



BASIC CHEMISTRY

Everything in the universe is composed of one or more elements, the unique building blocks of all matter. Although over 100 elemental substances exist, only four of these (carbon, hydrogen, oxygen, and nitrogen) make up more than 96% of all living material.

The student activities in this chapter consider basic concepts of both inorganic and organic chemistry. Chemistry is the science that studies the composition of matter. Inorganic chemistry studies the chemical composition of nonliving substances that (generally) do not contain carbon. Organic chemistry studies the carbon-based chemistry (or biochemistry) of living organisms, whether they are maple trees, fish, or humans.

Understanding of atomic structure, bonding behavior of elements, and the structure and activities of the most abundant biologic molecules (proteins, fats, carbohydrates, and nucleic acids) is tested in various ways. Mastering these concepts is necessary to understand how the body functions.

CONCEPTS OF MATTER AND ENERGY

1. Select *all* phrases that apply to each of the following statements and insert the letters in the answer blanks.

- _____ 1. The energy located in the bonds of food molecules:
- | | |
|----------------------------------|---|
| A. is called thermal energy | C. causes molecular movement |
| B. is a form of potential energy | D. can be transformed to the bonds of ATP |
- _____ 2. Heat is:
- | | |
|-----------------------|-----------------------|
| A. thermal energy | C. kinetic energy |
| B. infrared radiation | D. molecular movement |
- _____ 3. Whenever energy is transformed:
- | | |
|--|-----------------------------|
| A. the amount of useful energy decreases | C. some energy is created |
| B. some energy is lost as heat | D. some energy is destroyed |

2. Use choices from the key to identify the energy *form* in use in each of the following examples.

Key Choices

A. Chemical

B. Electrical

C. Mechanical

D. Radiant

- _____ 1. Chewing food
- _____ 2. Vision (two types, please—think!)
- _____ 3. Bending your fingers to make a fist
- _____ 4. Breaking the bonds of ATP molecules to energize your muscle cells to make that fist
- _____ 5. Lying under a sunlamp

COMPOSITION OF MATTER

3. Complete the following table by inserting the missing words.

Particle	Location	Electrical charge	Mass
		+ 1	
Neutron			
	Orbitals		

4. Insert the *chemical symbol* (the chemist's shorthand) in the answer blank for each of the following elements.

- _____ 1. Oxygen _____ 4. Iodine _____ 7. Calcium _____ 10. Magnesium
- _____ 2. Carbon _____ 5. Hydrogen _____ 8. Sodium _____ 11. Chlorine
- _____ 3. Potassium _____ 6. Nitrogen _____ 9. Phosphorus _____ 12. Iron

5. Using the key choices, select the correct responses to the following descriptive statements. Insert the appropriate answers in the answer blanks.

Key Choices

A. Atom

C. Element

E. Ion

G. Molecule

I. Protons

B. Electrons

D. Energy

F. Matter

H. Neutrons

J. Valence

- _____ 1. An electrically charged atom or group of atoms
- _____ 2. Anything that takes up space and has mass (weight)

- _____ 3. A unique substance composed of atoms having the same atomic number
- _____ 4. Negatively charged particles, forming part of an atom
- _____ 5. Subatomic particles that determine an atom's chemical behavior, or bonding ability
- _____ 6. The ability to do work
- _____ 7. The smallest particle of an element that retains the properties of the element
- _____ 8. The smallest particle of a compound, formed when atoms combine chemically
- _____ 9. Positively charged particles forming part of an atom
- _____ 10. Name given to the electron shell that contains the most reactive electrons
- _____ 11. _____ 12. Subatomic particles responsible for most of an atom's mass
6. For each of the following statements that is true, insert *T* in the answer blank. If any of the statements are false, correct the underlined term by inserting your correction in the answer blank.
- _____ 1. Na^+ and K^+ are needed for nerve cells to conduct electrical impulses.
- _____ 2. The atomic number of oxygen is 8. Therefore, oxygen atoms always contain 8 neutrons.
- _____ 3. The greater the distance of an electron from the nucleus, the less energy it has.
- _____ 4. Electrons are located in more or less designated areas of space around the nucleus called orbitals.
- _____ 5. An unstable atom that decomposes and emits energy is called retroactive.
- _____ 6. Iron is necessary for oxygen transport in red blood cells.
- _____ 7. The most abundant negative ion in extracellular fluid is calcium.
- _____ 8. The element essential for the production of thyroid hormones is magnesium.
- _____ 9. Calcium is found as a salt in bones and teeth.

MOLECULES, CHEMICAL BONDS, AND CHEMICAL REACTIONS

7. Match the terms in Column B to the chemical equations listed in Column A. Enter the correct letter or term in the answer blanks.

Column A	Column B
_____ 1. $A + B \rightarrow AB$	A. Decomposition
_____ 2. $AB + CD \rightarrow AD + CB$	B. Exchange
_____ 3. $XY \rightarrow X + Y$	C. Synthesis

8. Figure 2-1 is a diagram of an atom. Select two different colors and use them to color the coding circles and corresponding structures on the figure. Complete this exercise by responding to the questions that follow, referring to the atom in this figure. Insert your answers in the answer blanks provided.

- ☐ Nucleus
- ☐ Electrons

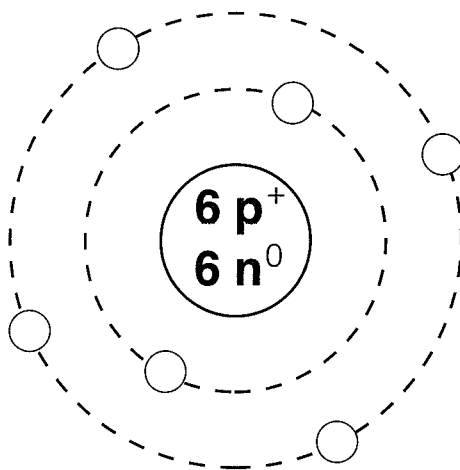
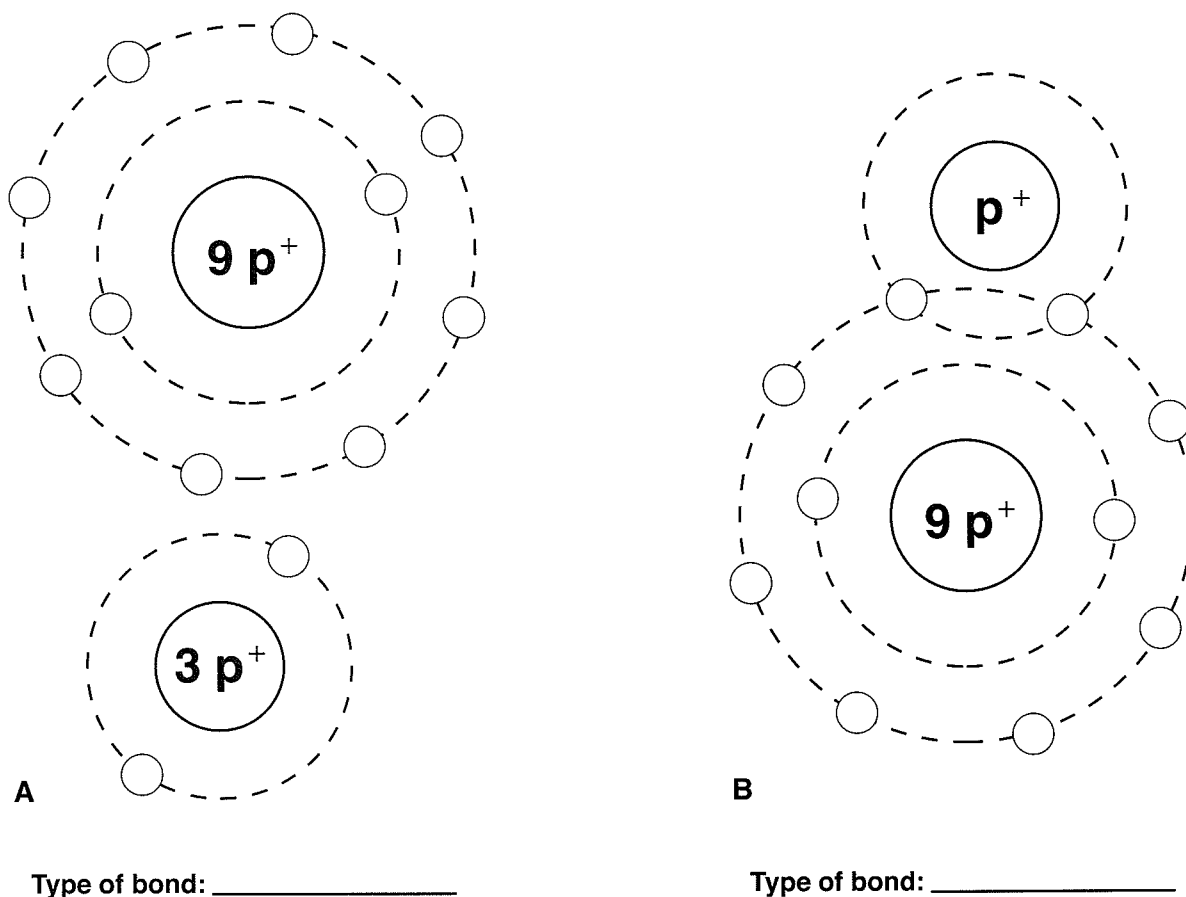


Figure 2-1

- What is the atomic number of this atom? _____
- What is its atomic mass? _____
- What atom is this? _____
- If this atom had one additional neutron but the other subatomic particles remained the same as shown, this slightly different atom (of the same element) would be called a(n) _____
- Is this atom chemically active or inert? _____
- How many electrons would be needed to fill its outer (valence) shell? _____

7. Would this atom most likely take part in forming ionic or covalent bonds? _____ Why? _____
-
9. Both H_2O_2 and 2OH^- are chemical species with two hydrogen atoms and two oxygen atoms. Briefly explain how these species are different:
-
-
10. Two types of chemical bonding are shown in Figure 2-2. In the figure, identify each type as a(n) *ionic* or *covalent* bond. In the case of the ionic bond, indicate which atom has lost an electron by adding a colored arrow to show the direction of electron transfer. For the covalent bond, indicate the shared electrons.

**Figure 2-2**

11. Figure 2-3 illustrates five water molecules held together by hydrogen bonds. First, correctly identify the oxygen and hydrogen atoms both by color and by inserting their atomic symbols on the appropriate circles (atoms). Then label the following structures in the figure:

- ☐ Oxygen
- ☐ Hydrogen
- ☐ Positive pole (end)
- ☐ Negative pole (end)
- ☐ Hydrogen bonds

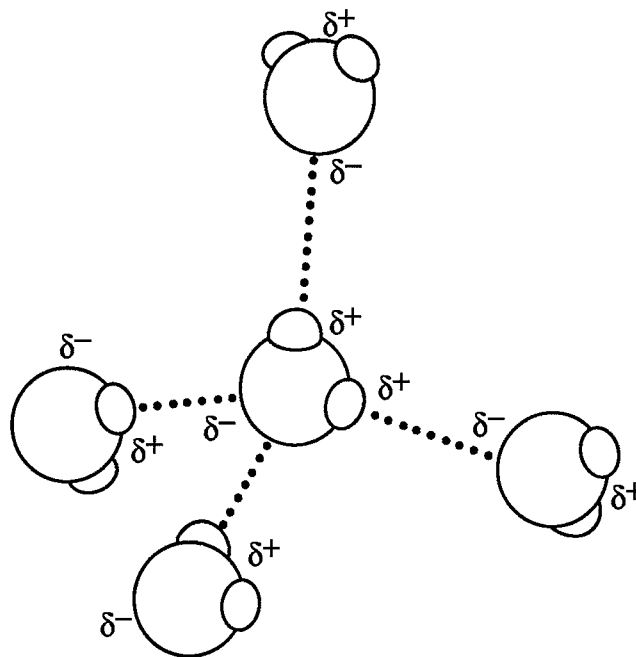
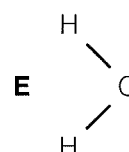
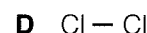
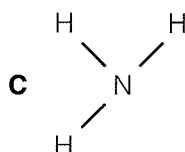
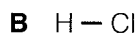
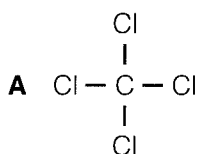


Figure 2-3

12. Circle each structural formula that is *likely* to be a polar covalent compound.



13. Respond to the instructions following the equation:



- In the space provided, list the chemical formula(s) of compounds. _____
- In the space provided, list the chemical formula(s) of ions. _____
- Circle the product(s) of the reaction.
- Modify the equation by adding a colored arrow in the proper place to indicate that the reaction is reversible.