# Unit: Unit 2: Atomic Structure and Bonding

## Chapter: Chapter 3: Unlocking the Atom

### Lesson: Lesson 1: The Evolution of Atomic Models and Structure

## Unit Title: \*\*Atomic Structure and Bonding\*\*  
  
## Chapter Title: \*\*Unlocking the Atom\*\*  
  
# Lesson Title: \*\*The Evolution of Atomic Models and Structure\*\*  
  
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### Lesson Objective:  
By the end of this lesson, students will:  
- Understand how atomic models have evolved over time.  
- Recognize the contributions of key scientists to the atomic theory.  
- Identify and explain the structure of the atom, including subatomic particles.  
- Relate historical models to the current understanding of atomic structure.  
  
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### Lesson Vocabulary:  
- \*\*Atom\*\*  
- \*\*Electron\*\*  
- \*\*Proton\*\*  
- \*\*Neutron\*\*  
- \*\*Nucleus\*\*  
- \*\*Subatomic particles\*\*  
- \*\*Atomic model\*\*  
- \*\*Electron cloud\*\*  
- \*\*Quantum theory\*\*  
  
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### Essential Question:  
- How has our understanding of atomic structure changed over time?  
- What are the key components of an atom and how do they interact?  
  
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### Performance Expectations:  
- Students will explain the historical development of atomic models.  
- Students will describe the structure of atoms using the modern atomic model.  
- Students will participate in hands-on activities and discussions to reinforce their understanding of atomic structure.  
  
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### Disciplinary Core Ideas:  
- \*\*PS1.A: Structure and Properties of Matter\*\*   
 - Matter is made up of atoms, and the structure of atoms determines their properties.  
- \*\*History of Science\*\*   
 - Scientific knowledge builds on past discoveries and evolves over time as new evidence is gathered.  
  
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### 1. Big Idea:  
- \*\*Main Concept:\*\* Atomic models have changed over time as scientists gathered more evidence about the structure and behavior of atoms.  
  
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### 2. Essential Questions:  
- How did scientists' ideas about the atom evolve?  
- What does the current atomic model tell us about the structure of matter?  
  
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### 3. Phenomenon-Based Learning:  
The lesson will be based on a common phenomenon: \*\*Why do some elements behave differently than others?\*\*   
This will be explored through the lens of atomic structure and its evolution.  
  
#### Phenomenon:  
- \*\*Why do some elements, like helium, not react, while others, like sodium, react easily with other substances?\*\*   
 This question will lead into the exploration of atomic models and the role of electrons in chemical behavior.  
  
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### 4. Vocabulary:  
- \*\*Atom\*\*: The smallest unit of an element that retains its properties.  
- \*\*Electron\*\*: A negatively charged subatomic particle found in the electron cloud outside the nucleus.  
- \*\*Proton\*\*: A positively charged subatomic particle located in the nucleus of an atom.  
- \*\*Neutron\*\*: A subatomic particle with no charge, also found in the nucleus.  
- \*\*Nucleus\*\*: The dense center of an atom that contains protons and neutrons.  
- \*\*Subatomic Particles\*\*: Particles that are smaller than an atom, including protons, neutrons, and electrons.  
- \*\*Atomic Model\*\*: Theoretical models that describe the structure of the atom.  
- \*\*Electron Cloud\*\*: A region around the nucleus where electrons are likely to be found, based on probability.  
- \*\*Quantum Theory\*\*: The theory that describes the behavior of electrons in atoms, incorporating the idea that their exact position cannot always be known.  
  
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### 5. SMART Objectives:  
1. \*\*Specific\*\*: Students will describe the atomic models proposed by Dalton, Thomson, Rutherford, Bohr, and modern quantum theory.  
2. \*\*Measurable\*\*: Students will complete a hands-on activity where they build a model of the atom and answer follow-up questions.  
3. \*\*Achievable\*\*: Students will work in groups to analyze the differences between historical and modern atomic models.  
4. \*\*Time-Based\*\*: By the end of the 45-minute class, students will answer questions related to the evolution of atomic models and the structure of the atom.  
  
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### 6. Engage (Ignite):  
\*\*Phenomenon-related Question:\*\*   
\*"Why do some materials conduct electricity, while others do not?"\*  
  
\*\*Hands-on Experiment: Building an Atomic Model\*\*   
Students will use colored beads to represent protons, neutrons, and electrons and build a model of an atom. Materials needed: colored beads, string, and paper.  
  
\*\*Procedure:\*\*  
1. Assign colors to protons, neutrons, and electrons (e.g., red for protons, blue for neutrons, yellow for electrons).  
2. Have students create a nucleus by placing the correct number of protons and neutrons in the center.  
3. Use string to create an "electron cloud" around the nucleus, placing the electrons in the correct arrangement.  
  
\*\*Follow-up Questions:\*\*  
- How does this model help you understand the structure of an atom?  
- Why are the electrons placed outside the nucleus?  
- How do you think this model differs from the real atom?  
  
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### 7. Pre-Explore (Direct Instruction):  
\*\*Background Information:\*\*  
- \*\*John Dalton (1803)\*\*: Dalton proposed that atoms were indivisible spheres. He suggested that each element consisted of its own unique type of atom.  
- \*\*J.J. Thomson (1897)\*\*: Discovered the electron and proposed the "plum pudding" model, where electrons were embedded in a positively charged sphere.  
- \*\*Ernest Rutherford (1911)\*\*: Conducted the gold foil experiment and proposed that atoms have a small, dense nucleus surrounded by electrons.  
- \*\*Niels Bohr (1913)\*\*: Suggested that electrons orbit the nucleus in fixed paths or energy levels.  
- \*\*Modern Quantum Model\*\*: Electrons occupy regions of space called electron clouds, and their exact position cannot be determined.  
  
\*\*Discussion Questions:\*\*  
- How did each scientist's model change our understanding of the atom?  
- What evidence led to the rejection of earlier models?  
  
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### 8. Evaluate (Progress Check) - Pre-Explore:  
1. What was John Dalton's model of the atom?  
2. Why did J.J. Thomson's discovery of the electron change Dalton's model?  
3. How did Rutherford's gold foil experiment provide evidence for the nuclear model of the atom?  
  
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### 9. Explore (Pathfinder):  
\*\*Activity:\*\*   
\*Analyzing Atomic Models over Time\*   
Students will work in groups to research and create a timeline of atomic models, including Dalton, Thomson, Rutherford, Bohr, and the modern quantum model.  
  
\*\*Instructions:\*\*  
1. Assign each group one or two atomic models to research and present.  
2. Have students create a visual timeline showing the progression of atomic models.  
3. Each group will present their findings to the class.  
  
\*\*Retrieval Practice:\*\*  
- After each presentation, ask the class:   
 "How did this model improve upon the previous one?"   
 "What evidence supported this model?"  
  
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### 10. Explain (Lightbulb):  
This section should span 4000-5000 words and provide a detailed explanation of the main concepts covered in the lesson. The content would explain the evolution of atomic models, starting with Dalton’s solid sphere model and ending with the modern quantum mechanical model. Key ideas like the discovery of subatomic particles, the nucleus, energy levels, and electron clouds should be discussed in detail.  
  
Students will be guided with prompts such as:   
- How did Rutherford's experiment change our understanding of the atom?  
- What new evidence made Bohr’s model necessary?  
- How does the quantum mechanical model explain the behavior of electrons?  
  
For each model, a sample solved problem will be provided. For example, a problem related to calculating the number of protons, neutrons, and electrons in an atom of a given element will be presented along with a solution. After each explanation, students will solve practice problems.  
  
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### 11. Evaluate (Progress Check) - Explain:  
1. What experiment led to the discovery of the nucleus?  
2. How does Bohr's model explain the behavior of electrons in an atom?  
3. Why is the quantum mechanical model considered more accurate than Bohr's model?  
  
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### 12. Elaborate (Power Up):  
\*\*Open-ended Question:\*\*   
How might our understanding of the atom change in the future as new evidence emerges?  
  
\*\*Mini-task:\*\*   
Have students write a paragraph predicting what future discoveries about the atom might reveal.  
  
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### 13. Final Evaluation:  
\*\*Debate Question:\*\*   
"Which atomic model had the most significant impact on modern science? Dalton's theory of indivisible atoms, Rutherford's nuclear model, or Bohr’s model of energy levels?"  
  
\*\*Assessment Questions:\*\*  
  
\*\*Multiple Choice:\*\*  
1. Who proposed the "plum pudding" model of the atom?  
 - (A) Dalton (B) Rutherford (C) Thomson (D) Bohr   
 \*\*Answer:\*\* (C) Thomson  
2. What did Rutherford's gold foil experiment demonstrate?  
 - (A) Atoms are indivisible (B) Atoms have a nucleus (C) Electrons orbit in fixed paths (D) Atoms are mostly empty space   
 \*\*Answer:\*\* (B) Atoms have a nucleus  
3. In Bohr’s model, electrons:  
 - (A) Are spread evenly throughout the atom (B) Orbit the nucleus in fixed paths (C) Are found in a cloud (D) Are located only in the nucleus   
 \*\*Answer:\*\* (B) Orbit the nucleus in fixed paths  
4. Which scientist is associated with the discovery of the electron?  
 - (A) Dalton (B) Thomson (C) Rutherford (D) Bohr   
 \*\*Answer:\*\* (B) Thomson  
  
\*\*Long-Answer:\*\*  
1. Describe how Rutherford's experiment led to the nuclear model of the atom.  
2. Compare and contrast Bohr’s model of the atom with the quantum mechanical model.  
3. Explain how the discovery of the neutron changed the atomic model.  
4. How did Thomson’s discovery of the electron challenge Dalton’s model of the atom?  
  
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### 14. Extend (Beyond the Lesson): [Optional]  
\*\*Extension Activity:\*\*   
Research how atomic models are applied in modern technology, such as MRI machines or nuclear energy. Write a short report on how understanding atomic structure has led to advances in these fields.  
  
\*\*Spaced Practice:\*\*   
Ask students to create flashcards for key terms and scientists. These can be used in future lessons for review.