Introduction to Atoms

Key Concepts

- How did atomic theory develop and change?
- What is the modern model of the atom?

Scientists once thought that atoms were the smallest particles of matter. In modern terms, an **atom** is the smallest particle of an element. Unlike Democritus's idea of the atom, atomic theory is based on scientific inquiry. **Atomic theory grew as a series of models that developed from experimental evidence. As more evidence was collected, the theory and models were revised.**

John Dalton used evidence from experiments to develop a model that described atoms as smooth hard balls. His model included the idea that all atoms of an element were alike and different from atoms of any other element. By 1897, J. J. Thomson did experiments that led to the discovery of the **electron,** negatively charged particles in atoms. Thomson's model described an atom as a ball of positive charge with electrons embedded in it. In 1911, Ernest Rutherford and his team did experiments that led to the discovery of the **nucleus**—the tiny, positively charged center of an atom. In Rutherford's model, the nucleus contained **protons,** positively charged particles. In 1913, Niels Bohr described electrons as having only certain amounts of energy and moving in specific orbits around the nucleus. By the 1920s, the model of the atom described electrons as moving in a cloudlike region around the nucleus. It also suggested that an electron moved in certain regions depending on its **energy level,** or specific amount of energy. To this model was later added the **neutron,** a particle having no charge and found in the nucleus. **At the center of the atom is a tiny, massive nucleus containing protons and neutrons. Surrounding the nucleus is a cloudlike region of moving electrons.**

Protons and neutrons are about equal in mass. Electrons are much smaller. It takes almost 2,000 electrons to equal the mass of one proton. Electrons, however, take up much more space in the atom than does the nucleus. Atoms are so small that their masses are measured in atomic mass units (amu). A proton or a neutron has a mass about equal to one amu.

Every atom of an element has the same number of protons. This unique number is called the **atomic number.** It is equal to the number of protons in the nucleus of an atom. Although all atoms of an element have the same atomic number, they may have different numbers of neutrons. **Isotopes** are atoms with the same number of protons and a different number of neutrons. An isotope is identified by its **mass number,** which is the sum of the protons and neutrons in the nucleus of that atom. Although isotopes have different mass numbers, they react the same way chemically.

Introduction to Atoms (pp. 124–130)

This section describes the development of atomic theory and the structure of atoms.

Use Target Reading Skills

Before you read, preview the diagram of a carbon atom in Figure 7 in your textbook. Then, complete the graphic organizer by writing two questions about the diagram. As you read, answer your questions.

Modern Model of an Atom

Q. What particles are in the center of an atom?
A.
Q.
A.

Development of Atomic Theory (pp. 125–127)

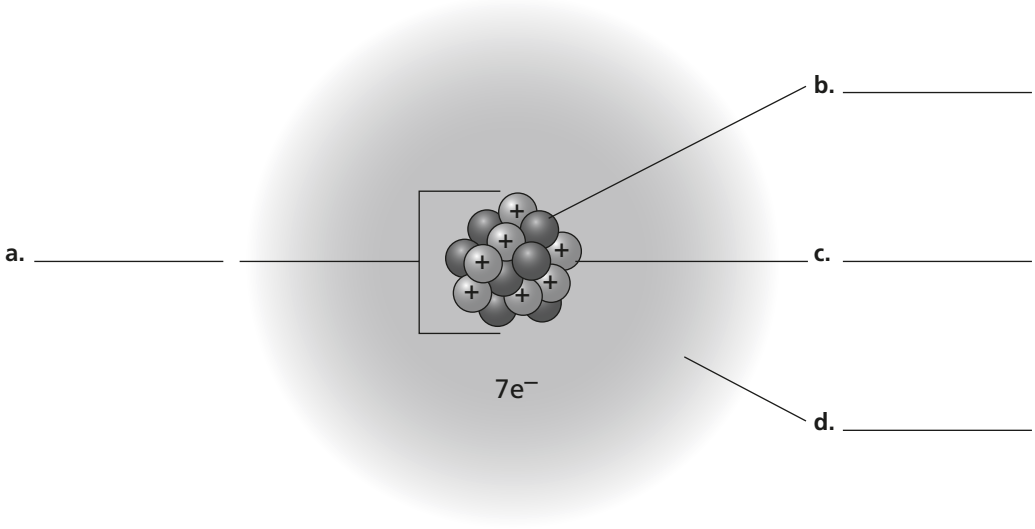
1. Is the following sentence true or false? Atoms are the smallest particles of matter. _____
2. Circle the letter of each sentence that is part of John Dalton's atomic theory.
   - **a.** All elements are composed of atoms.
   - **b.** No two atoms of the same element are exactly alike.
   - **c.** An atom of one element cannot be changed into an atom of a different element.
   - **d.** Atoms cannot be created or destroyed in any chemical changes.
3. Is the following sentence true or false? With only a few changes, Dalton's atomic theory is still accepted today. _____
4. Who described the atom as negative charges scattered through a ball of positive charges? _____
5. What experiment convinced Ernest Rutherford that the atom has a small, positively charged nucleus? _____

6. The term Rutherford gave to the positively charged particles in the nucleus of an atom was _____.
7. The atomic model of _____ resembled planets orbiting the sun.
8. What particle did Chadwick discover in 1932 that was hard to detect because it had no electrical charge? _____
9. Is the following sentence true or false? Since the 1930s, the model of the atom has changed a great deal.

   _____
10. Circle the letter of each sentence that correctly describes atoms.
    - **a.** Most of the mass of an atom is due to its protons and neutrons.
    - **b.** Atoms have no overall electrical charge.
    - **c.** Atoms of different elements have the same number of protons.
    - **d.** Most of the volume of an atom consists of its nucleus.

The Modern Atomic Model (pp. 128–130)

11. Label the parts of the atom in the diagram below.



12. Tell why an atom is neutral.

    _____

    _____

    _____

Introduction to Atoms *(continued)*

13. Which two particles in an atom have about the same mass?

_____

14. How does the mass of an electron compare to the mass of a proton?

_____

_____

15. An element can be identified by the number of _____ in the nucleus of its atoms.

16. What is the atomic number of an element?

_____

_____

17. What are isotopes?

_____

_____

_____

18. In the space below, draw two isotopes of carbon and give the mass number for each.