# 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 made up of three types of subatomic particles: protons, neutrons, and electrons. The atomic number and atomic mass help identify the characteristics of an element.  
  
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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 during winter. But why does the salt make the ice vanish, while metal street signs and lampposts remain unaffected? To answer this, we need to explore the basic building blocks of matter—atoms. All matter is made of atoms, but not all atoms are the same. In this lesson, we will investigate how the number of protons, neutrons, and electrons in an atom determine what kind of element it is and how heavy it is.  
  
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### 4. Vocabulary:  
  
- \*\*Atomic Mass Unit (amu)\*\*: A unit of mass used to express atomic and molecular weights, approximately equal to the mass of one proton or neutron.  
- \*\*Atomic Number\*\*: The number of protons in the nucleus of an atom, which determines the element's identity.  
- \*\*Element Symbol\*\*: A one- or two-letter abbreviation used to represent an element (e.g., H for hydrogen, O for oxygen).  
- \*\*Mass Number\*\*: The total number of protons and neutrons in an atom’s nucleus.  
  
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### 5. SMART Objectives:  
  
By the end of this lesson, students will be able to:  
  
1. Identify the subatomic particles (protons, neutrons, electrons) and their respective charges.  
2. Describe how the number of protons, neutrons, and electrons in an atom relates to the atomic number, mass number, and overall charge of an atom.  
3. Calculate the atomic mass of an element by using the number of subatomic particles present in the atom.  
  
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### 6. Engage (Ignite):  
  
\*\*Phenomenon-Related Question\*\*:   
Why does salt make ice vanish, but metal objects like street signs and lampposts don’t disappear when in contact with ice?  
  
\*\*Hands-On Activity\*\*:   
We will experiment with salt, ice, and metal.   
  
\*\*Materials\*\*:   
- Ice cubes   
- Table salt   
- Two metal spoons  
  
\*\*Procedure\*\*:   
1. Place an ice cube on a plate and sprinkle salt on top of it.  
2. Place another ice cube on a second plate and press a metal spoon on top of it.  
3. Observe what happens to both ice cubes over 5-10 minutes.  
  
\*\*Follow-Up Questions\*\*:   
1. What happens to the ice when salt is added?   
2. Does the metal spoon affect the ice the same way as the salt?   
3. Why do you think the salt has such a different effect on the ice compared to the metal?  
  
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### 7. Pre-Explore (Direct Instruction):  
  
\*\*Background Information\*\*:   
Atoms are the building blocks of all matter. Each atom is made up of three types of subatomic particles: protons, neutrons, and electrons. Protons have a positive charge, electrons have a negative charge, and neutrons have no charge. The number of protons in the nucleus of an atom is called its atomic number, which defines the type of element. The total number of protons and neutrons in an atom’s nucleus is called the mass number.  
  
- \*\*Protons\*\*: Positively charged particles in the nucleus.   
- \*\*Neutrons\*\*: Neutral particles in the nucleus.   
- \*\*Electrons\*\*: Negatively charged particles that orbit the nucleus.  
  
\*\*Interactive Discussion\*\*:   
- Break down the atom's structure by drawing a model of an atom on the board.  
- Ask students to identify the charges of each subatomic particle.  
- Consider how each particle contributes to the overall mass of the atom.  
  
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### 8. Evaluate (Progress Check) - Pre-Explore:  
  
1. What are the charges of protons, neutrons, and electrons?   
2. How do protons define the atomic number of an element?   
3. What is the difference between atomic number and mass number?  
  
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### 9. Explore (Pathfinder):  
  
\*\*Activity\*\*:   
Build a model of an atom.  
  
\*\*Materials\*\*:   
- Colored beads or small objects to represent protons, neutrons, and electrons  
- A small bowl to represent the nucleus  
- String or wire to represent electron orbits  
  
\*\*Procedure\*\*:   
1. Use red beads to represent protons, blue beads for neutrons, and yellow beads for electrons.  
2. Place the protons and neutrons into the bowl (the nucleus) and arrange the electrons on the string (the electron orbit).  
3. Make sure the number of protons equals the atomic number of the element you are modeling.  
  
\*\*Group Discussion\*\*:   
- How does the number of electrons compare to the number of protons?   
- What happens if you change the number of neutrons in the nucleus?  
  
\*\*Retrieval Practice\*\*:   
Have students quiz each other about the structure of their models. For example, "What is the atomic number of your atom?" or "How many neutrons are in the nucleus?"  
  
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### 10. Explain (Lightbulb):  
  
At the core of every atom is its \*\*nucleus\*\*, which contains \*\*protons\*\* and \*\*neutrons\*\*. Surrounding the nucleus are \*\*electrons\*\*, orbiting at various distances. Let’s break down the key components:  
  
#### 1. \*\*Protons, Neutrons, and Electrons\*\*:  
- \*\*Protons\*\* are positively charged particles. Each element has a unique number of protons, which is its \*\*atomic number\*\*. For example, hydrogen has 1 proton, and oxygen has 8 protons.  
- \*\*Neutrons\*\* have no charge and add mass to the atom. Neutrons, together with protons, contribute to the atom’s \*\*mass number\*\*.  
- \*\*Electrons\*\* are negatively charged and orbit the nucleus. In a neutral atom, the number of electrons equals the number of protons.  
  
#### 2. \*\*Atomic Number\*\*:  
The atomic number tells us how many protons are in the atom. It also helps us determine the element. For example, every atom with 6 protons is carbon, and every atom with 8 protons is oxygen. The atomic number defines the identity of the atom.  
  
#### 3. \*\*Mass Number and Atomic Mass\*\*:  
The \*\*mass number\*\* is the total number of protons and neutrons in an atom. For example, an oxygen atom with 8 protons and 8 neutrons has a mass number of 16. The \*\*atomic mass\*\*, usually given in units of \*\*atomic mass units (amu)\*\*, is slightly different because it takes into account the tiny mass of electrons and isotopes (atoms of the same element with different numbers of neutrons).  
  
\*\*Sample Problem\*\*:   
An atom has 6 protons, 7 neutrons, and 6 electrons. What is its atomic number and mass number?  
  
\*\*Solution\*\*:   
- \*\*Atomic number\*\* = Number of protons = 6   
- \*\*Mass number\*\* = Protons + Neutrons = 6 + 7 = 13   
  
\*\*Progress Check\*\*:   
An atom has 12 protons, 12 neutrons, and 12 electrons. What is its atomic number? What is its mass number?  
  
#### 4. \*\*Isotopes\*\*:  
Isotopes are atoms of the same element that have different numbers of neutrons. For example, carbon-12 has 6 protons and 6 neutrons, but carbon-14 has 6 protons and 8 neutrons. Even though they are both carbon, they have different mass numbers.  
  
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### 11. Evaluate (Progress Check) - Explain:  
  
1. What is the relationship between the atomic number and the number of protons in an atom?  
2. How do you calculate the mass number of an atom?  
3. What is an isotope, and how does it differ from a regular atom?  
  
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### 12. Elaborate (Power Up):  
  
\*\*Mini-Task\*\*:   
Research and create a chart showing the isotopes of hydrogen (protium, deuterium, and tritium). How do their neutron counts differ?  
  
\*\*Open-Ended Question\*\*:   
If an atom has 20 protons and 22 neutrons, what element is it? What would happen if it gained or lost neutrons?  
  
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### 13. Final Evaluation:  
  
\*\*Debate Question\*\*:   
Should isotopes of elements be treated as separate elements, or should they be considered the same element because they have the same number of protons?  
  
\*\*Assessment Questions\*\*:  
  
- \*\*Multiple-Choice\*\*:  
 1. What does the atomic number of an element represent?  
 a) Number of neutrons   
 b) Number of protons   
 c) Number of electrons   
 d) Total number of subatomic particles   
 \*\*Answer\*\*: b) Number of protons  
  
 2. Which subatomic particle has no charge?  
 a) Proton   
 b) Electron   
 c) Neutron   
 d) All of the above   
 \*\*Answer\*\*: c) Neutron  
  
 3. What is the mass number of an atom with 8 protons and 8 neutrons?  
 a) 8   
 b) 16   
 c) 24   
 d) 32   
 \*\*Answer\*\*: b) 16  
  
 4. Isotopes of the same element differ in the number of:  
 a) Protons   
 b) Neutrons   
 c) Electrons   
 d) None of the above   
 \*\*Answer\*\*: b) Neutrons  
  
- \*\*Long-Answer\*\*:  
 1. Explain the difference between atomic number and mass number.  
 2. How can you determine the number of neutrons in an atom using its atomic number and mass number?  
 3. Describe what isotopes are and provide an example.  
 4. Why do electrons in neutral atoms equal the number of protons?  
  
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### 14. Extend (Beyond the Lesson) [Optional]:  
  
\*\*Additional Challenge\*\*:   
Explore how isotopes are used in real-world applications like carbon dating or medical imaging. Write a one-page report on the role of isotopes in science.  
  
\*\*Future Lessons\*\*:   
In our next lesson, we will explore how atoms bond together to form molecules. Understanding atomic numbers and masses is essential for learning how atoms interact to form compounds.  
  
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This lesson plan ensures students understand the relationship between atomic number, atomic mass, and the structure of atoms while engaging them with hands-on activities and inquiry-based learning.