





2 The Chemistry of Life

2.1 The Nature of Matter

Lesson Objectives

-  Identify the three subatomic particles found in atoms.
-  Explain how all of the isotopes of an element are similar and how they are different.
-  Explain how compounds are different from their component elements.
-  Describe the two main types of chemical bonds.

Lesson Summary

Atoms The atom is the basic unit of matter, made up of three subatomic particles.

- ▶ Protons have a positive charge and neutrons carry no charge. Strong forces bind protons and neutrons together in the nucleus.
- ▶ An electron is a negatively charged particle that has only about $1/1840$ the mass of a proton. Electrons constantly move around the space surrounding the atom's nucleus.
- ▶ Because an atom has the same number of protons and electrons, it is electrically neutral.

Elements and Isotopes A chemical element is a pure substance that consists entirely of one type of atom.

- ▶ Atoms of the same element that differ in the number of neutrons are called isotopes. Isotopes are identified by their mass number, the total number of protons and neutrons in the nucleus. Because they have the same number of electrons in each atom, all isotopes of an element have the same chemical properties.
- ▶ Radioactive isotopes have unstable nuclei and break down at a constant rate.

Chemical Compounds A chemical compound is a substance formed by the chemical combination of two or more elements in definite proportions. The physical and chemical properties of a compound are usually very different from those of the elements from which it is formed. Scientists use formulas to show the ratio of elements that make up a compound.

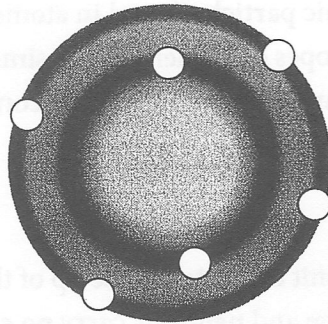
Chemical Bonds The atoms in compounds are held together by chemical bonds. Electrons that are available to form bonds are called valence electrons.

- ▶ An ionic bond forms when one or more electrons are transferred from one atom to another, forming ions. An atom that loses electrons becomes positively charged. An atom that gains electrons becomes negatively charged.
- ▶ A covalent bond forms when electrons are shared rather than transferred. The structure formed by atoms joined by covalent bonds is called a molecule. The molecule is the smallest unit of most compounds.

- When molecules are close together, a slight attraction can form between the oppositely charged portions of nearby molecules. These intermolecular forces of attraction are called van der Waals forces.

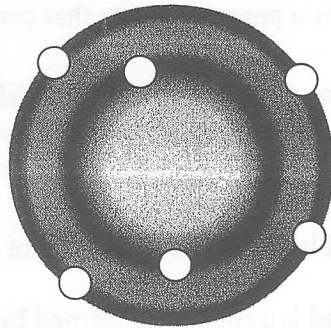
Atoms

1. The diagram shows a model of a carbon atom with an atomic number of 6. Complete the diagram by drawing in the rest of the atomic particles, including their charges. Label all particles and the nucleus.

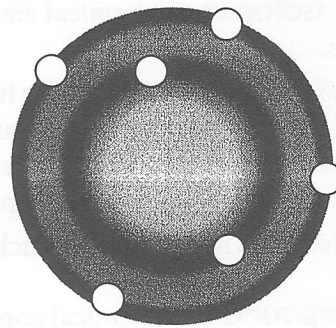


Elements and Isotopes

2. The diagrams show models of carbon isotopes. Complete the diagrams by drawing in the rest of the atomic particles, including their charges.



Nonradioactive
carbon-13



Radioactive
carbon-14

Use your completed diagrams to answer Questions 3–4.

3. Identify two differences between carbon-12 and carbon-14.

4. Identify two ways in which carbon-12, carbon-13, and carbon-14 are alike.

For Questions 5–7, complete each statement by writing the correct word or words.

- 5. A chemical element is a pure substance that consists entirely of one type of _____.
- 6. Atoms of the same element that differ in the number of neutrons they contain are called _____.
- 7. An atom is made up of protons, neutrons, and _____.

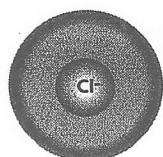
Chemical Compounds

- 8. What is a chemical compound?

- 9. What do the formulas for table salt, NaCl, and water, H₂O, indicate about these compounds?

Chemical Bonds

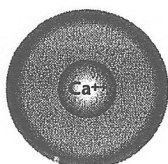
- 10. Sea salt contains calcium chloride (CaCl₂), an ionic compound similar to table salt. One atom of calcium (atomic number 20) bonds to two atoms of chlorine (atomic number 17). Fill in the number of protons and electrons in each ion.



Chloride ion

Protons _____

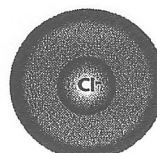
Electrons _____



Calcium ion

Protons _____

Electrons _____



Chloride ion

Protons _____

Electrons _____

- 11. What is the difference between an ionic bond and a covalent bond?

- 12. How are chemical bonds important in metabolism?
