# Project EASE

(Effective and Alternative Secondary Education)

# INTEGRATED SCIENCE I

## MODULE 6

BUREAU OF SECONDARY EDUCATION
Department of Education
DepED Complex, Meralco Avenue
Pasig City

# Module 6
# Behavior of Matter

You have learned how to classify matter in terms of the properties common to them. These properties are those that can be observed by our senses. Have you ever wondered how these properties came about and what matter is made of?

## What this module is about

This module presents activities that lead to your understanding of the structure of matter and the behavior of the particles of matter describing the chemical reactions of substances in our environment.

As you study the structure of matter, the simplest question you must ask is "What is matter?" You have already learned that matter occupies space and has mass. In this module, you will investigate more deeply into matter, take it apart and find out what it is made of.

You will study the following lessons in this module:

- **Lesson 1 - Structure of Matter**
- **Lesson 2 - Molecular Theory of Matter and its Evidences**
- **Lesson 3 - Symbols and Chemical Formulas**
- **Lesson 4 - Chemical Reactions**

## What you are expected to learn

After going through the module, you are expected to:

1. use models to describe atoms and molecules;
2. state molecular theory to explain some properties of matter;
3. identify the formula of common atoms and molecules; and
4. explain chemical reactions of substances.

## How to learn from this module

Here's a simple guide for you in going about the module

- Read the instructions carefully.
- Follow the instructions very carefully.
- Answer the pre-test in order to determine how much you already know about the lessons in this module.
- Check your answers against the given answer key at the end of this module.
- Read each lesson and do activities that are provided for you.
- Perform all the activities diligently to help and guide you in understanding the topic.
- Take the self-test after each lesson to determine how much you understood the topic.
- Answer the post-test to measure how much you have gained from the lessons.

**Good Luck and have fun!**

## What to do before (Pretest)

**Direction: Fill in the blank/s to complete the statements. Choose your answer on the list of words below.**

**Key Terms:**

**Atoms, elements, compounds, radioactive, nucleus, electrons, protons, neutron, atomic number, atomic mass, isotopes, shells, nuclear force, metals, non-metals, mixtures, solution, molecule, symbol, chemical formula, ionic bond, covalent bond, ion, physical property, chemical property, reactants, products, Law of conservation of mass, catalysts, acids, basis, salts, activation energy, chemical equation, composition, decomposition, single replacement, double replacement**

1. Scientists call a group of symbols and numbers that stands for a compound a/an _______________.

2. The central part of an atom is called the _______________.

3. Matter that is made up of only one kind of atom is a/an ______________.

4. The number of protons represents the number of _____________.

5. A substance formed when atoms of different elements combine is a/an _______________.

6. A tiny particle that travels around the nucleus is called the __________.

7. The number of protons and neutrons is equal to ______________.

8. _________ are elements that have luster and are good conductors of electricity.

9. A charged atom is a/an __________.

10. A bond in which electrons are shared between two atoms is a/an ___________ bond.

11. A mixture that is the same throughout is called a/an _____________.

12. A property of matter that retains its identity after a reaction is called ___________.

13. ___________ are formed when two or more atoms join together.

14. A __________ is a substance that speeds up the chemical reactions.

15. The energy needed to start a chemical reaction is called __________________.

16. What type of reaction is shown by this equation: $H_2O \longrightarrow H_2 + O_2$?

17. A/an ______________ produces $H^+$ ions in a liquid solution.

18. A/an ______________ produces $OH^-$ ion in a liquid solution.

19. _______________________ states that no atoms disappear and no atoms are formed in a chemical reaction.

20. _______________ are the electrons on its farthest or outermost electron shell.

Key to answers on page 23

## Lesson 1 Structure of Matter

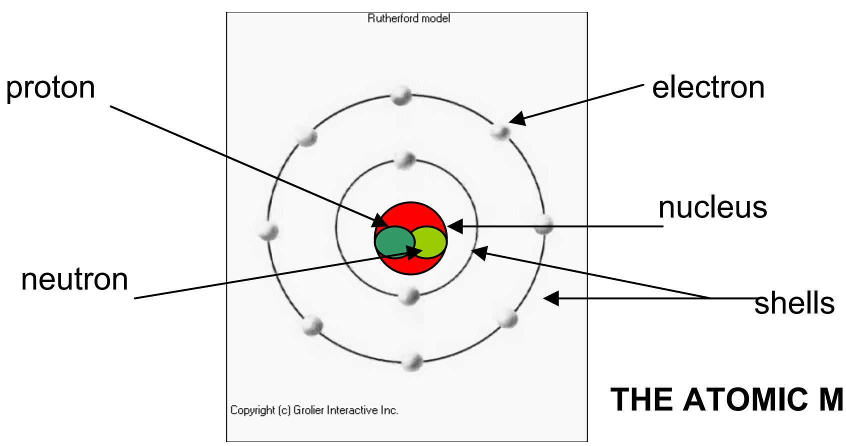
### Atomic Structure

This lesson tackles the structure of matter. Matter is composed of tiny particles called atom. An atom is the smallest particle of an element. Atoms of different elements may also combine into systems called molecules, which are the smallest units of chemical compounds. These are also considered as the ultimate building blocks of matter.

But what are atoms made of? What makes one type of atom different from another? A careful study of the atom shows that it has a small but dense core called the ***nucleus.*** The nucleus is composed of ***protons*** the positively charged particle and the ***neutrons***, the particle with no charge. Around the nucleus is the ***electron***, the negatively charged particle.

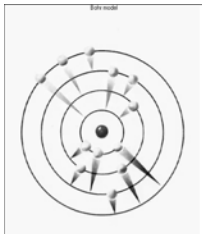
These subatomic particles were discovered by scientists who were performing experiments about atom: the electron by J.J. Thomson; the nucleus by Ernest Rutherford; the proton by Eugene Goldstein; and the neutron by James Chadwick.

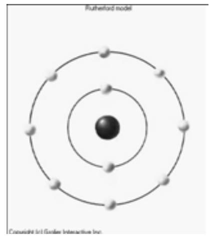
Study this diagram of the atom.

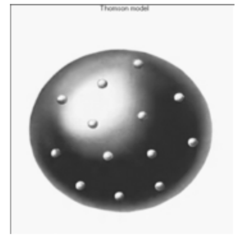


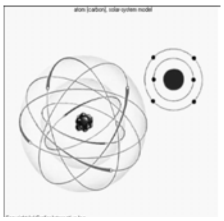

**THE ATOMIC MODEL**

Scientists agree on the idea of an atom having these particles – the protons and the neutrons in the nucleus and the electrons around the nucleus. However, they represent the atomic models differently as shown by the diagrams:

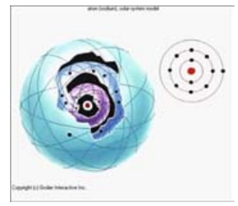

BOHR MODEL


RUTHERFORD MODEL


THOMSON MODEL

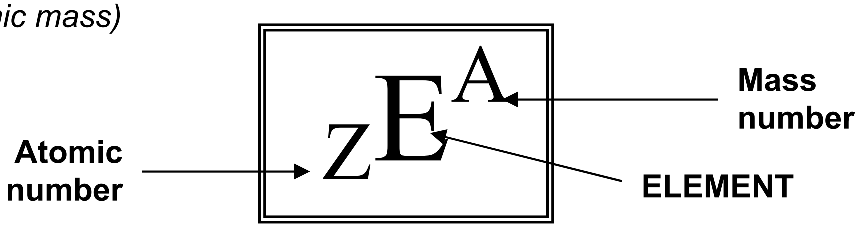

SOLAR SYSTEM MODEL


CARBON ATOM MODEL


SODIUM ATOM MODEL

The studies by Rutherford and other scientists showed both the neutron and the proton have a mass that is 1,800 times larger than the electrons. This explains why most of the mass of an atom is concentrated in the nucleus.

The total number of protons in a given atom determines the atomic number of an element. The atomic number is the number of protons (positively charged elementary particles) in the nucleus of one of its atoms. If the atom is electrically neutral, the same number of electrons is present, since the number of protons is equal to the number of electrons. The atomic mass or mass number is the sum of an atom's protons and neutrons that are always expressed in whole numbers. Atomic number is the subscript to the left and the atomic mass is the superscript to the right of a chemical symbol of an element found in the Periodic Table of Elements. For example, $_6C^{12}$ indicates a carbon atom of atomic mass 12 and atomic number 6, the difference being equal to the number of neutrons in the nucleus. This means for $_6C^{12}$**,** there are 6 protons and 6 neutrons, and it follows that it has 6 electrons, too. (*In other presentations of The Modern Periodic Table, the superscript is the atomic number and the subscript is the atomic mass. The atomic number is always less than the atomic mass)*




In most nuclei, the number of neutrons is equal to or slightly greater than the number of protons. As the elements get more massive, they tend to have an excess number of neutrons. For example, the nucleus of uranium, the heaviest natural element, has 146 neutrons and 92 protons **(**$_{92}U^{238}$**)**.

## Molecules and Chemical Bonds

Sometimes the atoms of an element are found alone. At other times they are found joined together. When two or more atoms combine, whether these are the same or different, they form a **molecule**. If these two or more molecules are fitted to combine, a chemical bond is formed.

There are three types of chemical bonds: ionic bond, covalent bond and metallic bond.

An **ionic bond** is formed when one atom shifts or transfers an electron to another atom. This happens commonly when atoms with one valence electron, the alkali metals, elements in Group IA are combined with seven valence electrons, the halogens or elements belonging to Group VIIA. A good example is table salt. When sodium ($Na^+$) reacts with chlorine ($Cl^-$), they form the molecule sodium chloride (table salt), which is written as NaCl. Elements in Group IIA may combine with elements in Group VIA. In general, atoms will form chemical bonds if the bonding will cause all atoms involved to have a stable outer electron shell or eight electrons. This rule is called the **OCTET RULE**. It states that atoms are in stable condition when the outermost electron shell has eight electrons.

Sometimes atoms form bonds in which they share electrons. This is called **covalent bond**. Water **($H_2O$)** is an example of covalent bond. Two electrons, one from each atom of hydrogen, is shared with one atom of oxygen, since oxygen needs two more electrons for it to become stable. Another example is carbon dioxide,**($CO_2$).** Carbon from Group IVA has four valence electrons. It can complete its outer shell by sharing two pairs of electrons with one oxygen atom and two pairs with another one.

The last type is the **metallic bond**. While in ionic and covalent bonds, a metal combines with a non-metal, in metallic bond, a metal shares electrons with another metal.

## *What you will do*
**Activity 1.1**

**Complete the table below:**

| ELEMENT | ATOMIC NUMBER | ATOMIC MASS | NUMBER OF PROTONS | NUMBER OF NEUTRONS | NUMBER OF ELECTRONS |
|---|---|---|---|---|---|
| **Lithium** | 3 | 7 | | | |
| **Magnesium** | 12 | 24 | | | |
| **Aluminum** | 13 | 27 | | | |
| **Calcium** | 20 | 40 | | | |
| **Silicon** | 14 | 28 | | | |
| **Lead** | 82 | 207 | | | |
| **Copper** | 29 | 64 | | | |
| **Silver** | 47 | 108 | | | |
| **Gold** | 79 | 197 | | | |
| **Nitrogen** | 7 | 14 | | | |

**Key to answers on page 24**

How did you determine the number of protons, number of electrons and the number of neutrons?

## *What you will do*
**Activity 1.2**

Given: Table of compounds with their molecular formula

| MOLECULE / COMPOUND | MOLECULAR FORMULA |
|---|---|
| Table salt | $NaCl$ |
| Vinegar | $CH_3COOH$ |
| Table sugar | $C_{12}H_{22}O_{11}$ |
| Muriatic acid | $HCl$ |
| Salitre | $KNO_3$ |
| Agua oxigenada | $H_2O_2$ |
| Rust | $Fe_2O_3$ |
| Sand | $SiO$ |
| Naphthalene ball | $C_{10}H_5$ |
| White wash | $Ca(OH)_2$ |
| Washing soda | $CaCO_3$ |

**Complete the table below. Refer to Table of Compounds and their Molecular formula for your answer: The first two (2) numbers were done for you.**

| Molecule/ Compound | Chemical Formula | Elements Present | No. of Atoms in each element | Total No. of Atoms Present |
|---|---|---|---|---|
| Table salt | $NaCl$ | Na & Cl | 1 Na & 1 Cl | 2 |
| Vinegar | $CH_3COOH$ | C, O & H | 2 C; 4 H & 2 O | 8 |
| Table sugar | $C_{12}H_{22}O_{11}$ | | | |
| Muriatic acid | $HCl$ | | | |
| Salitre | $KNO_3$ | | | |
| Agua oxigenada | $H_2O_2$ | | | |
| Rust | $Fe_2O_3$ | | | |
| Sand | $SiO$ | | | |
| Naphthalene ball | $C_{10}H_5$ | | | |
| White wash | $Ca(OH)_2$ | | | |
| Washing soda | $CaCO_3$ | | | |

**Key to answers on page 24**

## *What you will do*

**Self-Test 1.1**

**Direction: Match the term in column A to the phrase that describes it in Column B. Write the letter of your answer on the space provided before each term.**

| | COLUMN A | COLUMN B |
|---|---|---|
| ____________ | 1. compound | a. number of protons and neutrons in the nucleus |
| ____________ | 2. nucleus | b. positively charged particles in the nucleus |
| ____________ | 3. neutron | c. small but dense core of the atom |
| ____________ | 4. proton | d. negatively charged particle outside the nucleus of an atom |
| ____________ | 5. shells | e. energy states in which the electrons of an atom can exist |
| ____________ | 6. molecules | f. combination of two or more elements |
| ____________ | 7. ionic bond | g. used to represent a compound |
| ____________ | 8. metallic bond | h. particle in the nucleus with no charge |
| ____________ | 9. covalent bond | i. number of protons in the nucleus |
| ____________ | 10. chemical formula | j. element having the same atomic number but different atomic mass |

| | | |
|---|---|---|
| ____________ | 11. atomic number | k. this is formed when atoms combine |
| ____________ | 12. isotopes | l. states that eight electrons are needed to attain stability |
| ____________ | 13. electron | m. involves a shift or transfer of electron from one atom to another atom |
| ____________ | 14. atomic mass | n. involves a sharing of electrons in metals to another metal |
| ____________ | 15. octet rule | o. involves a sharing of electron in different kinds of atoms |

**Key to answers on page 24**

## Lesson 2 Molecular Theory of Matter

This lesson discusses the molecular theory of matter. The assumption that molecules are constantly moving is called the kinetic molecular theory of matter. That matter exerts force on another matter is an evidence of molecular force.

The following are some of the evidences that support the molecular theory:

1. **diffusion** – the intermingling of the molecules of a substance with the molecules of the air
2. **capillarity** – the rise of liquid on a fine or hair-like tube
3. **surface tension** – the formation of a temporary membrane on the surface of a liquid
4. **osmosis** – the passage of liquid from a semi-permeable membrane or from a liquid of greater concentration to a liquid of lesser concentration
5. **Cohesion** – the attraction between like or the same kind of molecules
6. **Adhesion** – the attraction between unlike or different kinds of molecules

### *What you will do*

**Activity 2.1**

**Perform the following activities and answer the question after each procedure**.

1. Open a bottle of rubbing alcohol. Do you smell something?

   ____________________________________________________________

This evidence is called **diffusion**. The molecules of alcohol mix with the molecules of the air, and since the air is constantly moving, the smell spread throughout.

Cite other examples:

2. Pour a few drops of water in a saucer. Cut a piece of tissue paper into strips. Put one end of the strip of tissue paper into the water. Observe.

This shows the ability of matter to rise on a fine or hair-like tube. This is called **Capillarity**. Since the tissue paper has these hair-like structures on its surface, the water clings to it and rises. Also, the tissue is absorbent. **Adhesion** is also evident. The molecules of water adhere to the molecules of the tissue. Adhesion is the attraction between unlike molecules.

Cite other examples:

3. Using a medicine dropper, put about two drops of water on top of a glossy or shiny table. Observe. Describe the shape of the water drops.

This shows that molecules of matter are cohesive. **Cohesion** is the force of attraction between molecules that are alike.

Cite other examples:

4. Add a drop of liquid soap on a basin with water. Observe. Touch it using your finger. What did you observe?

This is what we call **surface tension**. It is the ability of matter to form a temporary membrane. In this case, cohesive force is less than adhesive force.

Cite other examples:

**Key to answers on page 24**

## *What you will do*

**Self-Test 2.1**

**Direction: Choose the letter of the best answer:**

1. What idea about matter explains molecular theory?
    a. Matter exists in three phases.
    b. Matter is made up of small particles.
    c. Molecules of matter are always moving.
    d. Matter cannot occupy space filled up by another object.

2. Diffusion causes molecules to spread throughout the medium. In which of the following is there a faster rate of diffusion?
    a. ink in water
    b. acetone in air
    c. salt in water
    d. food color in gelatin

3. Why is the surface of a lake level?
    a. Cohesive force exists.
    b. Adhesive force exists.
    c. Adhesive force is greater than cohesive force.
    d. Cohesive force is greater than adhesive force.

4. Soap bubbles easily break. This is an example of
    a. brittleness
    b. adhesion
    c. cohesion
    d. surface tension

5. What evidence of molecular theory is portrayed in the advertisement of "Mr. Clean"? (*when a lady keeps on following the man carrying a plank of wood*)
    a. adhesion
    b. cohesion
    c. diffusion
    d. surface tension

**Key to answers on page 26**

## Lesson 3 Symbols and Chemical Formulas

This next lesson will teach you how to read symbols of elements from the Periodic Table and how to write chemical formula given the names of the compounds.

For many years, scientists particularly chemists have developed a unique system of symbols and notation designed to simplify the writing of chemical symbols, formula, and reactions. This system also shows the mathematical relations of atoms and reacting chemicals, the way atoms are put together to form complex molecules, and the type of chemical bond between atoms.

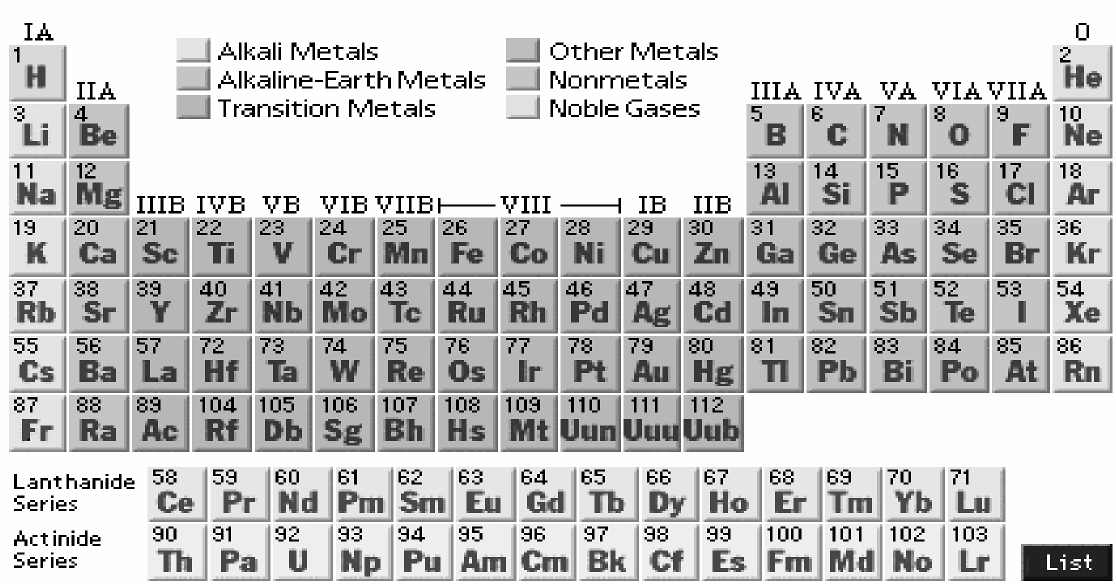
### Element and its Symbol

The early alchemists used various symbols to represent the **92** natural elements they used, a custom that was continued into the 19th century. Johann Jacob Berzelius of Sweden was the first to use letters to represent the elements. In most cases he was able to use the first letter of the name of the element as its symbol; **O** stood for **oxygen**, **C** for **carbon**, **H** for **hydrogen**, and so on. Two letters are used to distinguish between elements that have the same initial letter **N** for **nitrogen**, **Ne** for **neon**, and **Ni** for **nickel**. Sometimes the symbol is derived from the Latin name of the element; **gold (*aurum*)** is **Au, iron (*ferrum*)** is **Fe,** and **lead (*plumbum*)** is **Pb**. Whenever two letters are used for an element, the first letter is capitalized but the second is not. Thus the element **cobalt, Co**, is distinguished from the compound **carbon monoxide, CO**.

Due to the continued search for synthetic elements, aside from the 92 naturally - occurring elements, scientists found man-made elements and they devised another way of representing these elements in symbols. Some man-made elements are written in the table below:

| Element | Familiar Name or Place | Symbol of Element |
|---|---|---|
| Californium | California | Cf |
| Einsteinium | Albert Einstein | Es |
| Nobelium | Alfred Nobel (Nobel Prize) | No |
| Neptunium | Neptune | Ne |
| Plutonium | Pluto | Pu |
| Americium | America | Am |
| Berkelium | Berkeley, California | Bk |
| Curium | Marie and Pierre Curie | Cu |
| Francium | France | Fr |
| Scandium | Scandinavia | Sc |
| Polonium | Poland | Po |
| Tungsten | Wolfrom (Peter Woulf) | W |

These elements are organized in a table of elements called the periodic table. It is a classification and tabulation of the chemical elements in the order of their atomic numbers that shows elements' chemical and physical properties.




In this periodic table, the numbers on the left superscript is the atomic number of the element

## *What you will do*

**Activity 3.1**

**Write the symbol of the following elements:**

| Element | Symbol | Element | Symbol |
|---|---|---|---|
| Sodium | | Neon | |
| Mercury | | Sulfur | |
| Boron | | Radon | |
| Carbon | | Barium | |
| Nickel | | Thorium | |

**Key to answers on page 25**

## Compound and Its Chemical Formula

Two or more elements may combine by means of a chemical bond to form a compound. By combining the symbols of the participating atoms, a chemical formula is formed. A chemical formula is a group of symbols used to represent a compound. This is also called a molecular formula. More than one atom is indicated by a numerical subscript. For instance, $\mathbf{H_2O}$ means that the water molecule consists of two atoms of hydrogen and one of oxygen.

Certain combinations of atoms form stable groups called radicals or polyatomic ion, which form chemical bonds as an intact unit. The valence number of these radicals is taken as one. If a molecule contains more than one of a given radical, its written formula emphasizes this by using parentheses. Calcium phosphate, a major constituent of bones and teeth, is written $Ca_3(PO_4)_2$.

**Some Polyatomic Ions**

| **MONOVALENT** | **$1^-$** | **BIVALENT** | **$2^-$** | **TRIVALENT** | **$3^-$** |
|---|---|---|---|---|---|
| Ammonium | NH4 ($1^+$) | Carbonate | $CO_3$ | Phosphate | $PO_4$ |
| Acetate | $C_2H_3O_2$ | Chromate | $CrO_4$ | Borate | $BO_3$ |
| Chlorate | $ClO_3$ | Oxalate | $C_2O_4$ | | |
| Chlorite | $ClO_2$ | Sulfate | $SO_4$ | | |
| Bicarbonate | $HCO_3$ | Sulfite | $SO_3$ | | |
| Bisulfate | $HSO_4$ | Peroxide | $O_2$ | | |
| Hydroxide | OH | | | | |
| Nitrate | $NO_3$ | | | | |
| Nitrite | $NO_2$ | | | | |

**In writing a chemical formula, follow these rules:**

1. Write the correct symbols of the elements and the polyatomic ions.
2. Determine the charge or valence number of the elements and the ions.
3. Indicate the charge by writing it on the right superscript
4. Exchange their valence numbers using the **CRISS-CROSS METHOD**.

   Example: Write the chemical formula of the following compounds:

   a. Lithium oxide

   $Li^{1+}\ O^{2-}$ $= \mathbf{Li_2O}$

b. Magnesium chloride

$Mg^{2+} \quad Cl^{1-} \quad = \mathbf{MgCl_2}$

c. Calcium oxide:

$Ca^{2+} \quad O^{2-} \quad = \mathbf{CaO}$

(if the valence numbers are the same, no need to write them as subscript**)**

d. Calcium phosphate

$Ca^{2+} \quad (PO_4)^{3-} \quad = \mathbf{Ca_3(PO_4)_2}$

e. Hydrogen sulfate

$H^{1+} \quad (SO_4)^{2-} \quad \mathbf{= H_2SO_4}$

(if the valence number is 1, no need to write them as subscript**)**

## *What you will do*

**Activity 3.2**

**Write the chemical formula of the following compounds.**

| **COMPOND** | **FORMULA** | **COMPOUND** | **FORMULA** |
|---|---|---|---|
| Zinc oxide | | Calcium carbonate | |
| Potassium chloride | | Zinc nitrate | |
| Lithium hydride | | Aluminum nitrite | |
| Magnesium chloride | | Magnesium sulfate | |
| Hydrogen fluoride | | Sodium hydroxide | |

**Key to answers on page 25**

## *What you will do*

**Self-test 3.1**

**Direction: Write the formula of the following compound:**

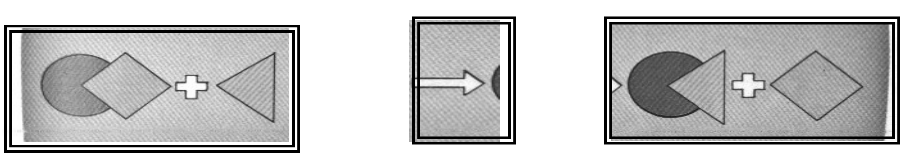
1. Sodium bromide ________________
2. Barium chloride ________________
3. Aluminum hydroxide ________________
4. Sodium oxalate ________________
5. Potassium oxide ________________
6. Nitrogen phosphate ________________
7. Hydrogen sulfide ________________
8. Zinc chloride ________________
9. Silicon oxide ________________
10. Ammonium sulfate ________________

**Key to answers on page 25**

## Lesson 4 Chemical Reactions

It is said that nothing is permanent in this world except change. Change is a good thing. Some changes take place very rapidly. Think of the burning of gasoline in a car engine or the explosion of gunpowder. Other changes like the baking of bread takes minutes or hours to occur. Still other changes such as the decay of wood or the yellowing of paper takes many days or even years.

This lesson will help you understand the different types of chemical reactions and transform these reactions into equations. In a chemical reaction, the substances that combine are called **reactants**, while the substance/s produced is/are called **product/s.** An **arrow** is used to represent a yield. Activation energy is needed to start up a chemical reaction. In order to speed up this reaction a catalyst is used.



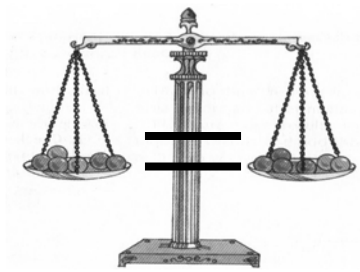
REACTANTS YIELD PRODUCTS

A **chemical equation** is used to represent a chemical reaction.

$$\mathbf{A + B \longrightarrow AB}$$

The **law of conservation of mass** is applied in writing a chemical equation. This law states that a new atom cannot be created in a chemical reaction and that the mass of the reactants is equal to the mass of the products.

**REACTANTS**



**PRODUCTS**

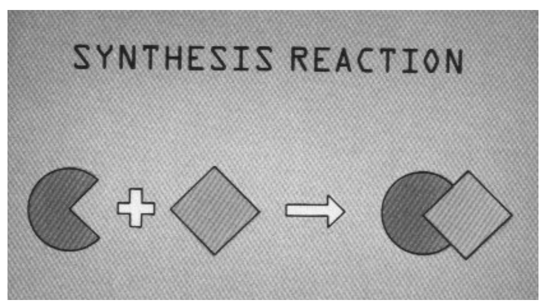
## *What you will do*

**Activity 4.1**

**There are four (4) general types of chemical reaction. Study the presentation:**

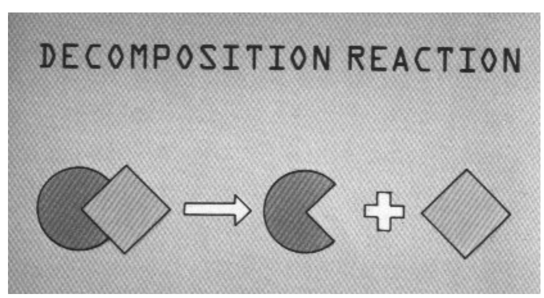
**1.** Composition or Synthesis Reaction – two or more elements combine to form one compound. $\mathbf{A + B \longrightarrow AB}$

**Ex.** $\mathbf{Na + Cl \longrightarrow NaCl}$




**2.** Decomposition or Analysis – one compound breaks into two or more other substances. $\mathbf{AB \longrightarrow A + B}$

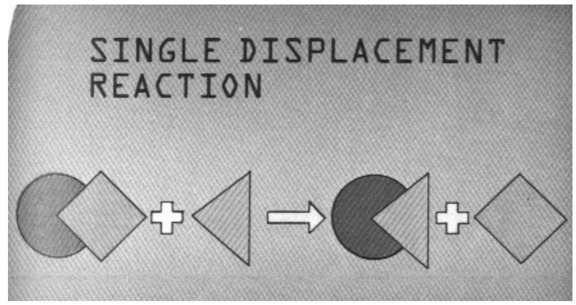
**Ex.** $\mathbf{ZnCl_2 \longrightarrow Zn + Cl_2}$



3. Single displacement – one element in the reactants replaces one of the elements in the given compound. The products are still one element and a compound.

**AB + C $\longrightarrow$ A + BC** or **AB + C $\longrightarrow$ B + AC**

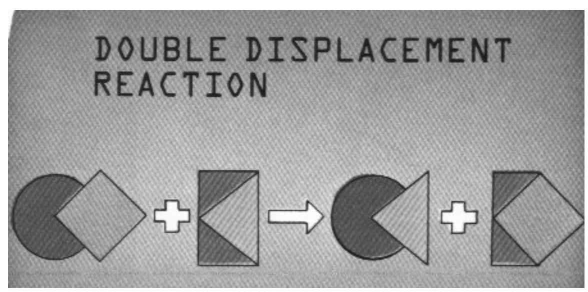
**Ex. $BeF_2$ + Mg $\longrightarrow$ $MgF_2$ + Be**




4. Double displacement – two compounds react to produce two new compounds.

**AB + CD $\longrightarrow$ AC + BD or AB + CD $\longrightarrow$ AD + BC**

**Ex. $AgNO_3$ + NaCl $\longrightarrow$ AgCl + $NaNO_3$**



## What you will do

**Self-Test 4.1**

**Based on the diagrams of chemical reactions above, identify the type of reaction shown by the following chemical equations:**

1. $S + O_2 \longrightarrow SO_2$ ______________________
2. $HgO \longrightarrow Hg + O_2$ ______________________
3. $2Al + 6HCl \longrightarrow 2AlCl_3 + H_2$ ______________________
4. $2KI + Cl_2 \longrightarrow 2KCl + I_2$ ______________________
5. $Al_2(SO_4)_3 + Ca(OH)_2 \longrightarrow 2Al(OH)_3 + 3CaSO_4$ _______________
6. $H_2 + Fe_3O4 \longrightarrow 3Fe + 4H_2O$ ______________________
7. $H_2O + SO_3 \longrightarrow H_2SO_4$ ______________________
8. $KClO_3 \longrightarrow KCl + O_2$ ______________________
9. $2Zn + O_2 \longrightarrow 2ZnO$ ______________________
10. $NaOH + FeCl_3 \longrightarrow NaCl + Fe(OH)_3$ ____________________

**Key to answers on page 26**

## Let's summarize

1. An **atom** is the smallest particle of an element. Atoms of different elements may also combine into systems called **molecules**.

2. An atom has a small but dense core called the ***nucleus.*** The nucleus is composed of ***protons***, the positively charged particle and the ***neutrons***, the particle with no charge. Around the nucleus is the ***electron***, the negatively charged particle.

3. The following are some evidences that support the molecular theory:

- diffusion – the intermingling of the molecules of  substance with the molecules of the air
- capillarity – the rise of liquid on a fine or hair-like tube
- surface tension – the formation of a temporary membrane on the surface of a liquid.
- osmosis – the passage of liquid from a semi-permeable membrane or from a liquid of greater concentration to a liquid of lesser concentration
- Cohesion – the attraction between like or the same kind of molecules.
- Adhesion – the attraction between unlike or different kinds of molecules

4. The total number of protons in a given atom determines the **atomic number** of an element.  The atomic number  is also equal to the number of electrons.

5. The **atomic mass or mass number** is the sum of an atom's protons and neutrons that are always expressed in whole numbers.

6. **Symbols** are used to represent an element, **chemical formula** for compound and **chemical equation** for chemical reaction.

7. In a chemical reaction, the substances that combine are called **reactants**, while the substance/s produced is/are called **product/s.**  An **arrow** is used to represent a forward or backward reaction.

8. The **law of conservation of mass** states that a new atom cannot be created in a chemical reaction and that the mass of the reactants is equal to the mass of the products.

9. There are four (4) general types of chemical reaction:

   - **Composition or Synthesis Reaction** – two or more elements combine to form one compound.
   - **Decomposition or Analysis** – one compound breaks into two or more other substances.
   - **Single displacement** – one element in the reactants replaces one of the elements in the given compound.
   - **Double displacement** – two compounds react to produce two new compounds

## Posttest

**Word search Puzzle**

**Search and shade the word or words in the puzzle that complete the sentence/s below:**

1. A/an _____________ represents a forward and backward reaction.
2. ______________ are used to represent an element.
3. Energy state in which the electrons of an atom can exist is the____________.
4. ____________ is the intermingling of molecules of the air with the molecules of another substance.
5. The elements and compound that start up a reaction are the _____________.
6. After a chemical reaction ____________ are produced.
7. The force of attraction that exists between molecules of different kinds is called _______________.
8. ____________ is a small dense core of an atom.
9. Atoms combine to form ________________.
10. The simplest form of matter is/are ________________.
11. The negatively charged particles that move around the nucleus are the _____.
12. ________ is considered the building blocks of elements.
13. Anything that has mass and volume is called ________.
14. Elements are made up of the same kind of _______.
15. A group of letters used to represent a compound is called _________.
16. A chemical ____________ is used to represent a chemical reaction.
17. The mass of the reactants is equal to mass of the products. This is the law of _____________________.

18. The passage of liquid from a substance of greater concentration to a less concentration is known as __________.

19. When two elements or compounds combine in a chemical reaction, this is called _____________.

20. ____________ is the force of attraction between two like molecules.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | A | R | R | O | W | S | Y | M | B | O | L | S | S | Y | N | T | H |
| S | C | D | D | I | F | F | U | S | I | O | N | E | F | G | P | R | O | T |
| H | H | I | J | K | L | P | R | O | D | U | C | T | S | M | N | E | O | A |
| S | U | E | L | C | U | N | F | O | M | P | M | E | T | A | L | A | V | D |
| W | X | Y | L | Z | A | B | A | C | D | O | E | E | E | F | G | C | H | H |
| I | A | J | K | L | L | M | C | A | P | I | L | L | A | R | I | T | Y | E |
| N | T | O | P | Q | S | O | E | R | S | T | E | E | U | V | W | A | X | S |
| Y | O | Z | A | B | M | A | T | O | M | C | M | C | C | D | E | N | E | I |
| G | M | H | I | P | A | J | E | K | L | M | E | T | N | U | O | T | S | O |
| Q | I | R | O | S | T | T | N | U | V | W | N | R | X | Y | L | S | I | N |
| A | C | U | R | B | T | C | S | D | E | F | T | O | G | H | I | E | S | K |
| J | N | K | B | L | E | M | I | N | O | P | S | N | C | O | H | E | O | I |
| D | U | Q | I | R | R | F | O | R | M | U | L | A | S | T | U | V | M | X |
| Y | M | Z | T | A | B | C | N | E | Q | U | A | T | I | O | N | S | S | E |
| F | B | C | O | N | S | E | R | V | A | T | I | O | N | O | G | H | O | J |
| R | E | B | M | U | N | S | S | A | M | K | L | M | N | F | M | A | S | S |
| O | R | S | Y | N | T | H | E | S | I | S | C | O | H | E | S | I | O | N |

Key to answers on page 26

# Key to Answers

**Pretest**

1. symbols
2. nucleus
3. element
4. atomic number
5. compound
6. electrons
7. mass number or atomic mass
8. metal
9. ion
10. covalent
11. solution
12. physical
13. molecules
14. catalysts
15. activation energy
16. decomposition or analysis
17. acids
18. bases
19. law of conservation of mass
20. valence electrons

**Activity 1.1**

| ELEMENT | ATOMIC NUMBER | ATOMIC MASS | NUMBER OF PROTONS | NUMBER OF NEUTRONS | NUMBER OF ELECTRONS |
|---|---|---|---|---|---|
| **Lithium** | 3 | 7 | **3** | **4** | **3** |
| **Magnesium** | 12 | 24 | **12** | **12** | **12** |
| **Aluminum** | 13 | 27 | **13** | **14** | **13** |
| **Calcium** | 20 | 40 | **20** | **20** | **20** |
| **Silicon** | 14 | 28 | **14** | **14** | **14** |
| **Lead** | 82 | 207 | **82** | **125** | **82** |
| **Copper** | 29 | 64 | **29** | **35** | **29** |
| **Silver** | 47 | 108 | **47** | **61** | **47** |
| **Gold** | 79 | 197 | **79** | **118** | **79** |
| **Nitrogen** | 7 | 14 | **7** | **7** | **7** |

Subtract the atomic number from the atomic mass to get the number of neutrons; the number of protons is equal to the number of electrons.

**Activity 1.2**

| MOLECULE / COMPOUND | FORMULA | ELEMENTS PRESENT | No. of Atoms in each element | Total No. of Atoms Present |
|---|---|---|---|---|
| Table salt | NaCl | Na & Cl | 1 Na & 1 Cl | 2 |
| Vinegar | $CH_3COOH$ | C, O & H | 2 C; 4 H & 2 O | 8 |
| Table sugar | $C_{12}H_{22}O_{11}$ | **C, H, O** | **12 C; 22 H; 11 O** | **45** |
| Muriatic acid | HCl | **H, Cl** | **1 H; 1 Cl** | **2** |
| Salitre | $KNO_3$ | **K, N, O** | **1 K, 1 N, 3 O** | **4** |
| Agua oxigenada | $H_2O_2$ | **H, O** | **2 H, 2 O** | **4** |
| Rust | $Fe_2O_3$ | **Fe, O** | **2 Fe, 3 O** | **5** |
| Sand | SiO | **Si, O** | **1 Si, 1 O** | **2** |
| Naphthalene ball | $C_{10}H_5$ | **C, H** | **10 C, 5 H** | **15** |
| White wash | $Ca(OH)_2$ | **Ca, O, H** | **1 Ca, 2 O, 2 H** | **5** |
| Washing soda | $CaCO_3$ | **Ca, C, O** | **1 Ca, 1 C, 3 O** | **5** |

**Self-test 1.1**

| COLUMN A | COLUMN B |
|---|---|
| 1. compound | f. combination of two or more elements |
| 2. nucleus | c. small but dense core of the atom |
| 3. neutron | h. particle in the nucleus with no charge |
| 4. proton | b. positively charged particles in the nucleus |
| 5. shells | e. energy states in which the electrons of an atom can exist |
| 6. molecules | h. this is formed when atoms combine |
| 7. ionic bond | m. involves a shift or transfer of electron from one atom to another atom |
| 8. metallic bond | n. involves a sharing of electrons in metals to another metal |
| 9. covalent bond | o. involves a sharing of electron in different kinds of atoms |
| 10. chemical formula | g. used to represent a compound |
| 11. atomic number | i. number of protons in the nucleus |
| 12. isotopes | l. element having the same atomic number but different atomic mass |
| 13. electron | d. negatively charged particle outside the nucleus of an atom |
| 14. atomic mass | a. number of protons and neutrons in the nucleus |
| 15. octet rule | l. states that eight electrons are needed to attain stability |

**Possible answers to Activity 2.1**

1. Yes; Cool and comfort
   Other examples:
   smell of the sauted garlic spread all over the house, body odor, air pollution
2. The water was absorbed the tissue paper.
   Other examples:

Plants can receive nutrients through the roots; towels are used to dry up our body after taking a bath; mops to use dry wet floors, the use of wick alcohol lamp

3. The water drops formed a sphere-like structure.
   Other examples:
   Globular formation of mercury; convex shape of ice in an ice tray; the surface of the water in a container is convex.
4. The molecules of the liquid soap formed a temporary enamel membrane on the surface of water. When it was touched, the membrane broke up.
   Other examples:
   Insects can run on a surface of water; detergents are used to wash clothes (*Deter* means to remove or put off)

**Self-Test 2.1**

1. **c** 2. **b** 3. **c** 4. **d** 5. **c**

**Activity 3.1**:

| ELEMENT | SYMBOL | ELEMENT | SYMBOL |
|---|---|---|---|
| Sodium | **Na** | Neon | **Ne** |
| Mercury | **Hg** | Sulfur | **S** |
| Boron | **B** | Radon | **Rn** |
| Carbon | **C** | Barium | **Ba** |
| Nickel | **Ni** | Thorium | **Th** |

**Activity 3.2**.

| COMPOND | FORMULA | COMPOUND | FORMULA |
|---|---|---|---|
| Zinc oxide | **ZnO** | Calcium carbonate | $\mathbf{CaCO_3}$ |
| Potassium chloride | **KCl** | Zinc nitrate | $\mathbf{Zn(NO_3)_2}$ |
| Lithium hydride | **LiH** | Aluminum nitrite | $\mathbf{Al(NO)_3}$ |
| Magnesium chloride | $\mathbf{MgCl_2}$ | Magnesium sulfate | $\mathbf{MgSO_4}$ |
| Hydrogen fluoride | **HF** | Sodium hydroxide | **NaOH** |

**Self-Test 3.1**

**1.** Sodium bromide **NaBr**
2. Barium chloride $\mathbf{BaCl_2}$
3. Aluminum hydroxide $\mathbf{Al(OH)_3}$
4. Sodium oxalate $\mathbf{Na_2C_2O_4}$
**5.** Potassium oxide $\mathbf{K_2O}$
6. Nitrogen phosphate $\mathbf{NPO_4}$
7. Hydrogen sulfide $\mathbf{H_2S}$
8. Zinc chloride $\mathbf{ZnCl_2}$
9. Silicon oxide $\mathbf{Si_2O_4}$
10. Ammonium sulfate $\mathbf{(NH_4)_2SO_4}$

**Self-Test 4.1**

1. $S + O_2 \longrightarrow SO_2$ **Composition or Synthesis**
2. $HgO \longrightarrow Hg + O_2$ **Decomposition or Analysis**
3. $2Al + 6HCl \longrightarrow 2AlCl_3 + H_2$ **Single replacement**
4. $2KI + Cl_2 \longrightarrow 2KCl + I_2$ **Single replacement**
5. $Al_2(SO_4)_3 + Ca(OH)_2 \longrightarrow 2Al(OH)_3 + 3CaSO_4$ **Double replacement**
6. $H_2 + Fe_3O4 \longrightarrow 3Fe + 4H_2O$ **Single replacement**
7. $H_2O + SO_3 \longrightarrow H_2SO_4$ **Composition or Synthesis**
8. $KClO_3 \longrightarrow KCl + O_2$ **Decomposition or Analysis**
9. $2Zn + O_2 \longrightarrow 2ZnO$ **Composition or Synthesis**
10. $NaOH + FeCl_3 \longrightarrow NaCl + Fe(OH)_3$ **Double replacement**

**Posttest**

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | B | [1]A | R | R | O | W | [2]S | Y | M | B | O | L | S | S | Y | N | T | H |
| [3]S | C | D | [4]D | I | F | F | U | S | I | O | N | E | F | G | P | [5]R | O | T |
| H | H | I | J | K | L | [6]P | R | O | D | U | C | T | S | M | N | E | O | [7]A |
| S | U | E | L | C | U | [8]N | F | O | [9]M | P | Q | R | S | T | U | A | V | D |
| W | X | Y | L | Z | A | B | A | C | D | O | [10]E | [11]E | E | F | G | C | H | H |
| I | [12]A | J | K | L | L | M | [13]C | A | P | I | L | L | A | R | I | T | Y | E |
| N | T | O | P | Q | S | O | E | R | S | T | E | E | U | V | W | A | X | S |
| Y | O | Z | A | B | [14]M | [15]A | T | O | M | C | M | C | C | D | E | N | E | I |
| G | M | H | I | P | A | J | E | K | L | M | E | T | N | U | O | T | S | O |
| Q | I | R | O | S | T | T | N | U | V | W | N | R | X | Y | L | S | I | N |
| A | C | U | R | B | T | C | S | D | E | F | T | O | G | H | I | E | S | K |
| J | N | K | B | L | E | M | I | N | O | P | S | N | C | O | H | E | O | I |
| D | U | Q | I | R | R | [16]F | O | R | M | U | L | A | S | T | U | V | M | X |
| Y | M | Z | T | A | B | C | N | [17]E | Q | U | A | T | I | O | N | S | S | E |
| F | B | [18]C | O | N | S | E | R | V | A | T | I | O | N | O | G | H | [19]O | J |
| R | E | B | M | U | N | S | S | A | M | K | L | M | N | F | M | A | S | S |
| O | R | [20]S | Y | N | T | H | E | S | I | S | [21]C | O | H | E | S | I | O | N |

**-End of Module-**

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