

CHAPTER ONE

An Introduction to Chemistry

SELF-EVALUATION SECTION

We will begin your use of the study guide with some straight-forward exercises followed by a quick mathematics section. As mentioned in the introduction, the use of mathematics is very important for your success in chemistry.

1. The scientific method is a general approach to answer questions or solve problems. Each of the following statements is missing an "action verb" which is to be selected from the list below.

Use these verbs to fill in the blanks:

- formulate
- modify
- analyze
- plan and do
- collect

- (1) \_\_\_\_\_ the facts or data that are relevant to the question which is usually done by experimentation.
- (2) \_\_\_\_\_ the data to find trends.
- (3) \_\_\_\_\_ a hypothesis that will account for the accumulated data and can be tested by further experimentation.
- (4) \_\_\_\_\_ additional experiments to test the hypothesis.
- (5) \_\_\_\_\_ the hypothesis as necessary so that it is compatible with all pertinent data.

2. Match the correct definition to each of the following terms.

- |                   |       |  |
|-------------------|-------|--|
| (1) macroscopic   | _____ | molecular view of substances                         |
| (2) amorphous     | _____ | indefinite shape, definite volume                    |
| (3) mixture       | _____ | the big picture; everyday objects                    |
| (4) gas           | _____ | containing two or more physically distinct phases    |
| (5) microscopic   | _____ | a solid lacking a regular internal geometric pattern |
| (6) liquid        | _____ | indefinite shape, no fixed volume                    |
| (7) heterogeneous | _____ | contains two or more substances                      |

3. Fill in the blank.

- (1) If a solid is not amorphous, it is \_\_\_\_\_.
- (2) If a mixture is not heterogeneous, it is \_\_\_\_\_.
- (3) If a material is not a mixture, it is a \_\_\_\_\_.

4. All matter in the universe can be classified into one of three states - gas, liquid, or solid. Determine to which of the three states of matter each of the following descriptions relates.

Description	States of Matter
(1) Has a definite fixed shape.	_____
(2) Particles flow over each other while retaining fixed volume.	_____
(3) Exerts a pressure on all walls of the container.	_____
(4) Exhibits no or very slight compressibility.	_____
(5) Particles move independently of each other.	_____
(6) Particles arranged in regular, fixed geometric pattern.	_____
(7) Exhibits slight compressibility.	_____
(8) Exhibits very high compressibility.	_____

5. Examine the following list of items. Some are mixtures, others are elements or compounds. Place an S next to the pure substance and an M next to the mixtures.

- (1) wood \_\_\_\_\_
- (2) sodium chloride \_\_\_\_\_
- (3) milk \_\_\_\_\_
- (4) oxygen \_\_\_\_\_
- (5) rubber \_\_\_\_\_
- (6) water \_\_\_\_\_
- (7) air \_\_\_\_\_
- (8) chlorine \_\_\_\_\_
- (9) soil \_\_\_\_\_
- (10) gasoline \_\_\_\_\_

6. As a good way to check your readiness to begin a course in chemistry, work through the following mathematical problems. Many students have found it helpful in determining areas to be reviewed.

Circle the response for each of the questions.

- (a) The problem is worked correctly.
- (b) The problem has been worked incorrectly.

- (1)  $2/4 = 0.33$  a b
- (2)  $1/16 = 0.0625$  a b
- (3)  $1/10 = 0.01$  a b
- (4)  $30/6 = 0.5$  a b
- (5)  $1/3 \times 4/5 = 5/8$  a b
- (6)  $1/2 + 1/4 = 2$  a b
- (7)  $3/4 + 3/5 = 3/20$  a b
- (8)  $1/3 - 1/4 = 1/12$  a b
- (9)  $\frac{2 \times 4 \times 3}{6 \times 2} = 2$  a b
- (10)  $10^4 = 100$  a b
- (11)  $\sqrt{25} = 5$  a b
- (12)  $2^3 = 6$  a b
- (13)  $\sqrt[3]{8} = 2$  a b
- (14)  $6^2 \times 6^3 = 6^6$  a b
- (15)  $9^4 = 9$  a b
- (16)  $\frac{a^7}{a^{10}} = a^{-3}$  a b
- (17)  $6.9 \times 10^3 = 690$  a b
- (18)  $0.0054 = 5.4 \times 10^{-3}$  a b
- (19)  $(2 \times 10^2)(5 \times 10^4) = 10^6$  a b
- (20)  $(5 \times 10^{-3})(3 \times 10^5) = 1.5 \times 10^2$  a b
- (21) 1594.61 rounded off to four figures is 1596 a b

Do your calculations  
in this space  
or on scratch paper

1. In order to handle large numbers efficiently, it is worthwhile to use scientific notation, which means writing a number as a power of 10. The numbers are always written between 1 and 10 with the associated power of 10.

(1) Express the following numbers as powers of 10:

- 0.0305 \_\_\_\_\_
- 29 \_\_\_\_\_
- 0.000721 \_\_\_\_\_
- 680,000,000 \_\_\_\_\_
- 36,800 \_\_\_\_\_

(2) Express the following in decimal form:

- $4.77 \times 10^4$  \_\_\_\_\_
- $8.41 \times 10^{-2}$  \_\_\_\_\_
- $5.8 \times 10^1$  \_\_\_\_\_
- $9.1 \times 10^0$  \_\_\_\_\_
- $1.415 \times 10^6$  \_\_\_\_\_

2. Express the following numbers in exponential form:

- (1) 67,000 \_\_\_\_\_ (4) 0.00078 \_\_\_\_\_
- (2) 0.0654 \_\_\_\_\_ (5) 411,000 \_\_\_\_\_
- (3) 10,000,000 \_\_\_\_\_ (6) 10 \_\_\_\_\_

3. Express the following numbers in decimal form:

- (1)  $4.8 \times 10^3$  \_\_\_\_\_ (4)  $1074 \times 10^{-2}$  \_\_\_\_\_
- (2)  $0.67 \times 10^2$  \_\_\_\_\_ (5)  $0.0034 \times 10^3$  \_\_\_\_\_
- (3)  $0.151 \times 10^{-5}$  \_\_\_\_\_ (6)  $11 \times 10^{-5}$  \_\_\_\_\_

## CHAPTER THREE

## Elements and Compounds

## SELECTED CONCEPTS REVISITED

The case of the symbols used is exceedingly important especially if you turn in hand-written work. For example, CA, Ca, and ca are unacceptable as a symbol for calcium. The correct symbol is Ca. Using the appropriate sizes and cases (upper versus lower) of letters is crucial.

Many instructors provide you with a periodic table for use during quizzes, tests etc. Although the periodic table shows symbols, most tables do not have the names of the elements. You will most likely have to learn the names of the most common ones. A couple symbols that students seem to get backwards often are P and K. P is phosphorus, K is potassium. The more you use these symbols, the faster you will learn the names.

Being able to identify metals vs. metalloids vs. nonmetals will be invaluable as you learn more about the reactivity of elements and compounds. Remember that the first few chapters of the text form the foundation of your chemistry knowledge.

Elements found in nature are not necessarily found in their elemental form. For example, although gold is often found in a relatively pure state, aluminum is generally found as a part of a compound (or compounds) that must be chemically converted to pure elemental aluminum.

## COMMON PITFALLS TO AVOID

It is important that subscripts are written as such and that parenthesis are in the appropriate position relative to the subscripts. CuCN is not the same as CuCN<sub>2</sub>, which is not the same as Cu(CN)<sub>2</sub>.

Double-check all chemical formulas in both typewritten and handwritten work. When writing or typing Co, did you mean Co for Cobalt, or CO for carbon monoxide? Is Pb referring to lead (Pb) or phosphorus and boron? Is Mn supposed to be Mn for manganese or MN for a metal-nitrogen compound? Be aware that word-processing programs often automatically change the second letter of a word that has been capitalized back to lower case letters. Spell-check programs do not usually recognize chemical symbols.

1. Fill in the missing word(s) from each sentence.

The building blocks of all substances are called (1) \_\_\_\_\_; at least 88 occur naturally on earth.

(2) \_\_\_\_\_ are composed of two or more elements chemically combined.

When an element is subdivided into smaller and smaller pieces, the final indivisible particle that is left is called an (3) \_\_\_\_\_.

When a compound, such as sugar, is subdivided into smaller and smaller pieces, the final indivisible particle that retains the identity of sugar, is called a (4) \_\_\_\_\_.

Some compounds are formed from electrically charged species called (5) \_\_\_\_\_.

Positively charged ions are called (6) \_\_\_\_\_ and negatively charged ions are called (7) \_\_\_\_\_.

True or False

(1) Atoms can combine only in simple whole number ratios.

(2) Ionic compounds can be broken down into molecules.

(3) There are over 100 known elements.

(4) A chemical compound retains the identities of its component elements.

3. Fill in the blank spaces.

All the elements, regardless of origin, can be classified into three subgroups: metals, (1) \_\_\_\_\_ and (2) \_\_\_\_\_.

Metals, except, for mercury, are in the (3) \_\_\_\_\_ state at room temperature.

Common characteristics of metals include that, they are good conductors of (4) \_\_\_\_\_ and (5) \_\_\_\_\_ and usually appear (6) \_\_\_\_\_.

Metals are also (7) \_\_\_\_\_, which means they can be drawn into wires, and are (8) \_\_\_\_\_, which means they can be flattened into sheets.

Most metals have (9) \_\_\_\_\_ melting points and (10) \_\_\_\_\_ densities.

Silicon and arsenic are examples of (11) \_\_\_\_\_.

Metals tend to react mainly with (12) \_\_\_\_\_ elements while nonmetals will react with any of the three subgroups.

There are (13) \_\_\_\_\_ elements that occur naturally as diatomic molecules and they are

(14) \_\_\_\_\_ (name all).

Most of the diatomic elements are gases, but (15) \_\_\_\_\_ is a liquid and (16) \_\_\_\_\_ is a solid at room temperature.

4. Write the chemical symbol for the five most abundant elements in the earth's crust, seawater, and atmosphere. Also write the six most abundant elements in the human body. Which elements are common to both lists?

Earth's Chemicals

- a. \_\_\_\_\_  
 b. \_\_\_\_\_  
 c. \_\_\_\_\_  
 d. \_\_\_\_\_  
 e. \_\_\_\_\_  
 f. \_\_\_\_\_

Human Body

- a. \_\_\_\_\_  
 b. \_\_\_\_\_  
 c. \_\_\_\_\_  
 d. \_\_\_\_\_  
 e. \_\_\_\_\_  
 f. \_\_\_\_\_

Elements common to both:

5. Although students are often not asked to memorize the periodic table, knowing the symbols for some of the more common elements will be to the student's advantage. Please write the chemical symbol or name as appropriate for each element below.

Si	_____	Mn	_____
S	_____	Mg	_____
Na	_____	Mercury	_____
N	_____	Gold	_____
Ni	_____	Silver	_____
Phosphorus	_____	Lead	_____
Potassium	_____	Tungsten	_____
C	_____	Tin	_____
Cu	_____	Titanium	_____
Co	_____	B	_____
Calcium	_____	Ba	_____
Cadmium	_____	Br	_____

6. Look at the following list of chemicals. From what you've learned in Chapter 3, try to identify each formula as to whether it represents a compound or not, and if the formula is that of a compound whether the compound is molecular or ionic in nature as described in Chapter 3.

Formula	Compound? Yes or No	If yes then	Molecular	or	Ionic
(1) Br <sub>2</sub>	_____	_____	_____	_____	_____
(2) CO <sub>2</sub>	_____	_____	_____	_____	_____
(3) S <sub>8</sub>	_____	_____	_____	_____	_____
(4) NH <sub>3</sub>	_____	_____	_____	_____	_____
(5) H <sub>2</sub> O	_____	_____	_____	_____	_____
(6) CCl <sub>4</sub>	_____	_____	_____	_____	_____
(7) Pb	_____	_____	_____	_____	_____
(8) KCl	_____	_____	_____	_____	_____
(9) Ar	_____	_____	_____	_____	_____
(10) NaI	_____	_____	_____	_____	_____

7. How many atoms of nitrogen are contained in each of the following formulas?

(1) N <sub>2</sub> Co(NO <sub>2</sub> ) <sub>6</sub>	_____
(2) NH <sub>4</sub> S <sub>2</sub> O <sub>8</sub>	_____
(3) NH <sub>4</sub> C <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	_____
(4) NH <sub>4</sub> CNS	_____
(5) N <sub>2</sub> Fe(CN) <sub>6</sub> NO • 2 H <sub>2</sub> O	_____
(6) K <sub>3</sub> Fe(CN) <sub>6</sub>	_____
(7) Fe <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> • 24 H <sub>2</sub> O	_____