2

DepED
DEPARTMENT OF EDUCATION

Lesson Exemplar for Science

Quarter 2
Lesson
2

Lesson Exemplar for Science Grade 8
Quarter 2: Lesson 2 of 6 (Week 3)
SY 2025-2026

Development Team

Writer:
- John Robert Bermillo (De La Salle University)

Reviewed and Revised:
- PNU-RITQ Development Team

Management Team
Philippine Normal University
Research Institute for Teacher Quality
SiMERR National Research Centre

SCIENCE (CHEMISTRY) /QUARTER 2/ GRADE 8

I. CURRICULUM CONTENT, STANDARDS, AND LESSON COMPETENCIES	
A. Content Standards	The current structure of the atom includes subatomic particles, their symbols, mass, charge, and location.
B. Performance Standards	*By the end of the quarter, learners* demonstrate an understanding of the structure of the atom and how our understandings have changed over time. They draw models of the atom and use tables to represent the properties of subatomic particles.
C. Learning Competencies and Objectives	***Learning Competencies:*** *The learners draw the structure of an atom in terms of the nucleus and electron shells within an atom; and differentiate the subatomic particles—protons, neutrons, and electrons—in terms of their symbol, mass, charge, and location within an atom.* **1.** Define isotopes and explain their significance in atomic structure. **2.** Calculate atomic mass using the relative abundance of isotopes. **3.** Compare isotopes of an element in terms of number of neutrons and mass number. **4.** Explain the concept of atomic mass and how it is calculated. **5.** Draw and label isotopes of a given element. **6.** Discuss how isotopes influence the average atomic mass of an element.
D. Content	**Isotopes** - Definition, significance, and comparison of isotopes - Drawing and labeling isotopes **Atomic Mass** - Explanation of atomic mass - Calculation of atomic mass **Influence of Isotopes on Atomic Mass** - Influence on average atomic mass
E. Integration	Discuss isotopes in relation to **environmental studies**, such as carbon dating. For example, in Archaelogy: - Carbon dating is used to date ancient artifacts, human remains, and other archaeological finds. For example, it was used to determine the age of the Dead Sea Scrolls, which were found to be around 2,000 years old. Link the concept of isotopes to **real-life applications** like medical imaging such as Positron Emission Tomography (PET) scans.

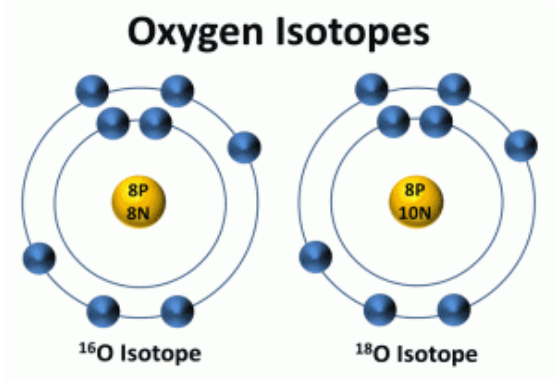
	- For example, PET scans are use in Cancer diagnosis. They are used to detect cancer and monitor its spread by highlighting areas of high metabolic activity, which are often cancerous tissues.

II. LEARNING RESOURCES
Center for Environmental Studies. (n.d.). *Isotopes and temperature measurement*. NASA Global Climate Change Education Modules. https://www.ces.fau.edu/nasa/module-3/how-is-temperature-measured/isotopes.php Chang, R., Goldsby, K.A. (2016). *Chemistry* (12th ed.). McGraw-Hill Education Elearnin. (2022, November 21). *Uses of radioactive isotopes – chemistry*. [Video]. Youtube. https://www.youtube.com/watch?v=E4B94zCY4ok Hill, J. W., & Kolb, D. K. (2001). *Chemistry for Changing Times* (9th ed.). Prentice Hall. U.S. Department of Energy. (n.d.). Isotope basics. National Isotope Development Center. https://www.isotopes.gov/isotope-basics

III. TEACHING AND LEARNING PROCEDURE		**NOTES TO TEACHERS**
A. Activating Prior Knowledge	**Short Review** **Day 1** **1. Review of Atomic Structure and Subatomic Particles:** Start by revisiting what students have previously learned about atoms, focusing on the basic structure and the roles of protons, neutrons, and electrons. - Example: *Protons are positively charged particles located in the nucleus of an atom and determine the atomic number of an element.* Engage students with questions about their knowledge of atomic structure to bridge into the topic of isotopes. - Example: "*How does the number of protons in an atom's nucleus determine its identity as a specific element?*"	**Nucleus** is the dense central core of an atom containing protons and neutrons. Electrons occupy specific **energy levels or shells** around the nucleus, with the arrangement determining the atom's reactivity. **Key**: The number of protons determines its identity because each element has a

	Day 2 **2. Review the Concept of Isotopes**: Recap the definition and significance of isotopes discussed in Day 1. Use examples to reinforce understanding. - Example: *Isotopes are atoms of the same element with different numbers of neutrons, thus having different mass numbers such as Carbon-12 and Carbon-14.* **Day 3** **3. Recap Atomic Mass Calculation**: Revisit the methods and formulas for calculating atomic mass using the relative abundance of isotopes. Discuss any challenges students faced during the previous day's activities and clarify any misunderstandings. - Example: *Atomic mass is the weighted average mass of an element's isotopes.* The formula is **Atomic Mass = ∑(Isotope Mass x Relative Abundance).** **Day 4** **4. Summary of Isotopes and Atomic Mass:** Summarize key points from the previous days about isotopes and atomic mass. Discuss real-life applications of isotopes to spark interest and connect the concepts to everyday experiences. **Key points:** - Isotopes: Atoms of the same element with different numbers of neutrons. - Atomic Number: Defined by the number of protons, which remain constant across isotopes. - Mass Number: The sum of protons and neutrons, which varies among isotopes. - Atomic Mass: The weighted average mass of an element's isotopes, based on their relative abundance. - Relative Abundance: The proportion of each isotope present in a sample. **Importance in Scientific Research and Practice Applications** - Example: *Isotopes are used in medical imaging* Isotopes such as Technetium-99 are crucial in diagnostic imaging, allowing for non-invasive internal scans to detect medical conditions.	unique number of protons (atomic number). Isotope mass is the mass of each isotope. Relative abundance is the fraction of each isotope present in a sample (often expressed as a decimal).

B. Establishing Lesson Purpose	**1. Lesson Purpose** Discuss the importance of understanding isotopes and atomic mass in chemistry. Elicit student responses on why knowing about isotopes and their different masses is crucial. **Sample Questions:** - *Why is it important to know that elements can have isotopes with different masses?* - *Why do you think some isotopes are stable while others are radioactive?* Enhance engagement by showing a short video clip that highlights the role of isotopes in various fields, making the learning relevant and interesting (Elearnin, 2012): https://www.youtube.com/watch?v=E4B94zCY4ok **Example of importance**: Understanding isotopes helps predict the chemical behavior of elements. Different isotopes of the same element can participate in chemical reactions slightly differently due to their mass differences. - For example, heavy water (D_2O, where D is deuterium, an isotope of hydrogen) has different physical properties compared to regular water (H_2O). **Example of question to ask**: Why is it important to know that elements can have isotopes with different masses? **2. Unlocking Content Vocabulary** **Gather Ideas from the Students:** Before introducing the vocabulary, engage the students in a discussion to see what they already know about isotopes and atomic mass. Ask questions such as: - *"Can anyone tell me what they know about isotopes?"* - *"What do you think makes one isotope different from another?"* - *"Have you heard of atomic mass before? What do you think it means?"* **Introduce and Explain the Key Vocabulary for the Lesson:** Use simple, clear language to explain each term, building on what students have shared. - **Isotopes**: Isotopes are variants of a particular chemical element which differ in neutron number. All isotopes of an element have the same number of	**Answers**:(Sample Questions) 1. Knowing about isotopes with different masses helps us understand variations in atomic mass and predict how elements behave in different chemical reactions. 2. Some isotopes are stable because their nuclear forces balance perfectly, while others are radioactive because they have an imbalance in these forces, causing them to decay over time. **After watching the video:** Ask the students to give an isotope mentioned in the video and their use. Call at least 2 students. **Answer:** It is important to know that elements can have isotopes with different masses because it helps us understand variations in atomic mass and how these differences can influence chemical reactions, physical properties, and practical applications such as dating archaeological finds and creating medical diagnostic tools.

	protons but different numbers of neutrons. For example, Carbon-12 and Carbon-14 are isotopes of carbon (Chang & Goldsby, 2016). - **Atomic Mass**: The atomic mass is the weighted average mass of an element's isotopes based on their natural abundance. It reflects the average mass of all the isotopes of an element (Hill & Kolb, 2001). - **Relative Abundance**: The relative abundance of an isotope is the percentage of that isotope found in nature. It is used to calculate the atomic mass of an element.	
C. Developing and Deepening Understanding	**Day 1** **SUB-TOPIC 1: DEFINITION AND SIGNIFICANCE OF ISOTOPES** **1. Explicitation** Contextualize isotopes within the study of atomic structure. Explain that isotopes are atoms of the same element with different numbers of neutrons, thus differing in mass. Use a diagram to illustrate isotopes and elicit responses from students about their prior knowledge  Image Source: https://tropicsu.org/atomic-mass/ **2. Worked Example** Draw isotopes of hydrogen (protium, deuterium, tritium) on the board, labeling protons, neutrons, and electrons. Discuss the differences in neutron number and mass.	

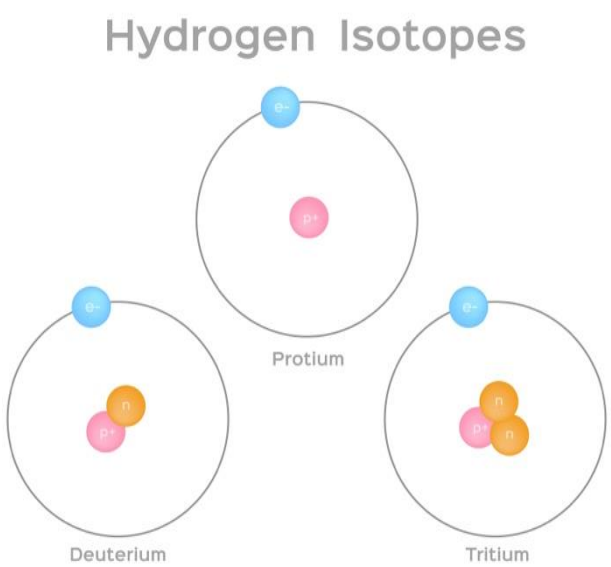


Image Source: https://quizlet.com/395956748/general-chemistry-flash-cards/

3. **Lesson Activity**

Activity 1: Have students **draw isotopes** of carbon (C-12, C-13, C-14), labeling subatomic particles.

Activity 2: **Poster Presentation on Isotopes**. Each group creates a poster about a specific isotope, detailing its properties and uses/applications in real life.

- **Materials needed**: Bond paper, markers/pens, reference materials
- Procedure:
  - Group Assignment: Divide the class into groups, each assigned a different isotope.
  - Research and Preparation: Each group creates a poster including the isotope's properties, uses, and interesting facts.
  - Presentation: Groups present their posters, followed by a class discussion to compare the isotopes.

Rubric for the short presentation:

- Evaluate the posters based on accuracy, creativity, and completeness.
- Assess group presentations on clarity and how well they communicated the information.
- Collect and review student reflections to gauge their understanding of subatomic particles.

Day 2

SUB-TOPIC 2: CALCULATION OF ATOMIC MASS

1. **Explicitation**

   Introduce the concept of atomic mass and how it is calculated using the relative abundance of isotopes. Use a formula to explain the calculation.

   Formula: Atomic Mass = ∑ (Isotope Mass × Relative Abundance)

   This formula calculates the average atomic mass of an element by considering all its isotopes and their respective abundances.

   - **Isotope Mass**: The mass of a particular isotope of an element.
   - **Relative Abundance: The fraction or percentage of that isotope as it occurs in nature, usually expressed** as a decimal.
   - **Summation (∑)**: This symbol indicates that you sum up the products of the isotope masses and their relative abundances for all the isotopes of the element.

2. **Worked Example**

   Give the students an example problem like calculating the atomic mass of chlorine using its isotopes: Cl-35 (75%) and Cl-37 (25%). Then, solve it using the following steps:

   Identify the Isotopes and their masses:
   - Isotope 1: Mass = 35 amu
   - Isotope 2: Mass = 37 amu

   Determine the Relative Abundance of Each Isotope:
   - Isotope 1: Relative Abundance = 0.75 (or 75%)
   - Isotope 2: Relative Abundance = 0.25 (or 25%)

   Multiply the Mass of Each Isotope by Its Relative Abundance:
   - For Isotope 1: 35 × 0.75 = 26.25 35×0.75=26.25
   - For Isotope 2: 37 × 0.25 = 9.25 37×0.25=9.25

   Add the Results from Step 3:
   - 26.25 + 9.25 = 35.5

   Result:
   - The average atomic mass of the element is 35.5 amu 35.5amu.

	3. Lesson Activity **Activity 1:** Worksheet on calculating atomic mass for various elements. **Seatwork: Calculating Atomic Mass** **Instructions:** For each of the following questions, calculate the average atomic mass of the element using the given isotopes and their relative abundances. 1. **Boron (B**) has two isotopes: Isotope 1: Mass = 10.0129 amu, Relative Abundance = 19.9% Isotope 2: Mass = 11.0093 amu, Relative Abundance = 80.1% 2. **Neon (Ne)** has three isotopes: Isotope 1: Mass = 19.9924 amu, Relative Abundance = 90.48% Isotope 2: Mass = 20.9938 amu, Relative Abundance = 0.27% Isotope 3: Mass = 21.9914 amu, Relative Abundance = 9.25% 3. **Chlorine (Cl)** consists of two naturally occurring isotopes: Isotope 1: Mass = 34.9689 amu, Relative Abundance = 75.78% Isotope 2: Mass = 36.9659 amu, Relative Abundance = 24.22% 4. Calculate the atomic mass of **Magnesium (Mg),** which has three isotopes: Isotope 1: Mass = 23.985 amu, Relative Abundance = 78.99% Isotope 2: Mass = 24.986 amu, Relative Abundance = 10.00% Isotope 3: Mass = 25.983 amu, Relative Abundance = 11.01% 5. **Nitrogen (N)** is found in nature with two stable isotopes. Determine its atomic mass: Isotope 1: Mass = 14.0031 amu, Relative Abundance = 99.63% Isotope 2: Mass = 15.0001 amu, Relative Abundance = 0.37% **Activity 2:** Pair students to quiz each other on atomic mass calculations. For example, student A will give student B an element. Student B must solve its atomic mass and vice versa. **Day 3** **SUB-TOPIC 3: COMPARISON OF ISOTOPES** **1. Explicitation** Discuss the differences between isotopes in terms of neutron number and mass number. Explain how these differences affect atomic properties.	See Learning Activity Sheet: *Activity #1: Understanding Isotopes* **Key:** 1. Boron (B): 10.81 amu 10.81amu 2. Neon (Ne): 20.18 amu 20.18amu 3. Chlorine (Cl): 35.45 amu 35.45amu 4. Magnesium (Mg): 24.31 amu 24.31amu 5. Nitrogen (N): 14.01 amu 14.01amu See Learning Activity Sheet: *Activity #2: Calculating Atomic Mass*

	Example: - Isotopes of an element have the same number of protons but different numbers of neutrons, leading to different mass numbers. For example, Carbon-12 has 6 neutrons, while Carbon-14 has 8 neutrons. - These differences in neutron number and mass affect atomic properties by influencing the stability and radioactive behavior of the isotopes. Stable isotopes do not change over time, while radioactive isotopes decay and emit radiation, which can be used in various scientific and medical applications. **2. Worked Example** Compare isotopes of oxygen (O-16, O-17, O-18) and discuss how the number of neutrons changes the mass but not the chemical properties. **Isotopes and Neutron Numbers:** Oxygen-16 (O-16): Protons: 8, Neutrons: 8, Mass Number: 16 Oxygen-17 (O-17): Protons: 8, Neutrons: 9, Mass Number: 17 Oxygen-18 (O-18): Protons: 8, Neutrons: 10, Mass Number: 18 **Effect on Mass:** The mass number of each isotope differs due to the varying number of neutrons. O-16 has a mass number of 16, O-17 has a mass number of 17, and O-18 has a mass number of 18. The increase in neutron number results in an increase in the mass of the isotope. **Chemical Properties:** Despite the differences in mass, the chemical properties of O-16, O-17, and O-18 remain the same. This is because chemical properties are primarily determined by the number of protons and electrons, which are identical in all isotopes of oxygen. The differences in neutron number do not affect the atom's ability to form chemical bonds or its reactivity with other elements. **3. Lesson Activity** **Isotope Detective Investigation** - Goal: Investigate and report on the properties and applications of different isotopes. - Role: Students act as detectives tasked with uncovering the characteristics and uses of specific isotopes.	See Learning Activity Sheet: *Activity #4: Investigatory Case Study – Isotopes in Environmental Science*

	- Audience: Classmates and teacher. - Situation: A mystery scenario where students must discover key information about assigned isotopes. - Product/Performance: A detective report summarizing their findings on the isotopes' properties and applications. **Procedure:** 1. Introduce the activity by explaining that students will become "isotope detectives" tasked with solving mysteries about specific isotopes. 2. Divide the class into small groups and assign each group a different isotope (e.g., Carbon-12 and Carbon-14, Uranium-235 and Uranium-238, Iodine-127 and Iodine-131). 3. Provide each group with a detective worksheet that includes the following prompts: - List the number of protons, neutrons, and electrons for your assigned isotopes. - Determine the mass number of each isotope. - Identify whether the isotope is stable or radioactive. - Research and note down at least two real-life applications of each isotope. 4. Groups analyze the gathered information and fill out their worksheets. Encourage students to use reference materials to ensure accurate information. 5. Each group creates a detective report summarizing their findings, including: (a) detailed information on the isotopes' properties; (b) clear descriptions of their real-life applications; and (c) any interesting facts discovered during the investigation. 6. Groups present their detective reports to the class. Facilitate a brief Q&A session after each presentation to reinforce learning and address any questions. 7. After all presentations, lead a class discussion on the importance of understanding isotopes. Encourage students to reflect on how different isotopes are used in scientific and practical applications. **Evaluation:** - Assess the completeness and accuracy of each group's detective report. - Evaluate the clarity and creativity of their presentations. - Provide feedback on their understanding of isotopes' properties and applications.	

	Day 4 **SUB-TOPIC 4: INLFUENCE OF ISOTOPES ON AVERAGE ATOMIC MASS** 1. **Explicitation** Explain how isotopes influence the average atomic mass of an element. Discuss the concept of weighted average and its application in atomic mass. - Isotopes are atoms of the same element with different numbers of neutrons, leading to different mass numbers. The average atomic mass of an element considers the masses of all its isotopes and their relative abundances. - A weighted average is used to calculate the atomic mass, where each isotope's mass is multiplied by its relative abundance (percentage of occurrence). This calculation reflects the contribution of each isotope to the element's overall atomic mass. 2. **Worked Example** Using a model or diagram illustrates how the average atomic mass is affected by the relative abundance of isotopes. 3. **Lesson Activity** **Activity: Research Assignment on Real-World Applications for Isotopes** **Overview**: Students will research and present a current news article related to the use of isotopes in real-world applications, such as carbon dating, medical imaging, nuclear energy, environmental studies, and more. **Materials needed**: access to internet, newspaper, or other news sources, pen and paper, presentation materials for creating visuals (optional) **Procedure:** 1. Look for news articles online using credible news websites, scientific journals, or find articles in newspapers that are related to isotopes. 2. Carefully read the chosen article to understand the key points and details. 3. Write down important information such as: the type of isotope discussed, the specific application and its significance, how the isotope is used in the application and any benefits or challenges mentioned in the article. 4. Write a summary of the article in your own words which includes an introduction to the topic, the main points of the article, and your analysis of the isotope's role and impact in the application.	See Learning Activity Sheet: *Activity #3: Isotope Comparison and their real-world applications*

	5. Written Report: Submit a written report (1-2 pages) that includes the title and source of the article, a summary of the article, your analysis and conclusions, your references used in your research. Presentation (Optional): If required, be prepared to present your findings to the class on the assigned date.	
D. Making Generalizations	**1. Learners' Takeaways:** Ask the learners, "Why is understanding the concept of relative abundance important in calculating the atomic mass of an element?" **2. Reflection on Learning:** Make the students write a short reflection on what they learned about isotopes and atomic mass, and how it applies to real-world scenarios.	

IV. EVALUATING LEARNING: FORMATIVE ASSESSMENT AND TEACHER'S REFLECTION		**NOTES TO TEACHERS**
A. Evaluating Learning	**1. Formative Assessment** **Day 1: Assessment of identifying and labeling isotopes** 1. What are isotopes? 2. Label the following isotopes of Carbon: C-12, C-13, C-14 C-12, C-13, C-14 Indicate the number of protons, neutrons, and electrons for each isotope. 3. How do isotopes of an element differ from each other? 4. Which isotope of Hydrogen has one proton and one neutron? 5. Why do isotopes of the same element have the same chemical properties? **Day 2: Worksheet on atomic mass calculations** 1. Calculate the atomic mass of Boron given the following isotopes: - Boron-10: Mass = 10.0129 amu, Abundance = 19.9% - Boron-11: Mass = 11.0093 amu, Abundance = 80.1% 2. Determine the atomic mass of Neon using its isotopes: - Neon-20: Mass = 19.9924 amu, Abundance = 90.48% - Neon-21: Mass = 20.9938 amu, Abundance = 0.27% - Neon-22: Mass = 21.9914 amu, Abundance = 9.25%	**Key 1**: 1. Isotopes are atoms of the same element with different numbers of neutrons. 2. C-12: 6 protons, 6 neutrons, 6 electrons C-13: 6 protons, 7 neutrons, 6 electrons C-14: 6 protons, 8 neutrons, 6 electrons 3. Isotopes differ in the number of neutrons and hence their mass number. 4. Deuterium (2 H 2 H). 5. Isotopes have the same chemical properties because they have the same number

	3. What is the atomic mass of Chlorine given these isotopes? - Chlorine-35: Mass = 34.9689 amu, Abundance = 75.78% - Chlorine-37: Mass = 36.9659 amu, Abundance = 24.22% **Day 3: Comparison chart of isotopes** 1. What is the primary difference between isotopes of the same element? 2. Why is Carbon-14 used in radiocarbon dating but not Carbon-12? 3. How does the mass number of an isotope affect its atomic mass? **Day 4: Presentation on isotope's applications** 1. Explain one application of Carbon-14 in archaeology. 2. How is Technetium-99m used in medical diagnostics? 3. What role do isotopes play in nuclear power generation? **Homework (Optional)** Topic: Isotopes and Atomic Mass Instructions: Complete the following tasks related to isotopes and atomic mass. Ensure you answer all questions and perform the calculations where required. This homework is due by the end of the week. **Part 1: Research Task**: - Choose one isotope that is commonly used in scientific research or medical applications (e.g., Carbon-14, Technetium-99m, Iodine-131, Uranium-235). - Write a one-page report on your chosen isotope, including the following: - Its properties (mass number, number of protons, neutrons, and electrons). - Its natural abundance or how it is produced. - Its main uses in research, medicine, or industry. - Any interesting historical facts or advancements related to this isotope. **Part 2**: **Calculations:** Calculate the atomic mass: - Oxygen (O) has three stable isotopes: Oxygen-16: Mass = 15.9949 amu, Relative Abundance = 99.76% Oxygen-17: Mass = 16.9991 amu, Relative Abundance = 0.04% Oxygen-18: Mass = 17.9992 amu, Relative Abundance = 0.20% Calculate the average atomic mass of Oxygen. (**Ans: 15.9996 amu**) - Chlorine (Cl) has two naturally occurring isotopes: Chlorine-35: Mass = 34.9689 amu, Relative Abundance = 75.78% Chlorine-37: Mass = 36.9659 amu, Relative	of protons and electrons, which determine chemical behavior. **Key 2:** 1. 10.81 amu 2. 20.18 amu 3. 35.45 amu **Key 3**: 1. The primary difference is the number of neutrons. 2. Carbon-14 is radioactive and decays over time, making it useful for dating, whereas Carbon-12 is stable. 3. The mass number directly influences the atomic mass as it is the sum of protons and neutrons. **Key 4**: 1. Carbon-14 is used in radiocarbon dating to determine the age of archaeological samples by measuring the decay of C-14. 2. Technetium-99m is used in medical diagnostics as a radioactive tracer in imaging to detect abnormalities in organs. 3. Isotopes like Uranium-235 are used as fuel in

<table>
<tr><td></td><td colspan="3">Abundance = 24.22% Calculate the average atomic mass of Chlorine. (Ans: 35.4658 amu)

Part 3: Comparison and Reflection
- Compare the isotopes of Hydrogen (Protium, Deuterium, Tritium). Write a short paragraph explaining how their differences in neutron number affect their physical and chemical properties. Discuss why Tritium is radioactive while Protium and Deuterium are not.
- Reflect on the importance of understanding isotopes and atomic mass in your daily life and future career. Write a short paragraph on how this knowledge might be useful to you personally.</td><td>nuclear reactors to generate power through nuclear fission.</td></tr>
<tr><td rowspan="5">B. Teacher's Remarks</td><td>Note observations on any of the following areas:</td><td>Effective Practices</td><td>Problems Encountered</td><td rowspan="5">Effective Practices:
Note any effective strategies that helped in explaining the structure of the atom. Record levels of student engagement and participation to identify successful approaches.

Problems Encountered: Document any difficulties students faced in understanding the concepts and note any issues with materials or resources that need addressing.</td></tr>
<tr><td>strategies explored</td><td></td><td></td></tr>
<tr><td>materials used</td><td></td><td></td></tr>
<tr><td>learner engagement/ interaction</td><td></td><td></td></tr>
<tr><td>Others</td><td></td><td></td></tr>
</table>

C. Teacher's Reflection	*Reflection guide or prompt can be on:* ▪ *<u>Principles behind the teaching</u>* *What principles and beliefs informed my lesson?* *Why did I teach the lesson the way I did?* ▪ *<u>Students</u>* *What roles did my students play in my lesson?* *What did my students learn? How did they learn?* ▪ *<u>Ways forward</u>* *What could I have done differently?* *What can I explore in the next lesson?*	Reflect on the principles behind the teaching methods used and consider student roles and learning outcomes. Use these reflections to plan for future lessons, addressing observed challenges and building on successes.