# 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:\*\*   
\*\*Unit 2: Atomic Structure and Bonding\*\*  
  
## \*\*Chapter Title:\*\*   
\*\*Chapter 3: Unlocking the Atom\*\*  
  
# \*\*Lesson Title:\*\*   
\*\*Lesson 1: The Evolution of Atomic Models and Structure\*\*  
  
### \*\*Essential Question:\*\*   
- How have discoveries over time influenced our current understanding of atomic structure?   
  
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### \*\*1. Big Idea:\*\*   
The understanding of atomic structure has evolved through the contributions of scientists over time, leading to the current quantum mechanical model of the atom.  
  
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### \*\*2. Essential Questions\*\*   
- How have discoveries over time influenced our current understanding of atomic structure?   
  
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### \*\*3. Phenomenon-Based Learning\*\*   
\*\*Unit Phenomenon:\*\*   
In northern countries, road salt is used to melt ice and snow during winter. But why does salt make ice disappear, while other materials do not? To understand this, we need to look at the structure of salt and water at the atomic level.  
  
\*\*Chapter 3 Phenomenon:\*\*   
Is salting the road a magic trick? No! To understand how salt melts ice, we must first understand the structure of atoms and how different types of atoms interact with each other. This lesson will take you on a journey through the discovery of the atom and how our understanding of its structure has changed over time.  
  
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### \*\*4. Vocabulary\*\*   
- \*\*Bohr\*\*: A scientist who proposed that electrons orbit the nucleus in fixed paths.  
- \*\*Dalton\*\*: Proposed that atoms are indivisible and the smallest unit of matter.  
- \*\*Democritus\*\*: An ancient philosopher who first suggested that matter is made of small, indestructible particles called atoms.  
- \*\*Electrons\*\*: Negatively charged particles that orbit the nucleus of an atom.  
- \*\*Nuclear Model\*\*: A model of the atom with a dense central nucleus and electrons orbiting around it.  
- \*\*Neutrons\*\*: Neutral particles found in the nucleus of an atom.  
- \*\*Plum-Pudding Model\*\*: Thomson’s model of the atom, where electrons were scattered throughout a positively charged "pudding."  
- \*\*Protons\*\*: Positively charged particles found in the nucleus of an atom.  
- \*\*Rutherford\*\*: Discovered that atoms have a small, dense nucleus.  
- \*\*Schrodinger\*\*: Developed the quantum mechanical model of the atom.  
- \*\*Thomson\*\*: Discovered the electron and proposed the plum-pudding model.  
- \*\*Quantum Mechanical Model\*\*: The modern model of the atom, where electrons exist in probability clouds around the nucleus.  
  
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### \*\*5. SMART Objectives\*\*   
1. Name key scientists who contributed to the development of atomic theory.  
2. Trace the evolution of atomic models over time.  
3. Compare and contrast the contributions of different scientists to the understanding of atomic structure.  
4. Understand how the discovery of protons, neutrons, and electrons has shaped the current quantum mechanical model of the atom.  
  
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### \*\*6. Engage (Ignite)\*\*   
\*\*Phenomenon-Related Question\*\*:   
Imagine you're walking on an icy road. Suddenly, workers spread salt on the ice, and it begins to disappear. Why does this happen? Is it magic? Could understanding atoms help explain this phenomenon?   
  
\*\*Hands-On Experiment\*\*:   
\*\*Objective\*\*: Illustrate the concept of atomic structure using simple materials.   
  
\*\*Materials\*\*:   
- Styrofoam balls (different sizes)  
- Toothpicks  
- Glue  
- Markers  
  
\*\*Procedure\*\*:   
1. Use the largest Styrofoam ball to represent the nucleus of an atom.  
2. Attach smaller Styrofoam balls with toothpicks to represent electrons orbiting the nucleus.  
3. Label the nucleus with "protons" and "neutrons" and the smaller balls as "electrons."  
   
\*\*Follow-up Questions\*\*:   
1. What does the nucleus represent in an atom?  
2. Why are the electrons orbiting the nucleus?  
3. How do you think this model compares to the real structure of an atom?  
  
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### \*\*7. Pre-Explore (Direct Instruction)\*\*   
Provide background information about how the discovery of the atom began with early philosophers like Democritus and evolved through the work of scientists such as Dalton, Thomson, Rutherford, Bohr, and Schrodinger. Link the phenomenon of road salt melting ice to the structure of salt at the atomic level, emphasizing the role of ions and atomic interactions.  
  
\*\*Interactive Elements\*\*:   
- \*\*Class Discussion\*\*: Ask students what they know about atoms. What do they think atoms look like?   
- \*\*Scaffolded Questions\*\*:   
 - What do you think Democritus imagined an atom looked like?  
 - How did Thomson’s idea of the atom differ from Dalton's?  
 - Why was Rutherford’s experiment important for changing our understanding of the atom?  
  
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### \*\*8. Evaluate (Progress Check) - Pre-Explore\*\*   
1. What was Democritus’s main contribution to atomic theory?   
2. How did Thomson’s discovery of the electron change the view of the atom?   
3. What did Rutherford’s gold foil experiment reveal about the structure of the atom?   
  
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### \*\*9. Explore (Pathfinder)\*\*   
\*\*Hands-On Activity\*\*:   
\*\*Objective\*\*: Simulate Rutherford’s gold foil experiment to explore how the discovery of the atomic nucleus changed atomic theory.   
  
\*\*Materials\*\*:   
- Ping pong balls  
- Large Styrofoam ball  
- Paper targets  
  
\*\*Procedure\*\*:   
1. Place the Styrofoam ball in the center of the table to represent the nucleus.  
2. Have students roll ping pong balls at the Styrofoam ball from different angles.  
3. Observe how some ping pong balls bounce back, while others pass by.  
  
\*\*Discussion\*\*:   
- What does the Styrofoam ball represent?  
- What do the bouncing ping pong balls tell us about the structure of the atom?  
- How does this activity mimic Rutherford’s experiment?  
  
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### \*\*10. Explain (Lightbulb)\*\*   
Provide a detailed explanation of the evolution of atomic models, focusing on the contributions of each scientist and how these discoveries led to our current understanding of the atom. Break down the discussion into sections for each key scientist:  
  
\*\*Democritus (460-370 BC)\*\*   
- Proposed that matter is made of small, indivisible particles called atoms.   
- His idea was purely philosophical, with no experimental evidence.  
  
\*\*John Dalton (1803)\*\*   
- Developed the first scientific atomic theory based on experiments.  
- Proposed that atoms are indivisible, and each element has its own type of atom.  
  
\*\*J.J. Thomson (1897)\*\*   
- Discovered the electron using the cathode ray tube experiment.  
- Proposed the Plum-Pudding Model, where electrons were embedded in a positively charged sphere.  
  
\*\*Ernest Rutherford (1911)\*\*   
- Conducted the gold foil experiment, discovering the nucleus.  
- Proposed the Nuclear Model, where a dense, positively charged nucleus is surrounded by electrons.  
  
\*\*Niels Bohr (1913)\*\*   
- Suggested that electrons orbit the nucleus in fixed energy levels.  
- Introduced the Bohr Model, where electrons can jump between energy levels.  
  
\*\*Erwin Schrodinger (1926)\*\*   
- Developed the Quantum Mechanical Model.  
- Proposed that electrons exist in probability clouds rather than fixed orbits.  
  
\*\*Connection to Phenomenon\*\*:   
The structure of atoms, particularly the arrangement of ions in salt, helps explain how road salt melts ice. Salt (NaCl) dissociates into sodium (Na⁺) and chloride (Cl⁻) ions, which interfere with the freezing process of water, lowering its freezing point and melting the ice.  
  
\*\*Sample Solved Problem\*\*:   
\*\*Q\*\*: How did Rutherford's gold foil experiment contradict Thomson's Plum-Pudding Model?   
\*\*A\*\*: In the Plum-Pudding Model, electrons are embedded in a sphere of positive charge. Rutherford’s experiment showed that instead of being spread out, the positive charge is concentrated in a small, dense nucleus, with most of the atom being empty space.  
  
\*\*Progress Check Question\*\*:   
How does the Bohr model differ from Rutherford's nuclear model?  
  
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### \*\*11. Evaluate (Progress Check) - Explain\*\*   
1. How did Thomson’s discovery of the electron change the atomic model?   
2. Explain how Rutherford’s gold foil experiment led to the discovery of the nucleus.   
3. How does the Quantum Mechanical Model describe the behavior of electrons?   
  
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### \*\*12. Elaborate (Power Up)\*\*   
- \*\*Mini-Task\*\*: Compare and contrast the Bohr Model with the Quantum Mechanical Model. What are the key differences?   
- \*\*Open-Ended Question\*\*: If new evidence were discovered about atomic structure, how might the current model of the atom change?   
  
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### \*\*13. Final Evaluation\*\*   
\*\*Debate Question\*\*:   
- Should scientists rely solely on experimental evidence, or can theoretical models like Democritus’s be valuable even without evidence?   
  
\*\*Assessment Questions\*\*:   
\*\*Multiple Choice\*\*   
1. Who first proposed that matter is made of indivisible particles called atoms?   
 a) Dalton   
 b) Democritus   
 c) Bohr   
 d) Thomson   
 \*\*Answer\*\*: b  
  
2. What did Rutherford discover in his gold foil experiment?   
 a) Electrons   
 b) Neutrons   
 c) Nucleus   
 d) Protons   
 \*\*Answer\*\*: c  
  
3. Which model of the atom describes electrons as existing in probability clouds?   
 a) Plum-Pudding Model   
 b) Nuclear Model   
 c) Bohr Model   
 d) Quantum Mechanical Model   
 \*\*Answer\*\*: d  
  
4. Who proposed that electrons orbit the nucleus in fixed paths?   
 a) Rutherford   
 b) Bohr   
 c) Schrodinger   
 d) Dalton   
 \*\*Answer\*\*: b  
  
\*\*Long Answer\*\*   
1. Explain how Dalton’s atomic theory differs from Democritus’s idea of the atom.   
2. Describe the key differences between Thomson’s Plum-Pudding Model and Rutherford’s Nuclear Model.   
3. How did Bohr’s model of the atom help explain the behavior of electrons in atoms?   
4. Compare and contrast the contributions of Bohr and Schrodinger to the understanding of atomic structure.  
  
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### \*\*14. Extend (Beyond the Lesson)\*\*   
- \*\*Additional Reading\*\*: Research the discovery of isotopes and how they contributed to our understanding of atomic structure.   
- \*\*Challenge\*\*: Investigate how understanding atomic structure has helped in modern medical technologies (e.g., MRI scans, radiation therapy).   
- \*\*Spaced Practice\*\*: Review the contributions of each scientist over several days, focusing on how each model improved upon the previous one and what evidence led to each new discovery.   
  
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This lesson provides a comprehensive introduction to the evolution of atomic models and the scientists who shaped our understanding of the atom. Through hands-on activities, interactive discussions, and progressive evaluations, students will gain a deeper understanding of how atomic theory has developed over time.