly.	This activity supports Learning Objectives 1–3 by providing tactile, visual reinforcement for learners who need extra support. **Note to Teacher** Provide students with cards containing terms and simple definitions/examples.

<table>
<tr><td></td><td colspan="2">Option 3</td></tr>
<tr><td></td><td>1. Reinforcement (For learners needing more practice)
Activity: Guided Matching Exercise
• Provide a worksheet with properties (surface tension, vapor pressure, boiling point, melting point) and everyday scenarios.
• Students match them with teacher support or word banks.</td><td>This activity supports Learning Objectives 1–3 by reinforcing recall of liquid properties and their everyday applications.
Note to Teacher
Provide a worksheet with properties and everyday scenarios, along with a word bank or hints.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">I. Multiple Choice
Direction: Encircle the letter of the correct answer. (1 point each)

1. Which of the following happens when a liquid has very strong intermolecular forces?
a. The liquid evaporates very quickly.
b. The liquid has a high boiling point.
c. The liquid has very low surface tension.
d. The liquid has a low boiling point.

2. Why does water form a dome or round bead on a waxy leaf?
a. Water forms a bead because it has high surface tension.
b. Water forms a bead because it has weak internal attraction.
c. Water forms a bead because its molecules strongly push each other away.
d. Water forms a bead because it easily soaks into a leaf.

3. If Liquid X boils at 50°C and Liquid Y boils at 100°C, what can you conclude?
a. Liquid X has stronger intermolecular forces than Liquid Y.
b. Liquid Y has stronger intermolecular forces than Liquid X.
c. Liquid X and Liquid Y have the same molecular “grip.”
d. Liquid X and Liquid Y do not have intermolecular forces.</td></tr>
</table>

4. Which statement best matches a liquid with low vapor pressure?
a. The liquid evaporates very quickly.
b. The liquid has weak particle attraction.
c. The liquid is less likely to escape into the gas phase.
d. The liquid always has a low boiling point.

5. What is the relationship between intermolecular forces and vapor pressure?
a. Stronger intermolecular forces result in higher vapor pressure.
b. Stronger intermolecular forces result in lower vapor pressure.
c. Weaker intermolecular forces result in lower vapor pressure.
d. Intermolecular forces have no relationship with vapor pressure.

II. True or False

Direction: *Write T if the statement is true and F if it is false. (1point each)*

_____ 1. Rubbing alcohol evaporates faster than water because it has weaker intermolecular forces.

_____ 2. A substance with stronger intermolecular forces usually has a higher melting point than a similar substance with weaker intermolecular forces.

_____ 3. Surface tension allows some insects to walk on the surface of the water without sinking.

_____ 4. Stronger intermolecular forces make it harder for molecules to separate, leading to higher boiling and melting points.

_____ 5. Vapor pressure is the tendency of a liquid to turn into gas.

	III. Short Answer ***Direction****: Answer the following questions in 2–3 sentences.* 1. Two different liquids are placed on the same clean surface. One liquid forms rounded beads, while the other spreads across the surface. How do the relative strengths of cohesive forces within each liquid and adhesive forces between each liquid and the surface explain these observations? 2. Application: In cooking, why does it take more heat (energy) to boil a pot of water compared to a liquid with weaker molecular "grip"?
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot to help organize activity wording and improve draft coherence. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.

Learning Title/Topic:	Intermolecular Forces and Properties of Substances	Lesson Exemplar:	23

I. OBJECTIVES	
A. Content Standard	*The learners learn that* Intermolecular forces affect the physical properties and behavior of substances
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners are expected to recall that matter is composed of particles and that substances can exist in different states—solids, liquids, and gases, with particles attracting one another to varying degrees. They should also remember that physical properties such as boiling point, evaporation rate, viscosity, and surface tension are observable characteristics of liquids.
	The learners conduct an investigation to compare substances based on intermolecular forces and their physical properties.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	• *Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine Murphy, and Patrick Woodward. Chemistry: The Central Science. 14th ed. Boston: Pearson, 2018.* • *Tro, Nivaldo J. Chemistry: A Molecular Approach. 5th ed. New York: Pearson, 2020.* • *Zumdahl, Steven S., and Susan A. Zumdahl. Chemistry. 10th ed. Boston: Cengage Learning, 2018.* • *Chemistry LibreTexts. Search: "Liquids and Intermolecular Forces," "surface tension," and "viscosity and intermolecular forces."* **Materials:** beakers or small cups; water; isopropyl alcohol, ethanol; glycerin; cooking oil (if used); medicine droppers; one-peso coins; metal paper clips; plastic tray or glass sheet; stopwatch/timer; labels/markers; tissue or paper towels; goggles.
III. CONTENT *(Sequencing Content)*	Intermolecular Forces and Properties of Substances

<table>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Explain how intermolecular forces influence physical properties such as boiling point, evaporation rate, viscosity, and surface tension.
2. Conduct a simple investigation comparing substances based on intermolecular forces.
3. Interpret investigation data to compare substances and justify the ranking of Intermolecular Forces strength using observed properties.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1 Think-Pair-Share: Perfume vs. Alcohol Vapor</td></tr>
<tr><td>Think: Read: “Why does ethanol evaporate faster than water?” Write one sentence using force or attraction.
Pair: Share with a partner, compare answers, and agree on the best explanation.
Share: Present your partner’s best idea to the class and listen to similarities or differences.</td><td>This activity supports Objectives 1–3 by helping students explain evaporation through IMFs, compare ideas, and use evidence-based reasoning.
Note to teacher: Use students’ experiences with scents to connect observable odor spread over time with molecular motion and intermolecular interactions.</td></tr>
<tr><td colspan="2">Option 2 KWL Chart – Intermolecular Forces and Physical Properties</td></tr>
<tr><td>Instructions for Students:
1. K – What I Know (5 min): Write what you already know about liquids. Example: “Water boils at 100°C.”
2. W – What I Want to Know (5 min): Write questions or curiosities. Example: “Why does ethanol evaporate faster than water?”
3. L – What I Learned (End of Lesson): Add new knowledge after the activity. Example: “Liquids with weaker intermolecular forces evaporate faster.”</td><td>The activity supports Learning Objectives 1–3 by activating prior knowledge, prompting curiosity about liquid properties, and consolidating new understanding of intermolecular forces.
Note to Teacher: Use the "K" and "W" columns to identify existing gaps in knowledge and recognize common misconceptions before formal teaching begins.</td></tr>
</table>

	Option 3 Review Questions	
	Instructions: Answer each question in 1–2 sentences, share it with a partner, then discuss it in front of the class. **Questions:** What property allows water striders to walk on water? Why does ethanol evaporate faster than water under the same conditions? Which has a higher boiling point, water or ethanol?	This recall exercise supports Learning Objectives 1–3 by prompting students to connect prior knowledge of liquid properties (surface tension, vapor pressure, boiling point, viscosity) with intermolecular forces.
	A.2. Establishing the Purpose of the Lesson	
	Option 1 *Prediction Exercise*	
	Instruction for Students: • *Present a simple experiment setup: two beakers, one with water, and one with ethanol.* • *Ask: "Which liquid will evaporate faster? Why?"* • *Students write predictions individually, then compare them with a partner.*	*This Prediction Exercise supports Learning* Objectives 1–3 by engaging students in hypothesizing evaporation behavior based on intermolecular forces. **Note to Teacher:** Probe the "Why" in student predictions to recognize common misconceptions, such as confusing evaporation with boiling.
	Option 2 *Prediction Poll*	
	Present two beakers: one with water and one with ethanol. Ask: "Which liquid will evaporate faster? Why?" Students write predictions, compare with a partner, and the teacher records responses.	This activity supports Learning Objectives 1–3 by engaging students in hypothesizing intermolecular force strength before investigation. **Note to Teacher:** Probe the reasoning behind the votes.

<table>
<tr><td></td><td colspan="2">Option 3</td></tr>
<tr><td></td><td>Guiding Question Anchor
Write the guiding question on the board, “Why do some liquids evaporate faster, boil at different temperatures, or feel thicker than others?” ask learners to answer it individually in 2–3 sentences, then compare responses in pairs before a short class synthesis.</td><td>This activity supports Learning Objectives 1–3 by prompting students to articulate explanations of liquid properties linked to intermolecular forces.
Note to Teacher: Refer back to this "Anchor Question" at the end of each segment of the lesson.</td></tr>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1 Comparative Table Activity</td></tr>
<tr><td>Teacher Preparation
Prepare a table with columns: Liquid, Boiling Point, Evaporation Rate, Viscosity, Surface Tension.
Instructions for Students
Answer guiding questions:
Which liquid molecules experience stronger intermolecular attractions, and why?
Which liquid evaporates fastest?
Discuss your answers with your partner.
Share your group’s insights with the class.
See Annex A for full activity sheet for tasks
https://tinyurl.com/3wa3kd9</td><td>This Comparative Table Activity supports Learning Objectives 1–3 by guiding students to analyze boiling points, evaporation rate, viscosity, and surface tension data to infer intermolecular force strength.
Note to Teacher: Assist learners to observe patterns in the data rather than memorize numbers. If students struggle, refer to the "stickiness" analogy to help them conclude that stronger intermolecular forces result in higher boiling points and slower flow.</td></tr>
<tr><td colspan="2">Option 2 Everyday Application Prompt</td></tr>
<tr><td>Setup: Show pictures of a boiling kettle and a frying pan with oil.
Ask: “Why is cooking oil generally more suitable than water for frying foods at high temperatures?”</td><td>This activity supports Learning Objectives 1–3 by relating the physical properties of liquids to a real-life cooking context. Water boils at about 100 °C at 1 atm, which limits its temperature during ordinary cooking, whereas cooking oils can reach the higher temperatures typically needed for frying.</td></tr>
</table>

		Note to Teachers: Emphasize that the suitability of oil for frying depends on its composition and smoke point. Avoid explaining the difference solely in terms of intermolecular force strength or boiling point because cooking oils are mixtures and may smoke or decompose before reaching a true boiling point.
	Option 3	
	Interactive Matching Activity • Provide cards with physical properties (e.g., "high boiling point," "low viscosity," "fast evaporation"). • Provide cards with substances (water, ethanol, hexane, glycerin). • Students match property cards to substance cards, then justify their choices based on IMFs.	This Interactive Matching Activity supports Learning Objectives 1–3 by engaging students in linking physical properties to specific substances through the lens of intermolecular forces. **Note to Teacher:** Listen for the justifications students provide during the match.
	B.2. Discussing New Concept	
	Option 1 Discussion: Intermolecular forces (IMFs) control how liquids behave:	
	• **Surface Tension** – Strong IMFs create a "skin" (water beads). • **Vapor Pressure** – Strong IMFs = slow evaporation; weak IMFs = fast (alcohol). • **Boiling Point** – Strong IMFs need more heat (water 100°C vs. ethanol 78°C). • **Viscosity – Strong IMFs** = thick flow (honey); weak IMFs = thin (water). *See Annex B for full activity sheet for tasks* *https://tinyurl.com/3wa3kd9*	This discussion activity supports Learning Objectives 1–3 by explicitly linking intermolecular force strength to four observable liquid properties: surface tension, evaporation rate/vapor pressure, boiling point, and viscosity. **Note to Teacher:** Use the provided examples to anchor the definitions. For each property, ask students:
	Option 2 ***Work Through Examples Together (Class Practice)***	
	• Example 1: Compare **water vs. ethanol** → Which evaporates faster? Why?	This Class Practice activity supports Learning Objectives 1–3 by guiding students through

	• Example 2: Compare **honey vs. water** → Which is more viscous? Why? • Example 3: Compare **oil vs. water** → Which has higher boiling point? Why? • Example 4: Surface tension test (paper clip on water vs. ethanol).	concrete comparisons of liquids (water, ethanol, honey, oil) and their properties. **Note to Teacher:** Facilitate the discussion by focusing on the "**Why**" for each example. Ensure students use the correct scientific reasoning.
	Option 3 Demonstration with Guided Questions	
	• Revisit droplet race or evaporation demo. • Ask scaffolded questions: o "Which liquid evaporated faster?" o "What does this suggest about the strength of its IMFs?" o "How do IMFs explain viscosity differences?"	This Demonstration with Guided Questions supports Learning Objectives 1–3 by combining observation with scaffolded reasoning. **Note to Teacher:** Probe predictions first to activate students' prior knowledge.
	B.3. Developing Mastery	
	Option 1 Guided Data Analysis	
	Materials: Provide a table of boiling points, evaporation rates, viscosities, and surface tensions for water, ethanol, and acetone **Student Task:** 1. Rank each property from lowest to highest. 2. Infer IMF strength for each liquid. 3. Write a short explanation: "Water has stronger IMFs than ethanol because…" See Annex C for full activity sheet for tasks https://tinyurl.com/3wa3kd9	This Developing Mastery sequence supports Learning Objectives 1–3 by combining direct observation (droplet race demo) with structured data analysis. **Note to Teacher:** Probe predictions first by asking students to look at the boiling points and guess which liquid is "stickiest."
	Option 2 *Activity Title: Laboratory Investigation: Liquid Face-Off*	
	Materials: Water, Ethanol, Glycerin; droppers; coins; paper clips; tray; stopwatch. **Procedures:**	This laboratory investigation supports Learning Objectives 1–3 by engaging students in hands-on tests (penny test, paper clip test, speed test) to compare surface tension and viscosity across water, ethanol, and glycerin.

	• **Penny Test (Surface Tension):** Count drops on a coin before spilling. More drops = stronger IMF. • **Paper Clip Test (Surface Tension):** See if a clip floats. Floating = stronger IMF. • **Speed Test (Viscosity):** Tilt tray, time liquid flow. Slower = stronger IMF. See Annex D for full activity sheet for tasks https://tinyurl.com/3wa3kd9	**Note to Teacher:** Closely monitor the "Penny Test" to ensure students add drops slowly and consistently, as this creates a clear visual of the molecular "dome."
	Option 3 Guided Investigation Stations	
	• Set up 3–4 stations: o **Station 1:** Evaporation timing (water vs. ethanol). o **Station 2:** Viscosity flow (oil vs. glycerin). o **Station 3:** Surface tension (paperclip float test). o **Station 4:** Boiling point data analysis (chart comparison).	This station-based investigation supports Learning Objectives 1–3 by engaging students in hands-on comparison. **Note to Teacher:** Facilitate the rotation by ensuring students focus on recording specific, measurable data.
C. Demonstrating Knowledge and Skills	***C.1. Finding Practical Application***	
	Option 1 *Concept-to-Application Mapping*	
	Directions: Provide a worksheet with four properties in one column and blank spaces, for example in the other. Students will write everyday examples for each property. **Example Prompts:** **Boiling Point:** Cooking oil vs. water in frying **Evaporation Rate**: Ethanol sanitizer vs. water **Viscosity:** Syrup vs. juice **Surface Tension:** Raindrops on leaves	This Concept-to-Application Mapping activity supports Learning Objectives 1–3 by prompting students to connect liquid properties (boiling point, evaporation rate, viscosity, surface tension) with everyday examples. **Note to Teacher:** Guide students to think about the "function" of each item—for example, ask why we want a sanitizer to have a fast evaporation rate or why syrup needs to be viscous.
	Option 2 Household Connection Journal	
	Directions: • Ask students to list 3–4 everyday situations where boiling, evaporation, viscosity, or surface tension are important	This Household Connection Journal supports Learning Objectives 1–3 by encouraging students to identify everyday situations where

<table>
<tr><td></td><td>(e.g., cooking rice, using Ethanol, pouring syrup, rainwater beading on leaves).
• For each, they explain: “Which property is involved? How do IMFs explain it?”
See Annex E for full activity sheet for tasks
https://tinyurl.com/3wa3kd9</td><td>boiling, evaporation, viscosity, or surface tension are evident and explain them through IMF.
Note to Teacher: Review the journals to ensure students are correctly linking the "why" to the property.</td></tr>
<tr><td></td><td colspan="2">Option 3 Real-Life Scenario Matching</td></tr>
<tr><td></td><td>Directions:
• Provide a set of scenarios and a set of properties.
• Students match each scenario to the correct property (boiling point, evaporation rate, viscosity, and surface tension).
• Then, they explain the IMF connection in their own words.
<table><tr><th>Scenario</th><th>Property</th><th>IMF Connection</th></tr><tr><td>Perfume scent spreads quickly</td><td></td><td></td></tr><tr><td>Honey flows slowly</td><td></td><td></td></tr><tr><td>Paper clip floats on water</td><td></td><td></td></tr><tr><td>Oil used for frying</td><td></td><td></td></tr></table>See Annex A for full activity sheet for tasks
https://tinyurl.com/3wa3kd9</td><td>This activity supports Objectives 1–3 by linking everyday phenomena to liquid properties and IMF strength.
Note to teacher: Use the “IMF Connection” column to check if learners correctly relate weak or strong forces to scent spread, floating, or slow flow.</td></tr>
<tr><td></td><td colspan="2">C.2. Making Generalization</td></tr>
<tr><td></td><td colspan="2">Option 1 Concept Mapping</td></tr>
</table>

	Directions: • Provide students with four properties (boiling point, evaporation rate, viscosity, and surface tension). • Ask them to draw a concept map showing how each property is connected to IMF strength.	This activity supports Learning Objectives 1–3 by helping students visualize the relationships between IMF strength and liquid properties. **Note to Teacher**: Look for the direction of the arrows on the map to ensure that students understand.
	Option 2 One-Minute Paper	
	• Ask students to write a short paragraph answering: "How do intermolecular forces explain the differences among liquids?" • Collect a few responses and read them aloud for class reflection.	This activity supports Learning Objectives 1–4 by prompting students to synthesize their understanding of how IMF was explained. **Note to Teacher**: Use the collected responses as a quick diagnostic to see if students are correctly linking "molecular grip" to the liquid properties.
	Option 3 Everyday Connection Wrap-Up (Revised)	
	Directions: 1. Readiness Check (5 min): Show data for three liquids. Ask: *"Which has the strongest IMFs? Explain briefly."* Collect quick answers. 2. Main Task (10 min): Present everyday scenarios (perfume evaporating, honey flowing, insects on water, oil for frying). Ask: *"Which property is involved? How do IMFs explain it?"* *See Annex G for full activity sheet for tasks* *https://tinyurl.com/3wa3kd9*	This revised Everyday Connection Wrap-Up supports Learning Objectives 1–3 by combining a readiness check with real-life scenario analysis. **Note to Teacher**: Use these scenarios to reinforce the consistent rules of molecular attraction.
	C.3. Evaluating Learning	
	Option 1	

Short Quiz

Directions: Answer the following questions.

1. Which liquid evaporates faster: water or ethanol? Why?
2. Why does honey flow more slowly than water?
3. What property allows a paper clip to float on water?
4. Which liquid has the highest boiling point among water, ethanol, and oil?

This activity supports Learning Objectives 1–3 by providing a quick formative check of students' ability to connect liquid properties to IMF strength.

Note to Teacher: Use this assessment to identify if students can correctly link the property to the cause.

Option 2 Matching Type

Directions: Match Column A (Scenario) to the correct Property influenced by IMFs Column B. Write the letter of your answer on the space provided.

Example Table: Matching Type and Expected Answers

Answer	Column A (Scenario)	Column B (Property)
1. **C**	Perfume scent spreads quickly	A. Surface Tension
2. **A**	Raindrops bead on leaves	B. Viscosity
3. **D**	Cooking oil used for frying	C. Evaporation Rate
4. **B**	Syrup flows slowly	D. Boiling Point

This matching activity supports Objectives 1–3 by reinforcing how everyday scenarios relate to liquid properties affected by IMFs.

Note to teacher: Use the activity to check if learners understand that weak forces allow scents to spread quickly, while strong forces make liquids like syrup flow slowly.

Option 3 Data Interpretation

Directions: Study the table below and answer the questions.

Liquid	Boiling Point (°C)	Evaporation Rate	Viscosity	Surface Tension
Water	100	Moderate	Low	High
Ethanol	78	Fast	Very Low	Low
Oil	>200	Slow	High	Moderate

1. Rank the liquids from the weakest to the strongest IMFs.
2. Which property most clearly shows IMF strength?
3. Explain why ethanol evaporates faster than water

This data interpretation activity supports Objectives 1–3 by having students analyze boiling points, evaporation rate, viscosity, and surface tension to infer IMF strength.

Note to teacher: Guide students to identify patterns across columns, such as higher boiling point often indicating stronger IMFs and greater viscosity.

C.4. Additional Activities

Option 1 Enrichment (Guess Liquid Challenge)

Guest Liquid Challenge

1. Pick a household liquid not used in class.
2. **Guess:** Is its "stickiness" (IMF) stronger or weaker than water?
3. **Test:** Do the Penny Test (drops) and Speed Test (flow time).
4. **Compare:** Add results to our class IMF list.
5. **Pitch:** In 2–3 sentences, explain how its "stickiness" helps in everyday use.

This Enrichment **Guest Liquid Challenge** supports Learning Objectives 1–3 by extending classroom investigation into students' homes.

Note to Teacher: Use this challenge to build a "Classroom Master List" of substances.

Option 2 Reinforcement (IMF Detective Photo Journal)

Activity: Go around your house or school and take **three photos** of liquids behaving differently.

Snap: A photo of a liquid beading (Surface Tension), liquid pouring (Viscosity), and liquid disappearing (Evaporation).

It supports Learning Objectives 1–3 by encouraging students to observe and document real-world evidence of intermolecular forces.

<table>
<tr><td></td><td>Label: For each photo, state if the intermolecular forces are Strong or Weak</td><td>Note to Teacher: Use this activity to check if students can correctly identify the macroscopic behavior in a real-life setting.</td></tr>
<tr><td></td><td colspan="2">Option 3 Remediation Activities</td></tr>
<tr><td></td><td>Concept Sorting with Teacher Prompts Provide simplified cards (e.g., “sticks together,” “flows easily,” “evaporates quickly”). Students sort them under IMF categories with teacher guidance.
Visual Analogy Support Use analogies (e.g., “IMFs are like Velcro—some stick strongly, some weakly”) to help struggling learners.
Guided Pair Work Pair weaker students with stronger peers to discuss one property at a time, using sentence starters like: “Water has stronger IMFs because…”</td><td>These Remediation Activities support Learning Objective 1 (describing IMF effects on liquid properties) by scaffolding understanding for struggling learners.
Note to Teacher: Use the "Velcro" or "handshake" analogy to make the invisible forces feel more concrete.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Culminating Performance Task
Title: Comparing Liquids – Investigating Intermolecular Forces
Directions: In groups, conduct a controlled comparison of at least three liquids (e.g., water, ethanol, oil, honey, and acetone). Investigate their evaporation rate, viscosity, and/or surface tension. Record your data, rank the liquids by IMF strength, and submit a short lab report using the Claim–Evidence–Reasoning (CER) format.
Materials:
Small containers or beakers
Droppers or pipettes
Leaf or glass surface
Paper towels/cloth (for cleanup)
Lab notebook or worksheet (for CER lab report)
At least three liquids (examples: water, ethanol, oil, honey, acetone)
Procedure:
1. Prepare Materials Gather liquids and simple tools for testing.
Select at least three liquids (e.g., water, ethanol, oil)
Prepare containers, stopwatch, droppers, and a tilted surface</td></tr>
</table>

	• Ensure equal volumes for fair comparison **2. Conduct Evaporation Test** Measure how quickly each liquid evaporates. • Place equal drops of each liquid on a plate • Observe and time how long each takes to evaporate • Record differences in evaporation speed **3. Conduct Viscosity Test** Compare how easily liquids flow. • Pour equal volumes down an inclined surface • Use a stopwatch to measure flow time • Record which liquid flows fastest or slowest **4. Conduct Surface Tension Test** Observe droplet formation and beading. • Place drops of each liquid on a leaf or glass surface • Note whether droplets bead up or spread out • Record observations of cohesion **5. Record and Rank Data.** Organize results and infer IMF strength. • Create a comparative table of properties • Rank liquids from strongest to weakest IMFs • Highlight patterns across properties **6. Write Lab Report** Summarize findings using Claim–Evidence–Reasoning. • **Claim:** State which liquid has strongest IMFs • **Evidence:** Present data from tests • **Reasoning:** Explain how IMF strength accounts for observed properties **Guided Questions** 1. Which liquid evaporated fastest? What does this suggest about its IMF strength? 2. Which liquid flowed most slowly? How does viscosity relate to IMF strength? 3. Which liquid showed the strongest surface tension? What IMF interactions explain this? 4. How do your data patterns support your claim about IMF ranking? *See Annex H for Rubrics* *https://tinyurl.com/3wa3kd9*

VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges? How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? *6.* What improvement would you make if you taught this lesson again?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot to help organize activity wording and improve draft coherence. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.

Learning Title/Topic:	Intermolecular Forces and Properties of Substances	Lesson Exemplar:	24

I. OBJECTIVES	
A. Content Standard	The learners learn that intermolecular forces affect the physical properties and behavior of substances.
B. Performance Standard	By the end of the quarter, learners write names and formulas particularly for compounds commonly used in everyday life, industries, and environment. They differentiate between ionic and covalent bonds and use diagrams to write Lewis structures of ionic and covalent compounds while applying the Octet Rule. They conduct experiments to differentiate the properties of ionic and covalent compounds. Learners predict polarity based on electronegativity and molecular geometry. Learners explain how intermolecular forces influence the physical properties of substances and conduct an investigation to compare substances based on these interactions.
C. Learning Competencies	***Prerequisite Knowledge and Skills***
	Learners are expected to recall that matter is composed of particles, and that substances can exist in different states—solids, liquids, and gases, with particles attracting one another to varying degrees. They should also remember that physical properties such as boiling points, evaporation rate, viscosity, and surface tension are observable characteristics of liquids.
	Analyze how chemical bonding, molecular polarity, and intermolecular forces influence product development and sustainable solutions.
II. REFERENCES and MATERIALS (*Selecting Resources and Material*)	*Atkins, Peter, and Julio de Paula. Physical Chemistry. 11th ed. Oxford: Oxford University Press, 2018.* • *Brown, Theodore L., H. Eugene LeMay, Bruce E. Bursten, Catherine J. Murphy, and Patrick M. Woodward. Chemistry: The Central Science. 14th ed. Upper Saddle River, NJ: Pearson Education, 2018.* • *Chang, Raymond, and Kenneth A. Goldsby. Chemistry. 12th ed. New York: McGraw-Hill Education, 2016.* • *Department of Education. The Department of Education Manual of Style. Pasig City: Department of Education, 2019.* • *Jones, Loretta. Chemistry: An Introduction to General, Organic, and Biological Chemistry. 13th ed. Boston: Pearson, 2019.* • *OpenStax. Chemistry 2e. Houston, TX: OpenStax, Rice University, 2019.* *https://tinyurl.com/mr36dazn ANNEX-ATTACHMENTS* Materials: water, ethanol or rubbing alcohol, cooking oil, honey, vinegar, labeled sample containers, droppers, small beakers or cups, chart paper, markers, worksheet copies, product labels or pictures, and PPE such as gloves and safety goggles when needed.

<table>
<tr><td>III. CONTENT
(Sequencing Content)</td><td colspan="2">Intermolecular Forces and Properties of Substances</td></tr>
<tr><td>IV. OBJECTIVES
(Setting Clear Objectives and Analyzing the Tasks)</td><td colspan="2">1. Explain how chemical bonding influences molecular polarity and intermolecular forces, and how these in turn affect boiling point, solubility, viscosity, and volatility.
2. Describe how bonding, polarity, and intermolecular forces are considered when designing or choosing products for effectiveness and sustainability.
3. Analyze at least two common products in terms of bonding, polarity, dominant Intermolecular Force and resulting property.</td></tr>
<tr><td colspan="2">V. PROCEDURES</td><td>ANNOTATIONS</td></tr>
<tr><td rowspan="5">A. Activating Prior Knowledge</td><td colspan="2">A.1. Activating Prior Knowledge</td></tr>
<tr><td colspan="2">Option 1 Think-Pair-Share</td></tr>
<tr><td>Objective: Activate prior knowledge about how bonding, polarity, and intermolecular forces affect substances.
Instructions for Students:
• Individually list 2–3 everyday products you use (e.g., soap, lotion, gasoline, perfume, cooking oil).
• Think: What property makes this product effective? (e.g., soap cleans, lotion moisturizes, gasoline burns easily).
• Pair: Share your list with a partner and compare similarities/differences.
• Share: Volunteers present to the class.
See Annex A for full activity sheet for tasks https://tinyurl.com/ewcsp2r2</td><td>This activity addresses Objectives 1–3 by linking product properties to bonding, polarity, and IMFs through guided discussion.

Note to teacher: Use prior experiences, probe misconceptions, and ask why perfume evaporates quickly.</td></tr>
<tr><td colspan="2">Option 2 Mini Concept Map Starter</td></tr>
<tr><td>• Instructions for Students:
o On a sheet, draw three linked boxes: Bonding → Polarity → Properties.
o Fill in one example for each (e.g., “Hydrogen bonding → water polarity → high boiling point”).</td><td>This activity supports Learning Objectives 1 and 3 by guiding students to visually connect bonding, polarity, and properties through simple mapping.</td></tr>
</table>

	• Teacher's Role: ○ Highlight how students are already connecting bonding and polarity to product properties.	**Note to Teacher:** Collect a few examples, project them, and highlight how learners are already connecting bonding and polarity to product properties.
	Option 3 Product Sorting Challenge	
	• Student Task: Provide a set of everyday product cards (soap, lotion, gasoline, perfume, cooking oil, vinegar). • Learners sort them into two groups: "Mixes with water" vs. "Does not mix with water." • Purpose: Assess knowledge of polarity and solubility, preparing students to connect to bonding and IMFs.	This activity supports Learning Objectives 2 and 3 by engaging learners in sorting everyday products. It applies to a constructivist approach. **Note to Teacher:** Assist learners to connect sorting outcomes to polarity differences and product design choices.
	A.2. Establishing the Purpose of the Lesson	
	Option 1 Everyday Challenge Question	

	• **Instructions for Students:**
	  ○ Teacher asks: "Why do we use ethanol as a fuel but not water?"
	  ○ Students brainstorm quick answers and share.
		This activity supports Learning Objectives 2 and 3 by prompting learners to reason for product effectiveness.
		Note to Teacher: Use this challenge to frame the lesson's purpose—chemistry explains product effectiveness and sustainability.

	Option 2 Sustainable Solutions Connection	

	• **Instructions for Students:**
	  ○ The teacher shows two product images: a traditional cleaning agent and an eco-friendly biodegradable cleaner.
	  ○ Students predict: "What chemical differences might make one more sustainable than the other?"
	  ○ Share ideas in small groups.
		This activity supports Learning Objectives 2 and 3 by prompting learners to compare traditional and eco-friendly products. It applies to a constructivist, integrative approach.
		Note to Teacher: Highlight on how chemistry knowledge is applied in product development for sustainability.

<table>
<tr><td></td><td colspan="2">Option 3 Mini Demonstration – Perfume vs. Lotion</td></tr>
<tr><td></td><td>Instructions for Students:
Observe perfume (volatile and evaporate quickly) and lotion (viscous and stay on skin).
Predict: “What differences in bonding, polarity, or IMFs might explain these contrasting properties?”
Record predictions in your notebook.</td><td>This activity supports Learning Objectives 1 and 3 by prompting learners to compare contrasting product properties. I
Note to Teacher: Recognize common misconceptions and redirect toward bonding/polarity/IMFs as the scientific explanation.</td></tr>
<tr><td rowspan="5">B. Instituting New Knowledge</td><td colspan="2">B.1. Presenting Examples</td></tr>
<tr><td colspan="2">Option 1 Cleaning Agents Comparison Soap vs. Water– Cleaning Effectiveness</td></tr>
<tr><td>Student Instructions:
Compare soap solutions and alcohol as cleaning agents.
Predict: “Which works better for oily stains? Why?”
Share reasoning in small groups.
Teacher’s Role:
Demonstrate mixing soap with water vs. water with oil.
Guide students to connect polarity differences to cleaning effectiveness.</td><td>This activity supports Learning Objectives 2 and 3 by prompting learners to compare soap and alcohol in terms of polarity and solubility.
Note to Teacher: Highlight how polarity explains product design (polar cleaners vs. nonpolar solvents). Connect to eco-friendly cleaning solutions.</td></tr>
<tr><td colspan="2">Option 2 Sustainable Packaging Comparison</td></tr>
<tr><td>Student Instructions:
Examine biodegradable starch-based plastic vs. petroleum-based plastic samples.
Predict: “How do bonding and polarity affect their breakdown in the environment?”</td><td>This activity supports Learning Objectives 2 and 3 by prompting learners to compare biodegradable and petroleum-based plastics, linking polymer structure and bond types to environmental breakdown.
Note to Teacher: Emphasize how chemistry knowledge informs sustainable product development.</td></tr>
</table>

Option 3 Comparative Data Table – Water, Ethanol, Hexane

Student Instructions:

- Study the table showing boiling points, solubility, and viscosity of water, ethanol, and hexane.
- Identify which substance has the highest boiling point, which dissolves in water, and which flows most easily.

Discuss: "How do bonding, polarity, and IMFs explain these differences?"

Substance	Boiling Point (°C)	Solubility in Water	Viscosity	Key IMF(s)
Water (H_2O)	100	Completely miscible	Moderate	Strong hydrogen bonding, dipole-dipole
Ethanol (C_2H_5OH)	78	Completely miscible	Low	Hydrogen bonding, dipole-dipole
Hexane (C_6H_{14})	~69	Insoluble	Very low (flows easily)	London dispersion forces

This activity supports Objectives 1 and 3 by linking property data to polarity and IMF strength.

Note to teacher: Emphasize that data reflect IMFs and correct the misconception that heavier molecules always boil higher.

B.2. Discussing New Concept

Option 1 Guided Lecture with Visuals

Student Instructions:

- Listen as the teacher explains the three key ideas: **chemical bonding, molecular polarity, and intermolecular forces**.
- Observe diagrams showing polar vs. nonpolar molecules, hydrogen bonding, and IMF strength.

This activity supports Learning Objectives 1 and 2 by using visuals and real-world examples to explain how bonding, polarity, and IMF strength influence properties such as vapor pressure, solubility, viscosity, and volatility. It applies to a direct instruction approach.

	• Take notes on how these concepts affect vapor pressure, solubility, viscosity, and volatility. *See Annex B for full activity sheet for tasks* *https://tinyurl.com/ewcsp2r2*	**Note to Teacher:** Keep explanations concise, connect to prior examples, and probe misconceptions before moving forward.
	Option 2 Group Analysis – Product Classification	

	• **Student Instructions:**
	  ○ In groups, classify sample products (detergent, perfume, gasoline, lotion) according to bonding type, polarity, and dominant IMF.
	  ○ Record findings in a chart: Product → Bonding → Polarity → IMF → Property.
	  ○ Share group results with the class.
	• **Teacher's Role:**
	  ○ Provide product samples or descriptions.
	  ○ Guide groups to justify classifications with evidence.
	  ○ Facilitate whole-class sharing to compare reasoning.
		This activity supports Learning Objectives 2 and 3 by engaging learners in classifying products based on bonding, polarity, and dominant IMF, linking these to observable properties. It applies to a collaborative, constructivist approach where group reasoning and teacher facilitation ensure evidence-based classifications and shared understanding.
		
		Note to Teacher: Encourage evidence-based reasoning. Highlight how chemistry explains product effectiveness and sustainability.

	Option 3 Brainstorming – Sustainable Solutions	
	Objective: Connect bonding, polarity, and IMFs to sustainable product design. **Student Instructions** 1. Form small groups (3–5). 2. Brainstorms on how chemistry concepts can improve sustainability (e.g., biodegradable plastics, renewable fuels, eco-friendly detergents, safer cosmetics). 3. Organize ideas in a concept map: Problem → Chemistry Concept → Solution. *See Annex C for full activity sheet for tasks* *https://tinyurl.com/ewcsp2r2*	This activity supports Learning Objectives 2 and 3 by engaging learners in collaborative brainstorming on how bonding, polarity, and IMFs can inform sustainable product design. **Note to Teacher:** Encourage creativity, emphasize sustainability relevance, and highlight chemistry's role in solving environmental challenges.

	B.3. Developing Mastery	
	Option 1 Investigation Stations – Properties and IMFs	
	Student Instructions: Rotate through three stations: 1. **Solubility Test:** Mix water, oil, and alcohol; observe which combinations mix. 2. **Evaporation Rate:** Compare how fast ethanol and water evaporate. 3. **Viscosity Comparison:** Observe flow rate of honey, vinegar, and oil. o Record observations and infer which IMF dominates each substance.	This activity supports Learning Objectives 1 and 3 by engaging learners in hands-on comparison of solubility, evaporation, and viscosity, linking observations to bonding, polarity, and IMF strength. It applies to a constructivist, inquiry-based approach with teacher facilitation to ensure evidence-based reasoning and conceptual connections. **Note to Teacher:** Encourage evidence-based reasoning. Reinforce links between IMF strength and observable properties. Facilitate discussion after each rotation.
	Option 2 Error Analysis Task	
	Student Instructions Review the sample statements: 1. "Hexane dissolves in water because both are liquids." 2. "Water evaporates faster than ethanol because it is lighter." For each statement, identify the error, correct it using bonding, polarity, and IMF concepts, and write the corrected explanation in your notebook. Share your answers with your group and compare your reasoning. See Annex D for full activity sheet for tasks https://tinyurl.com/ewcsp2r2	This activity supports Learning Objectives 1 and 3 by prompting learners to identify and correct misconceptions about bonding, polarity, and IMFs. It applies to a constructivist, reflective approach where guided error analysis and group discussion help refine scientific reasoning and strengthen conceptual understanding. **Note to Teacher:** Use misconceptions to strengthen conceptual understanding and critical thinking.

<table>
<tr><td rowspan="2"></td><td colspan="2">Option 3 Property Ranking Challenge</td></tr>
<tr><td>Student Instructions:
o Rank substances (water, ethanol, hexane, oil) from highest to lowest boiling point and solubility in water.
o Justify rankings using bonding, polarity, and IMF concepts.
Teacher's Role:
o Provide data or allow students to recall from previous activities.
o Facilitate reasoning and comparison among groups.</td><td>This activity supports Learning Objectives 1 and 3 by engaging learners in ranking substances based on boiling point and solubility, using bonding, polarity, and IMF concepts as justification.

Note to Teacher: Probe reasoning and highlight how IMF strength predicts physical properties.</td></tr>
<tr><td rowspan="6">C. Demonstrating Knowledge and Skills</td><td colspan="2">C.1. Finding Practical Application</td></tr>
<tr><td colspan="2">Option 1 Household Connection Journal</td></tr>
<tr><td>Student Instructions:
o List 3–4 household products (soap, perfume, cooking oil, sanitizer, candle wax).
o For each, explain: "Which property (boiling point, solubility, viscosity, volatility) makes it effective?"
o Connect the property to bond, polarity, or IMF.</td><td>This activity supports Learning Objectives 2 and 3 by prompting learners to connect everyday product effectiveness to properties (boiling point, solubility, viscosity, volatility) and explains these links through bonding, polarity, and IMFs.
Note to Teacher: Probe deeper connections (e.g., "Why does alcohol-based sanitizer dry faster than water?").</td></tr>
<tr><td colspan="2">Option 2 Mini Research Hunt</td></tr>
<tr><td>Student Instructions:
o Research one practical use of IMFs in industries (food, medicine, environment).
o Summarize findings in 2–3 sentences.
o Share with the class.</td><td>This activity supports Learning Objectives 2 and 3 by encouraging learners to investigate practical uses of bonding, polarity, and IMFs in industries such as food, medicine, or the environment.
Note to Teacher: Assist learners to connect findings to lesson objectives.</td></tr>
</table>

	Option 3 Product Design Challenge	
	Student Instructions: ○ In small groups, design a product (e.g., eco-friendly cleaner, lotion, or fuel). ○ Decide: What bonding, polarity, and IMF properties make it effective? ○ Present your design with a short explanation.	This activity supports Learning Objectives 2 and 3 by engaging learners in creative product design with evidence-based justification using bonding, polarity, and IMF concepts. **Note to Teacher:** Emphasize how chemistry knowledge informs product innovation and eco-friendly design.
	C.2. Making Generalization	
	Option 1 Co-Created Class Generalization	
	Student Instructions: • Collaboratively draft one class-wide generalization statement that captures the lesson's essence. • Example: "Bonding, polarity, and IMFs explain the properties of substances, which in turn determine product effectiveness and sustainability."	This activity supports Learning Objectives 1–3 by synthesizing key ideas into a single class-wide statement that captures the relationship between bonding, polarity, IMFs, and product properties/sustainability. **Note to Teacher**: This serves as closure and ensures all learners leave with a unified understanding.
	Option 2 Everyday Connection Wrap-Up	
	Student Instructions: • Choose one everyday product (perfume, soap, lotion, fuel). • State a generalization: "The effectiveness of [product] can be explained by [bonding/polarity/IMFs]." • Share with the class.	This activity supports Learning Objectives 2 and 3 by prompting learners to generalize how bonding, polarity, and IMFs explain the effectiveness of everyday products. **Note to Teacher:** Use this to reinforce relevance and responsiveness of chemistry in daily life.

	Option 3 Exit Ticket – Generalization Statement	
	Student Instructions: o Before leaving, write one sentence that generalizes today's lesson (e.g., "The strength of IMFs explains why substances differ in boiling point, solubility, and product use."). o Submit your exit ticket to the teacher.	This activity supports Learning Objectives 1–3 by prompting learners to individually synthesize the lesson into a single generalization statement that connects bonding, polarity, and IMFs to substance properties and product effectiveness. **Note to Teacher:** Quick, efficient way to check conceptual consolidation.
	C.3. Evaluating Learning	
	Option 1 Activity 1: Structured Quiz	
	Student Instructions: Answer a short quiz with mixed formats: **Multiple Choice:** Which IMF explains water's high boiling point? **True/False:** Hexane dissolves in water because both are liquids. **Short Answer:** Explain why ethanol evaporates faster than water.	This activity supports Learning Objective 1 by assessing learners' ability to explain how bonding, polarity, and IMFs influence boiling points, solubility, and evaporation. **Note to Teacher:** Keep items concise and application oriented.
	Option 2 Performance Task – Product Investigation	
	Student Instructions: o Investigate two everyday products (e.g., lotion vs. gel, ethanol vs. gasoline). o Analyze bonding, polarity, IMF, and property. Present findings in a short report or oral presentation. *See Annex E for full activity sheet for tasks* *https://tinyurl.com/ewcsp2r2*	This activity supports Learning Objectives 2 and 3 by requiring learners to analyze everyday products. It applies to a performance-based, inquiry approach. **Note to Teacher:** Encourage creativity and evidence-based reasoning.

	Option 3 Product Analysis Case Study	
	Student Instructions 1. Work with at least two products (e.g., soap, lotion, and gasoline). 2. Identify chemical features: bonding type, polarity, dominant IMF. 3. Link features to properties (e.g., soap dissolves in water, lotion texture, gasoline volatility). 4. Suggest sustainable improvements (eco-friendly alternatives, biodegradable, renewable). Present findings in a short report or poster. *See Annex F for full activity sheet for tasks https://tinyurl.com/ewcsp2r2*	This activity supports Learning Objectives 1–3 by requiring learners to analyze everyday products in terms of bonding, polarity, IMFs, and resulting properties, then connect findings to sustainability. **Note to Teacher:** Assist learners to analyze everyday products (e.g., cleaning agents, cosmetics, fuels) by identifying bonding, polarity, and IMFs. Encourage students to connect these scientific concepts to product effectiveness and sustainability.
	C.4. Additional Activities	
	Option 1 Reinforcement Activity: Guided Matching Exercise	
	Task: Match each product property with the correct bonding type, polarity, and IMF concept. **Word Bank (Scaffolding)** • **Bonding Types:** Hydrogen bonding, Dispersion forces, Dipole–dipole interactions • **Polarity:** Polar, Nonpolar • **Properties:** High boiling point, Low boiling point, Soluble in water, Insoluble in water, Volatile, Viscous *See Annex G for full activity sheet for tasks https://tinyurl.com/ewcsp2r2*	*This activity supports Objectives 1 and 3 by linking bonding, polarity, and IMFs to product properties through structured practice.* *Note to teacher: Use prompts to support learners and reinforce IMF-property relationships.*

<table>
<tr><td></td><td colspan="2">Option 2 Enrichment Activity: Sustainable Product Redesign Proposal</td></tr>
<tr><td></td><td>Task: Learners select a product (e.g., detergent, cosmetic, fuel) and propose a redesign that improves sustainability, explaining how bonding, polarity, and IMFs guide their choices.
Student Instructions
1. Choose a product (detergent, cosmetic, fuel).
2. Identify the property that makes it effective (boiling point, solubility, viscosity, volatility).
See Annex H for full activity sheet for tasks
https://tinyurl.com/ewcsp2r2</td><td>This activity supports Learning Objectives 2 and 3 by engaging learners in proposing sustainability-focused redesigns of everyday products.
Note to Teacher: Encourage creativity and evidence-based reasoning. Probe for sustainability insights and real-world application of chemical concepts.</td></tr>
<tr><td></td><td colspan="2">Option 3 Remediation Activity: Concept Sorting Cards</td></tr>
<tr><td></td><td>• Task: Students sort cards with bonding types, polarity labels, IMF names, and simple definitions/examples.
• Scaffolding: Teacher circulates, prompting with guiding questions.</td><td>This activity supports Learning Objectives 1 and 3 by helping learners clarify misconceptions.
Note to the Teacher: Provide repeated practice and immediate feedback.</td></tr>
<tr><td>VI. ASSESSMENT
(Assessing Learnings)</td><td colspan="2">Part A: Multiple Choice — Correct Answers
1. B – NaCl dissolves in water due to ion-dipole attraction between water molecules and Na^+/Cl^- ions.
2. B – Ethanol evaporates faster because it has weaker overall hydrogen bonding than water.
3. A – Soap molecules clean grease because they have both polar and nonpolar regions.
4. C – Honey's high viscosity is mainly due to extensive hydrogen bonding among sugar molecules and water.
5. D – Designing biodegradable cleaners that dissolve in water applies polarity in sustainable product design.
Part B: True or False — Correct Answers
1. FALSE – Nonpolar molecules generally do not dissolve well in water.
2. TRUE – Water has stronger hydrogen bonding than ethanol, giving it a higher boiling point.
3. TRUE, with caution – Dispersion forces are often taught as the weakest IMF, but in large molecules, their combined effect can become strong.
4. TRUE – Polarity can guide the design of eco-friendly cleaning agents.
5. FALSE – Fast evaporation does not mean a substance is polar; gasoline is mostly nonpolar.
Part C: Short Answer (2 items) (Answer briefly but clearly)
1. Explain why water is considered a "universal solvent" in terms of bonding and polarity.</td></tr>
</table>

	Expected Answer: Water is polar and forms hydrogen bonds, allowing it to dissolve many ionic and polar substances. 2. Analyze one everyday product (e.g., lotion, fuel, or perfume) in terms of bonding, polarity, and IMFs. How do these properties affect their use or sustainability? **Expected Answer:** Example: Perfume contains volatile nonpolar molecules with weak dispersion forces, allowing quick evaporation. Sustainable perfumes use water-based or biodegradable solvents to reduce environmental impact.
VII. REFLECTION *(Feedback and Continuous Improvement)*	Use the following reflection prompts to guide your evaluation of the lesson after implementation. Reflect on learners' performance, determine which activities and lesson parts were most and least effective, identify learners who need enrichment or remediation, analyze the assessment results, and note possible improvements to enhance future lesson delivery. 1. How many learners successfully demonstrated the learning objectives based on the assessment results? 2. Which activity helped learners understand the lesson the most? Which activity helped the least? 3. Which part of the lesson was easiest for learners? Which part was the most difficult? 4. How many learners need enrichment or additional challenges How many learners need remediation or additional support? 5. What did the assessment results show about learners' understanding of the lesson? 6. What improvement would you make if you taught this lesson again? 7. Which objective (1, 2, or 3) showed the strongest mastery? Which objective needs reteaching, and what evidence from the assessment supports that conclusion?
VIII. USE OF GENERATIVE AI	In preparing this Learning Exemplar (LE), the author(s) used Microsoft Copilot to help organize activity wording and improve draft coherence. The author(s) reviewed and finalized the writing of the content. The author(s) take full responsibility for the content of this LE.