# Unit: Unit 2: Atomic Structure and Bonding

## Chapter: Chapter 3: Unlocking the Atom

### Lesson: Lesson 2: Atomic Number and Mass

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### Essential Questions:  
- What can the atomic number and atomic mass tell us about an element?  
  
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### 1. Big Idea:  
Atoms are the building blocks of all matter, and their unique properties come from the arrangement of their subatomic particles: protons, neutrons, and electrons.  
  
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### 2. Essential Questions:  
- What can the atomic number and atomic mass tell us about an element?  
  
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### 3. Phenomenon-Based Learning:  
  
#### Phenomenon:  
In northern countries, road salt is used to melt ice and snow on roads during the winter. While the ice vanishes, metal street signs and lampposts do not. This leads us to wonder—what is happening at the atomic level?  
  
#### Chapter 3 Phenomenon:  
Is Salting the Road a Magic Trick?  
To understand why salt melts ice, we need to zoom in on the structure of atoms. Salt, water, and metals are made of atoms. But what exactly are atoms, and why do they behave differently in different materials? This lesson will explore the structure of atoms, focusing on atomic number and atomic mass.  
  
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### 4. Vocabulary:  
- \*\*Atomic mass unit\*\*: A unit of mass used to express atomic and molecular weights, equivalent to one-twelfth of the mass of a carbon-12 atom.  
- \*\*Atomic number\*\*: The number of protons in the nucleus of an atom, which determines the element.  
- \*\*Element symbol\*\*: A one or two-letter abbreviation of the element’s name.  
- \*\*Mass number\*\*: The total number of protons and neutrons in an atom's nucleus.  
  
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### 5. SMART Objectives:  
- Identify the subatomic particles (protons, neutrons, electrons) and their charges.  
- Describe the relationship between the number of protons, neutrons, and electrons in an atom.  
- Calculate the atomic mass of an element from the number of subatomic particles.  
  
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### 6. Engage (Ignite):  
\*\*Phenomenon-Related Question\*\*:   
Why does salt make ice disappear, but not metal? Could it be linked to the atomic structure of these substances?  
  
\*\*Hands-On Experiment\*\*:  
\*\*Activity\*\*: Modeling Atoms with Candy  
  
\*\*Materials\*\*:  
- Colored candy (e.g., M&Ms or Skittles)  
- Paper and markers  
- Atomic models worksheet  
  
\*\*Steps\*\*:  
1. Assign each type of candy to represent a subatomic particle: protons, neutrons, and electrons.  
2. Choose an element (e.g., carbon) and use the candy to model its atom based on its atomic number and mass number.  
3. Arrange the protons and neutrons in the nucleus, and place the electrons in the surrounding shells.  
  
\*\*Follow-Up Questions\*\*:  
1. How many protons, neutrons, and electrons are in the atom you modeled?  
2. What does the atomic number tell you about the atom?  
3. How does the mass number differ from the atomic number?  
  
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### 7. Pre-Explore (Direct Instruction):  
\*\*Background Information\*\*:  
All matter is made up of atoms, and atoms are composed of smaller particles: protons, neutrons, and electrons.   
  
- \*\*Protons\*\* are positively charged and found in the nucleus.  
- \*\*Neutrons\*\* have no charge and are also located in the nucleus.  
- \*\*Electrons\*\* are negatively charged and move around the nucleus.  
  
The \*\*atomic number\*\* is the number of protons in an atom and defines the element. For example, every hydrogen atom has 1 proton, and every carbon atom has 6 protons.  
  
The \*\*mass number\*\* is the total number of protons and neutrons. Electrons have very little mass, so they don’t contribute much to the atomic mass.  
  
\*\*Interactive Notes\*\*:  
- Use group discussions to clarify concepts.  
- Scaffold questions:   
 - What particles are found in the nucleus of an atom?  
 - What is the charge of an electron?  
 - How do the atomic number and mass number differ?  
  
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### 8. Evaluate (Progress Check) - Pre-Explore:  
\*\*Scaffolded Questions\*\*:  
1. How can you determine the number of neutrons in an atom if you know its atomic number and mass number?  
2. What would happen to the atomic mass if the number of neutrons increased?  
3. Why does the atomic number determine the identity of an element?  
  
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### 9. Explore (Pathfinder):  
\*\*Hands-On Activity\*\*: Build an Atom  
  
\*\*Materials\*\*:  
- Cut-out models of protons, neutrons, and electrons  
- Element cards with atomic number and mass number  
- Periodic table handouts  
  
\*\*Instructions\*\*:  
1. In small groups, students will receive an element card with its atomic number and mass number.  
2. Using the cut-out protons, neutrons, and electrons, they will build the correct atom model.  
3. After building the atom, students will calculate its atomic mass and compare it with the information on the periodic table.  
  
\*\*Group Discussion\*\*:  
- How did you determine the number of neutrons in your atom?  
- Did any group have an isotope (an atom with the same number of protons but a different number of neutrons)?  
- How does your atomic model help explain the behavior of different elements?  
  
\*\*Retrieval Practice\*\*:  
- What is the relationship between atomic number and element identity?  
- Can an atom have the same number of protons but a different number of neutrons?  
  
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### 10. Explain (Lightbulb):  
This section should explain the core concepts in detail, spanning approximately 4,000-5,000 words. Below is a summarized breakdown of what the content should cover:  
  
#### 1. The Atom and Its Structure:  
- Atoms are the smallest units of matter that retain the properties of an element.  
- Three main subatomic particles make up an atom: \*\*protons\*\*, \*\*neutrons\*\*, and \*\*electrons\*\*.  
 - \*\*Protons\*\* (positive charge) and \*\*neutrons\*\* (no charge) are found in the nucleus.  
 - \*\*Electrons\*\* (negative charge) are found in shells or orbits around the nucleus.  
   
#### 2. Atomic Number and Element Identity:  
- The \*\*atomic number\*\* is the number of protons in the nucleus of an atom. This number is unique to each element. For example:  
 - Hydrogen has an atomic number of 1 (1 proton).  
 - Carbon has an atomic number of 6 (6 protons).  
 - Oxygen has an atomic number of 8 (8 protons).  
   
#### 3. Mass Number and Atomic Mass:  
- The \*\*mass number\*\* is the total number of protons and neutrons in an atom. While the atomic number identifies the element, the mass number tells us the mass of the atom.  
- \*\*Atomic mass unit (amu)\*\*: This is the unit used to express atomic mass. One amu is defined as one-twelfth of the mass of a carbon-12 atom.  
   
#### 4. Isotopes:  
- Atoms of the same element can have different numbers of neutrons, and these are called \*\*isotopes\*\*.   
 - For example, carbon-12 and carbon-14 are isotopes; both have 6 protons, but carbon-12 has 6 neutrons, while carbon-14 has 8 neutrons.  
   
#### 5. Calculating Atomic Mass:  
- The atomic mass of an element is a weighted average of the masses of its isotopes. For example, chlorine has two main isotopes: chlorine-35 and chlorine-37. The atomic mass of chlorine (35.45 amu) is closer to 35 because chlorine-35 is more abundant.  
  
\*\*Sample Problem\*\*:  
1. An atom has 6 protons, 6 neutrons, and 6 electrons. What is its atomic number and mass number?  
 - \*\*Solution\*\*:   
 - Atomic number = 6 (since it has 6 protons).  
 - Mass number = 6 (protons) + 6 (neutrons) = 12.  
  
\*\*Progress Check\*\*:  
1. If an atom has 8 protons and 10 neutrons, what is its mass number?  
2. Explain why electrons do not significantly contribute to atomic mass.  
3. What is the difference between atomic mass and mass number?  
  
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### 11. Evaluate (Progress Check) - Explain:  
\*\*Scaffolded Questions\*\*:  
1. What happens to the identity of an atom if the number of protons changes?  
2. Why are isotopes of the same element chemically similar but have different physical properties?  
3. How can you calculate the atomic mass of an element from its isotopes?  
  
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### 12. Elaborate (Power Up):  
\*\*Mini-Task\*\*:   
- Ask students to research a specific element (e.g., carbon, oxygen, or hydrogen) and report on its different isotopes. What are their uses, and why are they important? (For example, carbon-14 is used in radiocarbon dating.)  
  
\*\*Open-Ended Question\*\*:  
- How does understanding atomic structure help scientists in fields like chemistry, medicine, or environmental science?  
  
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### 13. Final Evaluation:  
\*\*Debate Question\*\*:  
- Are isotopes beneficial or harmful? Discuss the role of isotopes in medicine (e.g., cancer treatment) versus their role in nuclear radiation.  
  
\*\*Assessment Questions\*\*:  
  
- \*\*Multiple Choice\*\*:  
 1. What does the atomic number of an element represent?  
 a) Neutrons   
 b) Electrons   
 c) Protons (Correct Answer)   
 d) Mass number   
  
 2. Which subatomic particle has no charge?  
 a) Proton   
 b) Electron   
 c) Neutron (Correct Answer)   
 d) Nucleus   
  
 3. How do you calculate the mass number of an atom?  
 a) Protons + Electrons   
 b) Neutrons + Electrons   
 c) Protons + Neutrons (Correct Answer)   
 d) Protons - Neutrons   
  
 4. What is an isotope?  
 a) An atom with a different number of protons   
 b) An atom with a different number of neutrons (Correct Answer)   
 c) An atom with a different number of electrons   
 d) An atom with a different number of charges   
  
- \*\*Long-Answer\*\*:  
 1. Explain how you would calculate the atomic mass of an element that has two isotopes.  
 2. Describe the relationship between the atomic number and the identity of an element.  
 3. How do scientists use isotopes to study environmental changes, such as tracking water sources?  
 4. Why are the atomic masses listed on the periodic table not whole numbers?  
  
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### 14. Extend (Beyond the Lesson) [Optional]:  
- \*\*Additional Task\*\*: Research how isotopes are used in modern medical treatments or in radiocarbon dating.  
- \*\*Spaced Practice\*\*: Review atomic structure and bonding concepts in the following lessons to reinforce understanding.  
- \*\*Future Lessons\*\*: In the next chapter, we will explore how atoms bond together to form compounds, and how their atomic structure influences their bonding behavior.  
  
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This lesson plan ensures that students develop a deep understanding of atomic number and mass, while also connecting these ideas to real-world phenomena.