General Chemistry

First year

All departments of the college

Summary

By

Dr. Bahaa Malik Altahir

Rana alkalidi

Dr. Wafa Walid Nafi

Dr.Shurooq Badri Salman

Dr. Omar Abdulateef Mohammed

Wasan Abdul Ameer

2019-2020

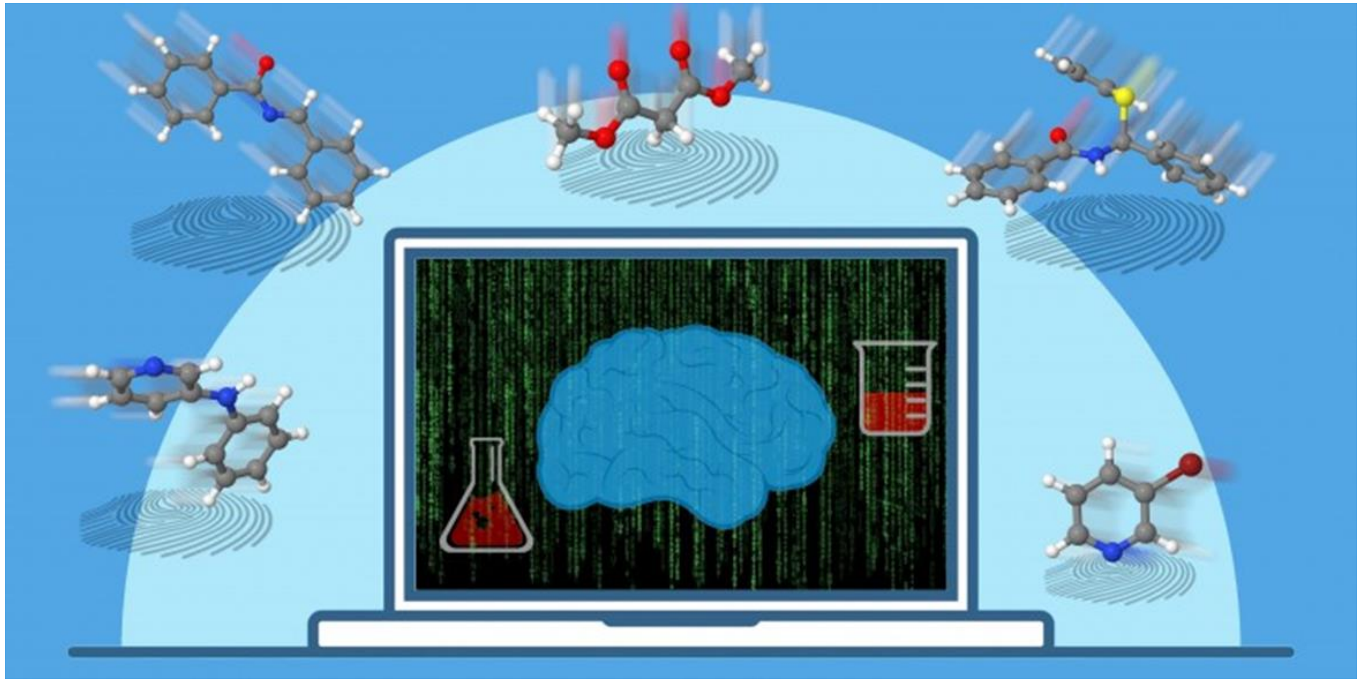
General chemistry

Chapter one

1.1 The Study of Chemistry

- What chemists do? Chemistry is largely an experimental science, and a great deal of knowledge comes from *laboratory research*.

- In addition, chemist may use a **computer** to study the microscopic structure and chemical properties of substances or employ electronic equipment to analyse **pollutants ملوثات** from auto emissions الانبعاث الذاتيor toxic substances المواد السامة in the soil.



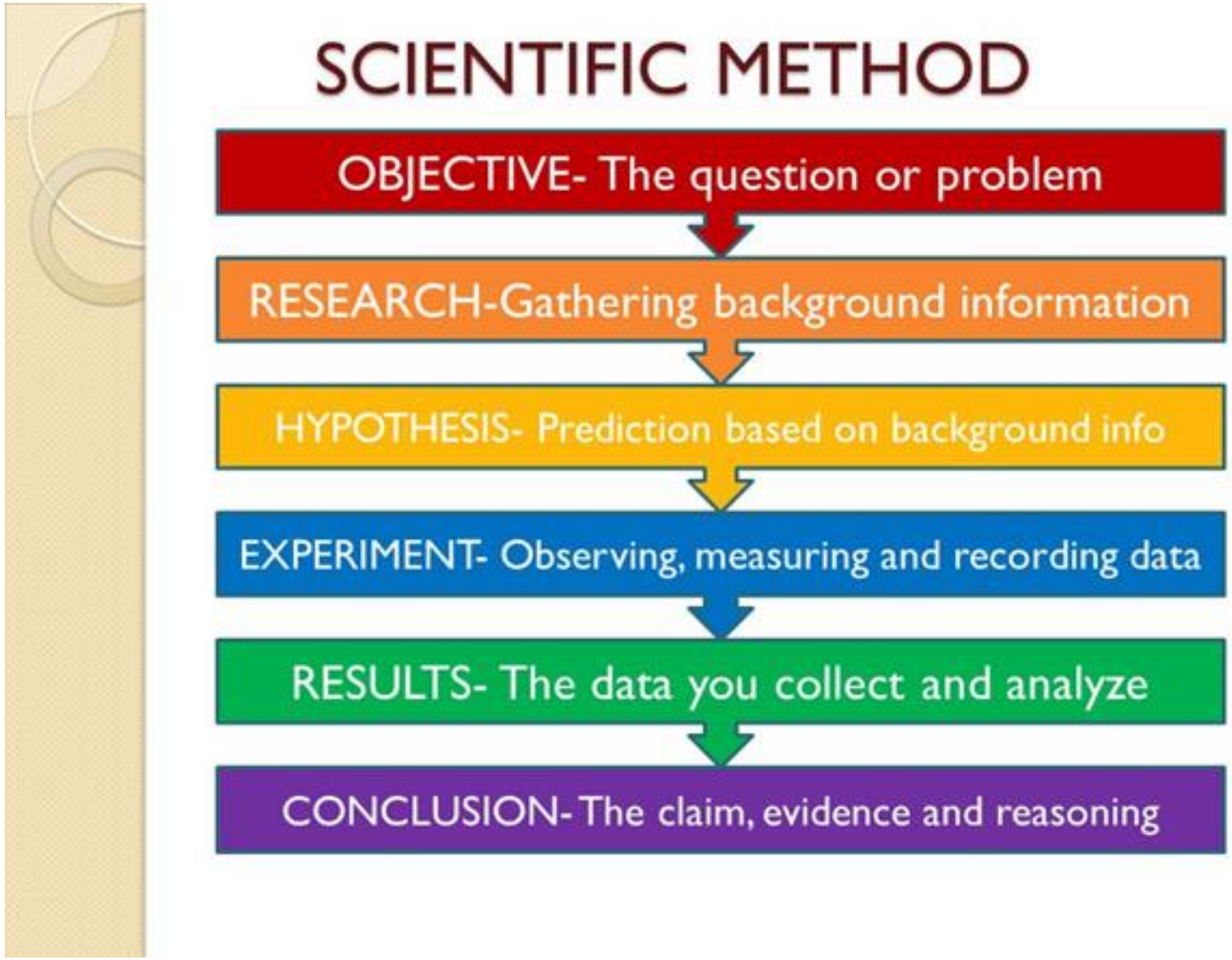
- What’s more, they are seeking solutions to the problem of environmental pollution التلوث البيئي along with replacements for energy sources. And most industries, whatever their products, have a basis in chemistry.

- For example, chemists developed the polymers بوليمرات(very large molecules) that manufacturers use to make a wide variety of goods, including clothing, cooking utensils اواعي منزلية, artificial organs, and toys. Chemistry is often called the “**central science**.”

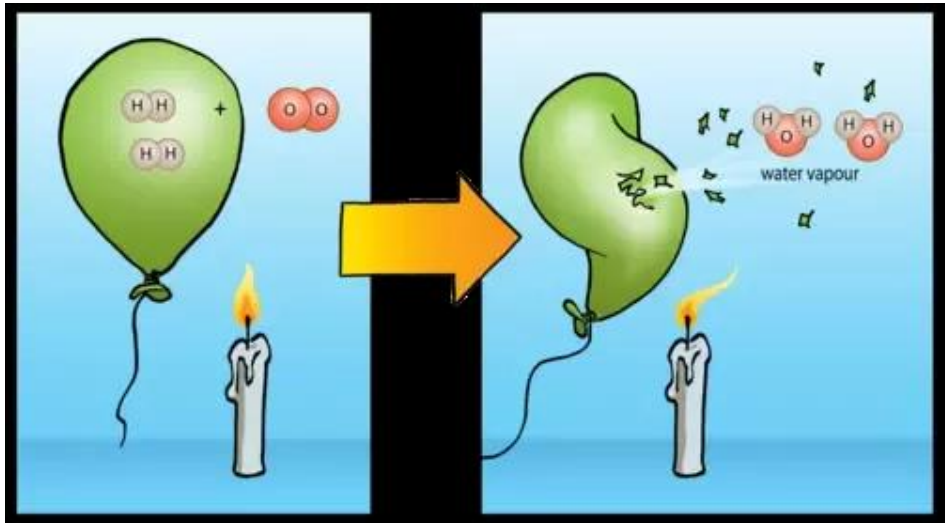
1.1.1 How to Study Chemistry

- At first, studying chemistry is like learning a **new language**. Furthermore, some of the concepts are **abstract**. Nevertheless, with diligence اجتهاد you can complete this course successfully—and perhaps even pleasurably بشكل ممتع .
- You will find that chemistry is much more than numbers, formulas, and abstract theories. It is a logical discipline التدريب الفكري brimming تزود او تملأ with interesting ideas and applications.

1.2 Scientific Method



- The scientific method a systematic approach to research. For example, a chemist interested in measuring the **heat** given off when **hydrogen gas burns in air** follow roughly the same procedure in carrying out their investigations. First step is defining the problem. Secondary includes performing experiments, making careful observations, and recording information, or data, about the system.



- The data obtained in a research study may be both qualitative, consisting of general observations about the system, and quantitative, comprising numbers obtained by various measurements of the system. Chemists generally use standardized symbols and equations in recording their measurements and observations.
- When the **experiments** have been completed and the **data** have been recorded, the next step in the scientific method is interpretation, meaning that the scientist attempts to explain the observed phenomenon.

1.3 Classifications of Matter

- Matter *is anything that occupies space and has mass,* and chemistry is the study of matter and the changes it undergoes. All matter, can exist in three states: solid, liquid, and gas, without changing the composition of the substance. Solids are rigid objects with definite shapes (for example, ice). Liquids are less rigid than solids and are fluid (for example, water), gases are fluid, but unlike liquids, they can expand indefinitely. **Melting point** *is the temperature at which a solid form will transition to form a liquid*. The **boiling point** *is the temperature at which a liquid form will transition to form a gas*.

1.3.1 Substances and Mixtures

- A substance is *matter that has a definite or constant composition and distinct properties.* Examples are water, silver, ethanol, table salt (sodium chloride), and carbon dioxide. *Substances differ from one another in composition and can be identified by their appearance, smell, taste, and other properties.*
- A mixture is a *combination of two or more substances in which the substances retain their distinct identities*. Some examples are air, soft drinks, milk, and cement. *Mixtures do not have constant composition*. Therefore, samples of air collected in different cities.

- Mixtures are either homogeneous or heterogeneous,
- a **homogeneous mixture** *the composition of the mixture is the same solution* such as sugar dissolves in water,
- a **heterogeneous mixture** *which the composition is not uniform* such as oil to water creates another heterogeneous mixture because the liquid does not have a constant composition.

1.3.2 Elements and Compounds

- A substance can be either an element or a compound.
- An element is a *substance that cannot be separated into simpler substances by chemical means*. At present, 114 elements have been positively identified.
- Chemists use alphabetical symbols to represent the names of the elements. The first letter of the symbol for an element is always capitalized, but the second letter is never capitalized.

- For example, **Co** is the symbol for the element cobalt, whereas **CO** is the formula for carbon monoxide, which is made up of the elements carbon and oxygen.
- Table 1.1 shows some of the more common elements. The symbols for some elements are derived from their Latin names for example, Au from au rum (gold), Fe from ferrum (iron), and Na from natrum (sodium)—although most of them are abbreviated forms of their English names.

Table 1-1 .Some Common Elements and Their Symbols

Name	Symbo	Name	Symbo	Name	Symbo
Aluminum	Al	Fluorine	F	Oxygen	O
Arsenic	As	Gold	Au	Phosphoru	P
Barium	Ba	Hydrogen	H	Platinum	Pt
Bromine	Br	Iodine	I	Potassium	K
Calcium	Ca	Iron	Fe	Silicon	Si
Carbon	C	Lead	Pb	Silver	Ag
Chlorine	Cl	Magnesiu	Mg	Sodium	Na
Chromiu	Cr	Mercury	Hg	Sulfur	S
Cobalt	Co	Nickel	Ni	Tin	Sn
Copper	Cu	Nitrogen	N	Zinc	Zn

- Most elements can interact with one or more other elements to form compounds.
- We define a **compound** as a *substance composed of two or more elements chemically united in fixed proportions*. Hydrogen gas, for example, burns in oxygen gas to form water, a compound whose properties are distinctly different from those of the starting materials. Water is made up of two parts of hydrogen and one part of oxygen. This composition does not change.

1.4 Physical and Chemical Properties of Matter

- A **physical property** *can be measured and observed without changing the composition or identity of a substance*. For example, color, the melting point, boiling point, freezing, and density. For example, we can measure melting point of ice by heating a block of ice and recording the temperature at which the ice is converted to water, we can freeze the water to recover the original ice.
- On the other hand, a **chemical property** *can be measured and observed with a chemical changing the composition or identity of a substance.* For example, “Hydrogen gas burns in oxygen gas to form water”. After the change, the original substances, hydrogen and oxygen gas, will have vanished and a chemically.

1.5 Measurement

- **Chemists use measurements** to *compare the properties of different substances and to assess تقييم changes resulting from an experiment*. علل A simple measurements of a substance's properties:
- The meter stick measures length;
- the buret, the pipet, the graduated cylinder, and the volumetric flask measure volume;
- the balance measures mass;
- the thermometer measures temperature.
- These instruments provide measurements of macroscopic properties, which can be determined directly. Microscopic properties, on the atomic or molecular scale, must be determined by an indirect method,

1.5.1 SI Units

- The international authority on units, proposed a revised راجعوا metric system called the *International System of Units* (abbreviated SI, from the French System International d'Unites).
- Table 1.2 shows the seven SI base units. All other SI units of measurement can be derived from these base units.

TABLE 1-2. SI Base Units

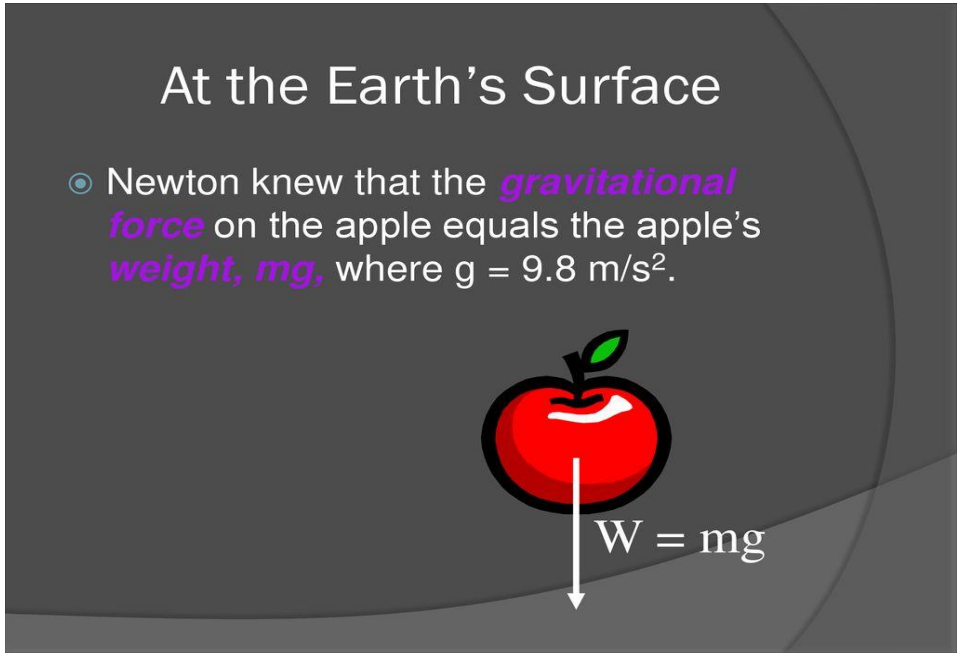
Base Quantity	Name of Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electrical current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

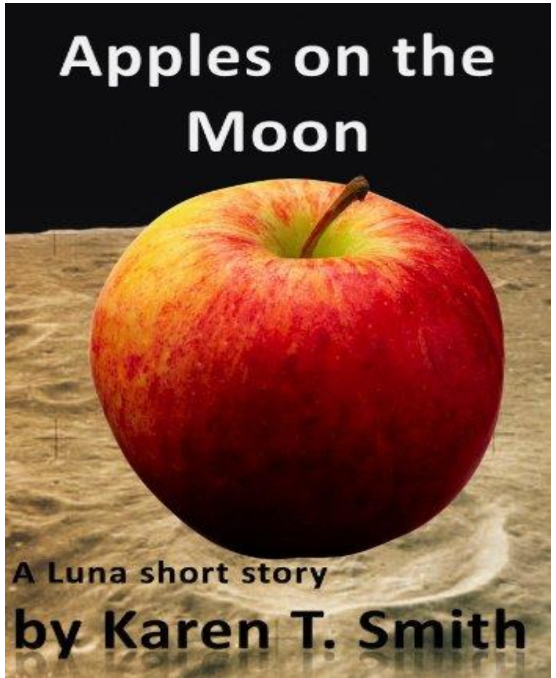
Measurements that we will utilize frequently in our study of chemistry include time, mass, volume, density, and temperature.

1.5.2 Mass and Weight

- **Mass** *is a measure of the quantity of matter in an object*.
- *The terms "mass" and "weight" are often used interchangeably* متبادلة, although, strictly speaking, they refer to different quantities. In scientific terms,
- **weight** *is the force that gravity exerts*تبذل*on an object*.

An **apple** that falls from a tree is pulled تنجذب downward by Earth's gravity الجاذبية.
The mass of the apple is constant and does not depend on its location, but its weight does. كتلة التفاحة ثابتة ولا تعتمد على موقعها ولكن الوزن يعتمد
For example, on the surface of the moon the apple would weigh only one-sixth what it does on Earth, because of the smaller mass of the moon.





- This is why **astronauts** رواد الفضاء were able to jump about rather freely on the moon's surface despite their bulky suits and equipment.
- The mass of an object can be determined readily with a **balance**, and this process, oddly, is called **weighing**.

  The SI base unit of mass is the kilogram (kg), but in chemistry the smaller gram (g) is more convenient:

  1 kg = 1000 g= 1 X 10^3 g

1.5.3 Volume

- **Volume** is *length (m) cubed,* so its SI-derived unit is the cubic meter (m^3). Generally, however, chemists work with much smaller volumes, such as the cubic centimeter (cm^3) and the cubic decimeter (dm^3):
- $1cm^3 = (1 \times 10^{-2}\ m)^3 = 1 \times 10^{-6}\ m^3$
- $1dm^3 = (1 \times 10^{-1}\ m)^3 = 1 \times 10^{-3}\ m^3$
- Another common, non-SI unit of volume is the liter (L). A liter is the volume occupied by one cubic decimeter. Chemists generally use L and mL for liquid volume. *One liter is equal to 1000 milliliters (mL)* or 1000 cubic centimeters:

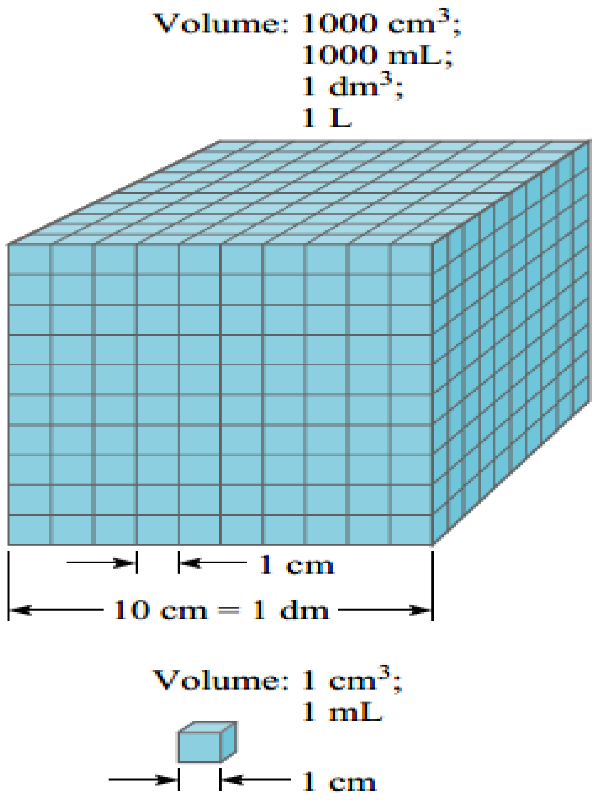
$$1\ L = 1000\ mL$$

$$= 1000\ cm^3$$

$$= 1\ dm^3$$

and one milliliter is equal to one cubic centimeter:

$$1\ mL = 1\ cm^3$$



1.5.4 Density

- **Density** *is the mass of an object divided by its volume:*
- $density = \frac{mass}{volum} \quad or \quad d = m/V$
- Where d, m, and V denote density, mass, and volume, respectively. Note that density is an intensive property that does not depend on the quantity of mass present. علل *The reason is that V increases as m does, so the ratio of the two quantities always remains the same for a given material.*
- The SI-derived unit for density is the kilogram per cubic meter (kg/m^3). This unit is awkwardly بشكل غير ملائم large for most chemical applications. Therefore, grams per cubic centimeter (g/cm^3) and its equivalent, grams per milliliter (g/mL), are more commonly used for solid and liquid densities.

1.6 Handling Numbers

- Having surveyed some of the units used in chemistry, we now turn to techniques for handling numbers associated with measurements:
- scientific notation. الرموز العلمية
- significant figures. الاشكال المميزة

1.6.1 Scientific Notation الرموز العلمية

602,200,000,000,000,000,000,000

0.00000000000000000000000166 g

$$0.0000000056 \times 0.00000000048 = 0.000000000000000002688$$

$$N \times 10^{n}$$

(1) Express 568.762 in scientific notation:

$$568.762 = 5.68762 \times 10^2$$

Note that the decimal point is moved to the left by two places and n =2.

(2) Express 0.00000772 in scientific notation:

$$0.00000772= 7.72\times10^{-6}$$

1.6.1.1 Addition and Subtraction

$(7.4\times 10^{3}) + (2.1\times 10^{3}) = 9.5 \times 10^{3}$

$(4.31\times 10^{4}) + (3.9\times 10^{3}) = (4.31\times 10^{4}) + (0.39\times 10^{4})$

$=4.70\times 10^{4}$

$(2.22\times 10^{-2}) - (4.10\times 10^{-3}) = (2.22\times 10^{-2})-(0.410\times 10^{-2})$

1.81×10^{-2}

1.6.1.2 Multiplication and Division

$$(8.0 \times 10^4) \times (5.0 \times 10^2) = (8.0 \times 5.0)\,(10^{4+2})$$

$$= 40 \times 10^6$$

$$= 0.4 \times 10^7$$

$$(4.0 \times 10^{-5}) \times (7.0 \times 10^3) = (4.0 \times 7.0)\,(10^{-5+3})$$

$$= 28 \times 10^{-2}$$

$$= 2.8 \times 10^{-1}$$

$$\frac{6.9 \times 10^7}{3.0 \times 10^{-5}} = \frac{6.9}{3.0} \times 10^{7-(-5)}$$

$$= 2.3 \times 10^{12}$$

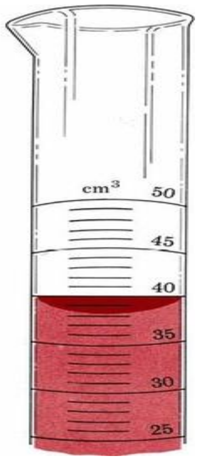
$$\frac{8.5 \times 10^4}{5.0 \times 10^9} = \frac{8.5}{5.0} \times 10^{4-9}$$

$$= 1.7 \times 10^{-5}$$

1.6.2 Significant Figures

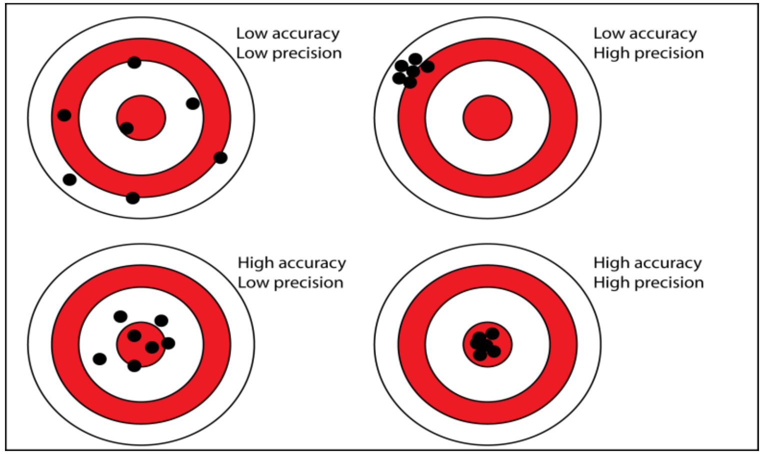
- The number of significant figures, which are the meaningful digits in a measured or calculated quantity. When significant figures are used, the last digit is understood to be uncertain.

- For example, we might measure the volume of a given amount of liquid using a graduated cylinder with a scale that gives an uncertainty of 1 mL in the measurement. If the volume is found to be 6 mL, then the actual volume is in the range of (5 to 7) mL. We represent the volume of the liquid as (6 ± 1) mL. In this case, there is only one significant figure (the digit 6) that is uncertain by either plus or minus 1 mL



- For greater accuracy, we might use a graduated cylinder that has finer divisions, so that the volume we measure is now uncertain by only 0.1 mL. If the volume of the liquid is now found to be 6.0 mL, we may express the quantity as (6.0 ± 0.1) mL, and the actual value is somewhere between 5.9 mL and 6.1 mL.

- **Accuracy** *tells us how close a measurement is to the true value of the quantity that was measured*. To a scientist there is a distinction between accuracy and precision.
- **Precision** *refers to how closely two or more measurements of the same quantity agree with one another*

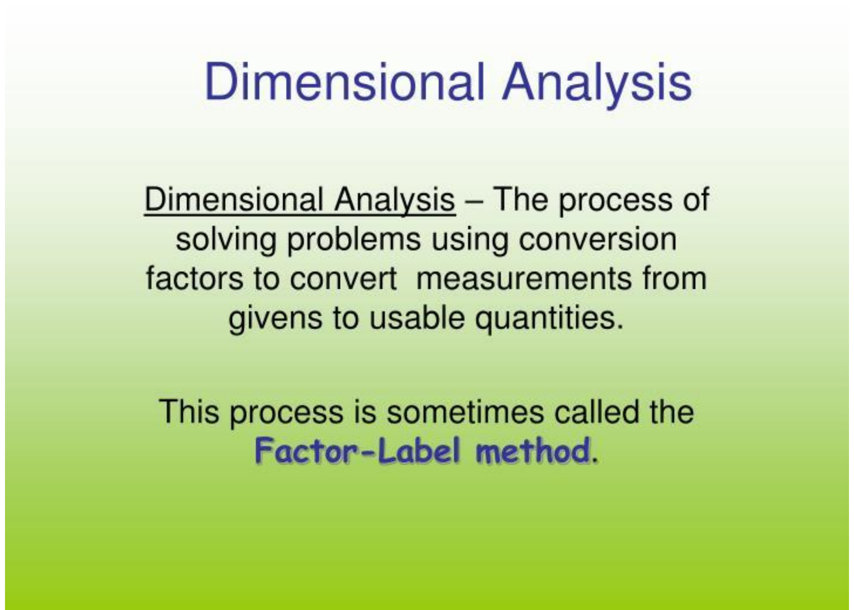


	Student A	Student B	Student C
	1.964 g	1.972 g	2.000 g
	1.978 g	1.968 g	2.002 g
Average value	1.971 g	1.970 g	2.001 g

- **The true mass of the wire is 2.000 g.**
- Therefore, Student B's results are more precise than those of Student A (1.972 g and 1.968 g deviate less from 1.970 g than 1.964 g and 1.978 g from 1.971 g), but neither set of results is very accurate.
- Student C's results are not only the most precise, but also the most accurate, because the average value is closest to the true value. Highly accurate measurements are usually precise too. On the other hand, **highly precise measurements do not necessarily guarantee accurate results.**

1.8 Dimensional Analysis in Solving Problems

- The procedure we use to convert between units in solving chemistry problems is called dimensional analysis (also called the factor-label method). A simple technique requiring little memorization, dimensional analysis is based on the relationship between different units that express the same physical quantity.



For example, let us consider the conversion of 57.8 meters to centimeters. This problem can be expressed as

$$? \text{ cm} = 57.8 \text{ m}$$

By definition,

$$1 \text{ cm} = 1 \times 10^{-2} \text{ m}$$

Because we are converting "m" to "cm," we choose the conversion factor that has meters in the denominator:

$$\frac{1 \text{ cm}}{1 \times 10^{-2} \text{ m}}$$

and write the conversion as

$$\begin{aligned} ? \text{ cm} &= 57.8 \cancel{\text{m}} \times \frac{1 \text{ cm}}{1 \times 10^{-2} \cancel{\text{m}}} \\ &= 5780 \text{ cm} \\ &= 5.78 \times 10^{3} \text{ cm} \end{aligned}$$

$$\text{given quantity} \times \text{conversion factor} = \text{desired quantity}$$

and the units cancel as follows:

$$\cancel{\text{given unit}} \times \frac{\text{desired unit}}{\cancel{\text{given unit}}} = \text{desired unit}$$

Thanks for listining

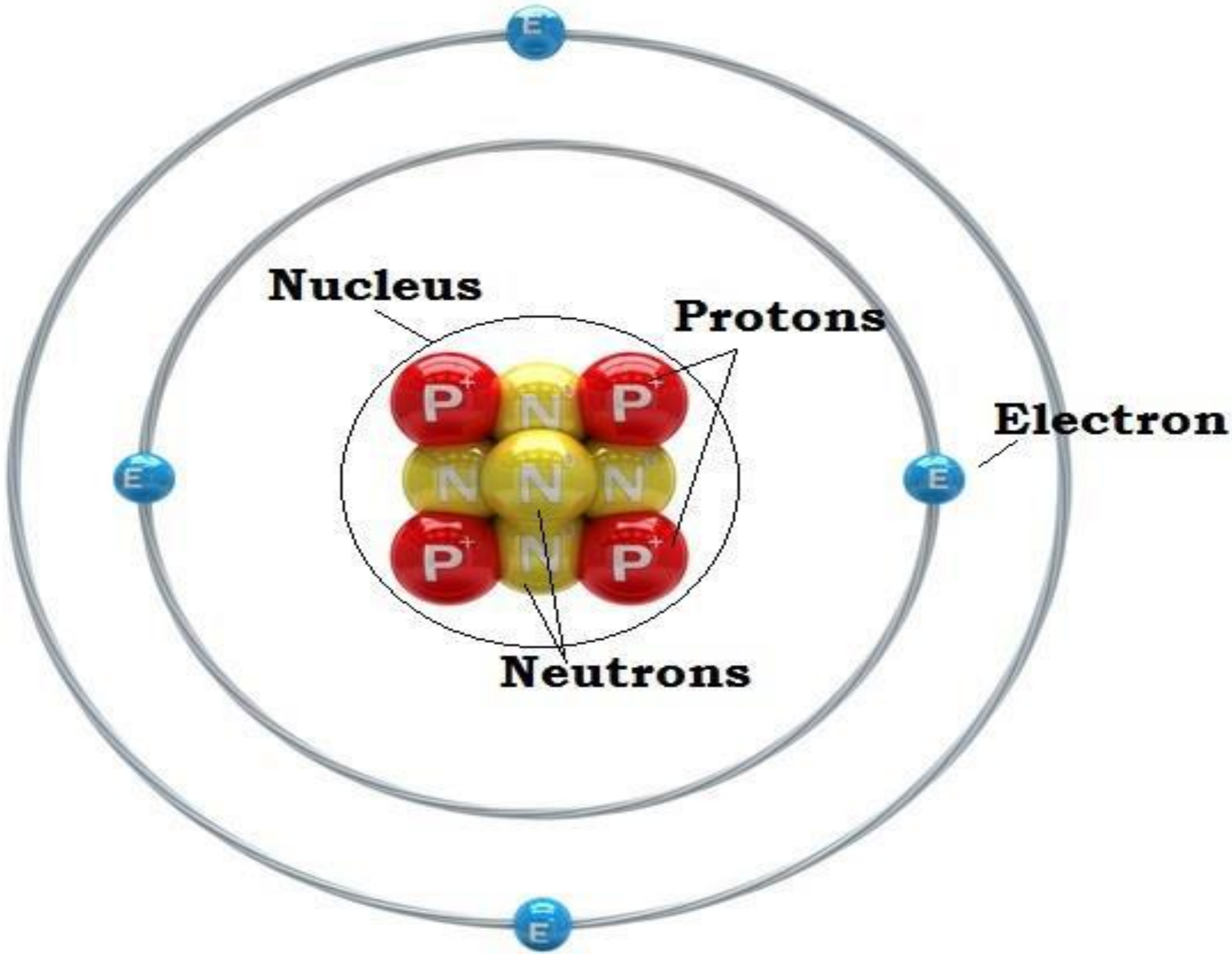
CHAPTER TWO

ATOMS, MOLECULES AND IONS

By
Assistant proff. Rana Abid Ali

2.1. ATOMIC MODEL

The atom is thought as a tiny solar system in which there is a central core (like the sun) with other particles traveling in circular path or orbits.


Nucleus
Protons
Electron
Neutrons
P
N
E

2.2. THE NUCLEUS

The central core from the solar system model is called the nucleus. The nucleus contains two types of particles, proton and neutron.

1- The Proton is a particle that has a mass (or weight) of one amu (atomic mass unit) and a positive one (+1) electrical charge. The symbol for the proton is p^+ or H^+.

2- The Neutron has a mass of one amu (atomic mass unit) but has no electrical charge; that is, it is a neutral particle. The symbol for the neutron is n.

2.3. The outer structure

The particles that orbit the nucleus are called electrons. These particles have an electrical charge of negative one (-1) but their mass is so small that it is considered to be zero. The symbol for the electron is e^-.

Mass number (A): is the total number of neutrons and protons present in the nucleus of an atom of an element. Except for the most common form of hydrogen, which has one proton and no neutrons, all atomic nuclei contain both protons and neutrons. In general, the mass number is given by:

mass number = number of protons + number of neutrons

= atomic number + number of neutrons

2.4. Atomic Number, Mass Number, and Isotopes

Atomic number(Z) of an atom of an element is equal to the number of protons in the nucleus of the atom. In a neutral atom the number of protons is equal to the number of electrons, so the atomic number also indicates the number of electrons present in the atom. For example, the atomic number of nitrogen is 7; this means that each neutral nitrogen atom has 7 protons and 7 electrons.

Isotopes: **are atoms of an element that have the same atomic number or the same number of protons and the same number of electron but different numbers of neutrons .**

for example : C-12 and C-13

Different isotopes always have the same atomic number and different mass numbers.*

****Isotopes of an element have the same chemical properties, but their physical properties are often slightly different***

2.5. The Periodic Table

The periodic table is a chart in which elements having similar chemical and physical properties are grouped together. The periodic table is a handy tool that correlates the properties of the elements in a systematic way and helps us to make predictions about chemical behavior.

Figure 2.1 shows the modern periodic table, in which the elements are arranged by atomic number (shown above the element symbol) in horizontal rows called periods and in vertical columns known as groups or families, So A period is a horizontal row of element in the periodic table.

A group is a vertical column of elements in the periodic table that have similar properties.

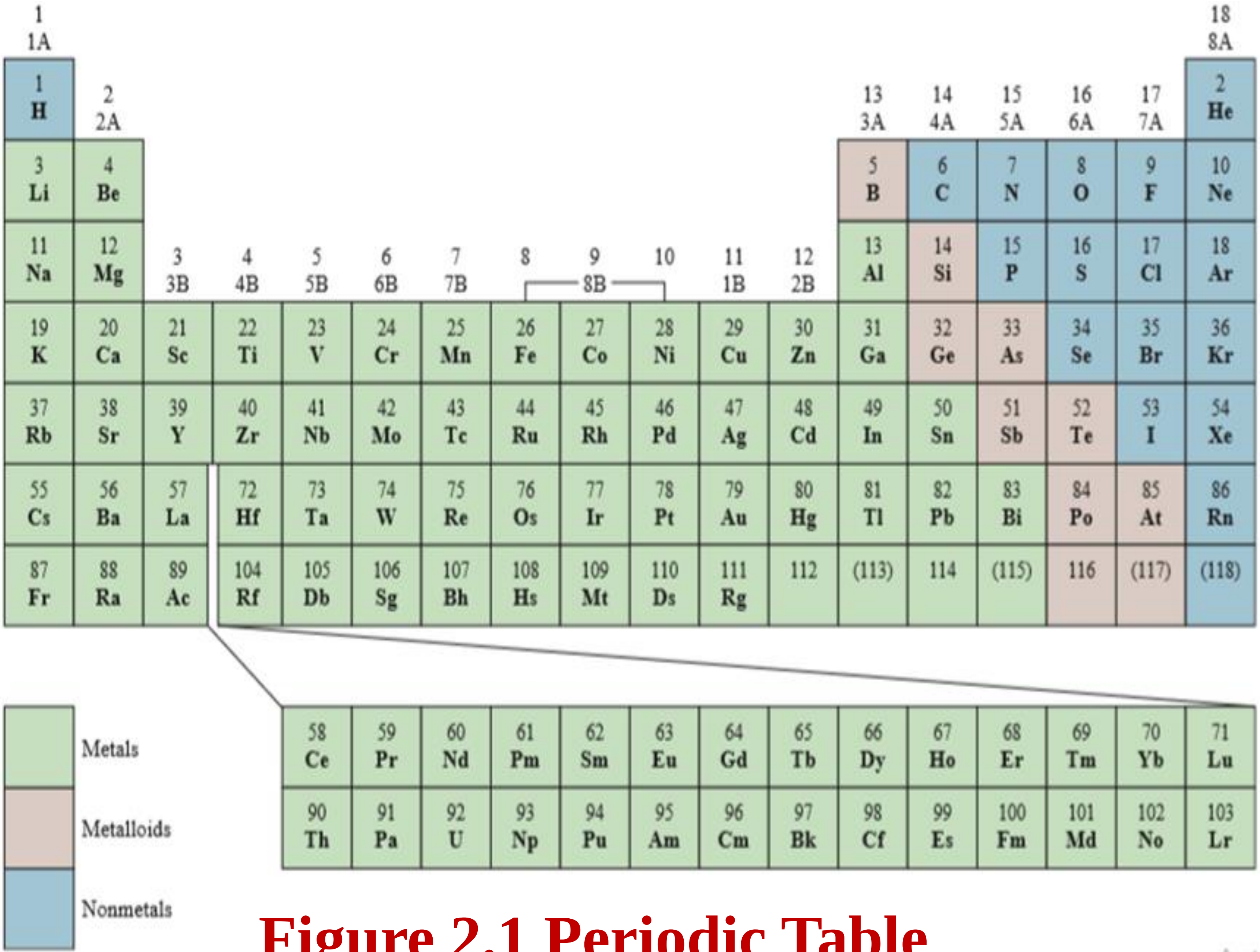


Figure 2.1 Periodic Table

2.5.1. Classification of groups

Some element groups have special names.

The Group 1A elements (Li, Na, K, Rb, Cs, and Fr) are called alkali metals.

Group 2A elements (Be, Mg, Ca, Sr, Ba, and Ra) are called alkaline earth metals.

Group 7A (F, Cl, Br, I, and At) are known as halogens.

Group 8A (He, Ne, Ar, Kr, Xe, and Rn) are called noble gases (or rare gases).

2.5.2. Metals, Nonmetals, and Metalloids

The elements can be divided into three categories—metals, nonmetals, and metalloids.

Metal is a good conductor of heat and electricity. Nonmetal is usually a poor conductor of heat and electricity. Metalloid has properties that are intermediate between those of metals and nonmetals.

the majority of known elements are metals; which are on the left line in the periodic table except for hydrogen. only seventeen elements are nonmetals, which are on the right line in the periodic table and eight elements are metalloids.

***From left to right across any period, the physical and chemical properties of the elements change gradually from metallic to nonmetallic.**

2.6. Molecules and atom

2.6.1. Molecule

is an aggregate of at least two atoms in a definite arrangement held together by chemical forces (also called chemical bonds). A molecule may contain atoms of the same element or atoms of two or more elements joined in a fixed ratio.

A molecule is not necessarily a compound, which, by definition, is made up of two or more elements. Hydrogen gas, for example, is a pure element, but it consists of molecules. Water, on the other hand, is a molecular compound that contains hydrogen and oxygen in a ratio of two H atoms and one O atom. Like atoms, molecules are electrically neutral. The hydrogen molecule, symbolized as H_2, is called a diatomic molecule because it contains only two atoms.

Other elements are nitrogen (N_2) and oxygen (O_2), as well as the Group 7A elements—fluorine (F_2), chlorine (Cl_2), bromine (Br_2), and iodine (I_2). Of course, a diatomic molecule can contain atoms of different elements. Examples are hydrogen chloride (HCl) and carbon monoxide (CO). The vast majority of molecules contain more than two atoms. They can be atoms of the same element, as in ozone (O_3), which is made up of three atoms of oxygen, or they can be combinations of two or more different elements. Molecules containing more than two atoms are called polyatomic molecules. Like ozone, water (H_2O) and ammonia (NH_3) are polyatomic molecules.

2.6.2. Ion

Is an atom or a group of atoms that has a net positive or negative charge. The number of protons in the nucleus of an atom remains the same during chemical reactions, but electrons may be lost or gained. The loss of one or more electrons from a neutral atom results in a cation, an ion with a net positive charge. On the other hand, an anion is an ion whose net charge is negative due to an increase in the number of electrons.

2.7. Chemical formula

A molecular formula shows the exact number of atoms of each element in the smallest unit of a substance. For example, H_2 is the molecular formula for hydrogen, O_2 is oxygen, O_3 is ozone, and H_2O is water. The subscript numeral indicates the number of atoms of an element present. Note that oxygen (O_2) and ozone (O_3) are allotropes of oxygen. An allotrope is one of two or more distinct forms of an element. Two allotropic forms of the element carbon—diamond and graphite—are dramatically different not only in properties but also in their relative cost.

Empirical Formulas

The molecular formula of hydrogen peroxide, is H_2O_2. This formula indicates that each hydrogen peroxide molecule consists of two hydrogen atoms and two oxygen atoms. The ratio of hydrogen to oxygen atoms in this molecule is 2:2 or 1:1. The empirical formula of hydrogen peroxide is HO. Empirical formula; tells us which elements are present and the simplest whole-number ratio of their atoms, but not necessarily the actual number of atoms in a given molecule. As another example, the compound hydrazine (N_2H_4), The empirical formula of hydrazine is NH_2. Although the ratio of nitrogen to hydrogen is 1:2 in both the molecular formula (N_2H_4) and the empirical formula (NH_2), only the molecular formula tells us the actual number of N atoms (two) and H atoms (four) present in a hydrazine molecule.

Formula of Ionic Compounds

The formulas of ionic compounds are usually the same as their empirical formulas because ionic compounds do not consist of discrete molecular units. For example, a solid sample of sodium chloride (NaCl) consists of equal numbers of Na^+ and Cl^- ions arranged in a three-dimensional network.

2.8. Naming compound

Chemists have developed a system for naming substances on the basis of their composition. First, we divide them into three categories: ionic compounds, molecular compounds, and acids and bases. Then we apply certain rules to derive the scientific name for a given substance.

2.8. 1. Ionic Compounds

Many ionic compounds are binary compounds, or compounds formed from just two elements. For binary ionic compounds the first element named is the metal cation, followed by the nonmetallic anion. Thus, NaCl is sodium chloride. The anion is named by taking the first part of the element name (chlorine) and adding "-ide." Potassium bromide (KBr), zinc iodide (ZnI_2), and aluminum oxide (Al_2O_3) are also binary compounds. The "-ide" ending is also used for certain anion groups containing different elements, such as hydroxide (OH^-) and cyanide (CN^-). Thus, the compounds LiOH and KCN are named lithium hydroxide and potassium cyanide. These and a number of other such ionic substances are called ternary compounds, meaning compounds consisting of three elements. Certain metals, especially the transition metals, can form more than one type of cation. Take iron as an example. Iron can form two cations: Fe^{2+} and Fe^{3+}.

2.8. 2. Molecular Compounds

The prefix "mono-" may be omitted for the first element. For example, PCl_3 is named phosphorus trichloride, not monophosphorus trichloride. Thus, the absence of a prefix for the first element usually means that only one atom of that element is present in the molecule. • For oxides, the ending "a" in the prefix is sometimes omitted. For example, N_2O_4 may be called dinitrogen tetroxide rather than dinitrogen tetraoxide.

2.8. 3. Acids and Bases

Naming Acids: An acid can be described as a substance that yields hydrogen ions (H^+) when dissolved in water. (H^+ is equivalent to one proton, and is often referred to that way.) Formulas for acids contain one or more hydrogen atoms as well as an anionic group. Anions whose names end in "-ide" have associated acids with a "hydro-" prefix and an "-ic" ending. In some cases two different names are assigned to the same chemical formula. For instance, HCl is known as both hydrogen chloride and hydrochloric acid. The name used for this compound depends on its physical state. In the gaseous or pure liquid state, HCl is a molecular compound called hydrogen chloride.

When it is dissolved in water, the molecules break up into H^+ and Cl^- ions; in this condition, the substance is called hydrochloric acid. Acids that contain hydrogen, oxygen, and another element (the central element) are called oxoacids. The formulas of oxoacids are usually written with the H first, followed by the central element and then O, as illustrated by this series of common oxoacids: H_2CO_3 carbonic acid, $HClO_3$ chloric acid, HNO_3 nitric acid, H_3PO_4 phosphoric acid, H_2SO_4 sulfuric acid. Often two or more oxoacids have the same central atom but a different number of O atoms. Starting with the oxoacids whose names end with "-ic," we use these rules to name these compounds.

2.8. 4. Naming Bases

A base can be described as a substance that yields hydroxide ions (OH^-) when dissolved in water. Some examples are NaOH Sodium hydroxide, $Ba(OH)_2$ Barium hydroxide, KOH Potassium hydroxide. Ammonia (NH_3), a molecular compound in the gaseous or pure liquid state, is also classified as a common base. At first glance this may seem to be an exception to the definition of a base. But note that as long as a substance yields hydroxide ions when dissolved in water, it need not contain hydroxide ions in its structure to be considered a base. In fact, when ammonia dissolves in water, NH_3 reacts partially with water to yield NH_4^+ and OH^- ions. Thus, it is properly classified as a base.

2.8. 5. Hydrates

Hydrates are compounds that have a specific number of water molecules attached to them. For example, in its normal state, each unit of copper(II) sulfate has five water molecules associated with it. The systematic name for this compound is copper(II) sulfate pentahydrate, and its formula is written as $CuSO_4 \cdot 5H_2O$. *The water molecules can be driven off by heating*. When this occurs, the resulting compound is $CuSO_4$, which is sometimes called anhydrous copper(II) sulfate; "anhydrous" means that the compound no longer has water molecules associated with it.

Example:

$BaCl_2$	Barium chloride
$FeCl_3$	Iron (III) chloride
$ZnCl_2$	Zinc chloride
Al_2O_3	Aluminum oxide
N_2O	Nitrous oxide
$Cu(NO_3)_2$	Copper(II) nitrate
KH_2PO_4	Potassium dihydrogen phosphate
NH_4ClO_3	Ammonium chlorate
PbO	Lead(II) oxide
Li_2SO_3	Dilithium sulphite es

General Chemistry

الكيمياء العامه

Chapter Three

الفصل الثالث

(Reactions in Aqueous Solutions)

التفاعلات في المحاليل المائيه

By Dr. Wafaa Al-Qayssi

3.1 General Properties of Aqueous Solutions
الخواص العامه في المحاليل المائيه

A solution: is a homogeneous mixture of two or more substances.

المحلول هو مزيج متجانس لمادتين او اكثر من ماده

Homogeneous: means that the mixture has the same composition everywhere. When sugar dissolves in water.

التجانس يعني بانه المزيج يحتوي على المكونات نفسها في اي مكان مثل اذابة السكر في الماء

Heterogeneous: A mixture that is not the same composition everywhere (such as orange juice, which has suspended solids).

الغيرتجانس هو مزيج لا يحتوي على نفس المكونات في اي مكان مثل عصير البرتقال الذي يحتوي على حبيبات

Solute: The substance present in a smaller amount (we will assume the solute is a liquid or a solid).

المذاب هو ماده موجوده بكميه اصغر (نفترض المذاب يكون صلب او سائل)

Solvent: The substance present in a larger amount (aqueous solutions such as water). A solution may be gaseous (such as air), solid (such as an alloy),or liquid (seawater, for example).

المذيب هو ماده موجوده بكميات اكبر(المحلول المائي مثل الماء) المحلول ممكن ان يكون غاز مثل الهواء او صلب كسبيكه او سائل كماء البحر

(mass)units: The masses of substance in unit of; gram (g), milligram (mg), microgram (μg), nanogram (ng).

وحدات الكتله هي كتلة الماده بوحدة الغرام والمليغرام والمايكرو غرام والنانوغرام

3.1.1 Concentration of Solutions
تركيز المحاليل

- The concentration of a solution is how much (mass) of solute is contained in a given volume of solvent or mass of solution.

  تركيز المحلول هو كمية الكتله للمذاب المحتواة في الحجم المعطى للمذيب او كتلة المحلول

- The concentration of a solution can be expressed in many different ways.

  تركيز المحلول ممكن ان يعبر عنه بعدة طرق مختلفه

Here we will consider one of the most commonly used units in chemistry.

هنا يمكن ان نعبرعن واحده من معظم الوحدات الشائعة الاستخدام في الكيمياء

Mole: symbol (mol.) is Avogadro's number ($6.02*10^{23}$) of particles (atoms, molecules, ions, or anything else).

المول هو عدد افكادرو للجزيئات ($6.02*10^{23}$) (الذرات او الجزيئات اوالايونات او اي شيء اخر)

$$\text{Number of moles for compounds} = \frac{mass}{Molar\ mass}$$

$$\text{عدد المولات للمركبات} = \frac{\text{الكتله}}{\text{الكتله الموليه}}$$

<u>Atomic mass units (amu)</u> of an element is the number of **grams** containing Avogadro's number of atoms.

وحدة الكتله الذريه للعنصر هي عدد الغرامات التي تحتوي عدد افوكادرو في الذره

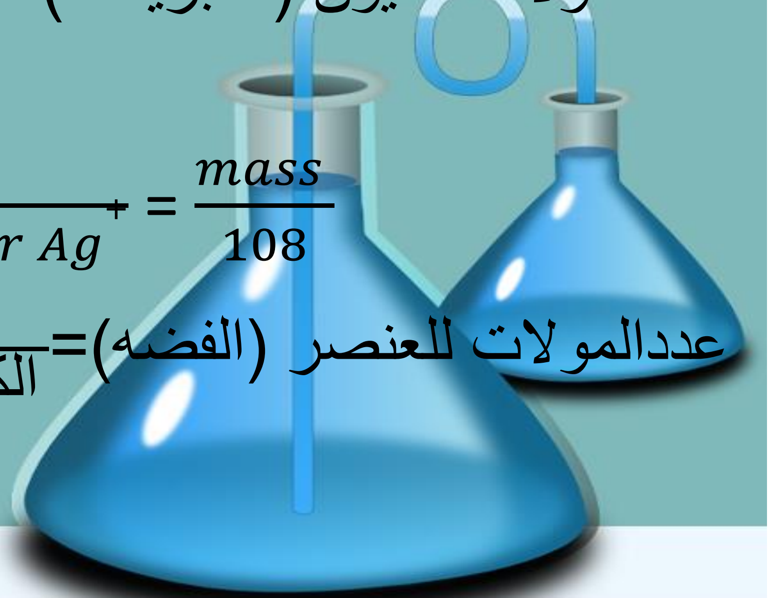
For example:

Number of moles of ion (SO_4^{2-}) = $\frac{mass}{Ionic\ mass,\ for\ SO_4^{-2}} = \frac{mass}{I\times32+(4\times16)}$

عدد المولات للايون (الكبريتات)= $\frac{\text{الكتله}}{\text{الكتله الايونيه}}$

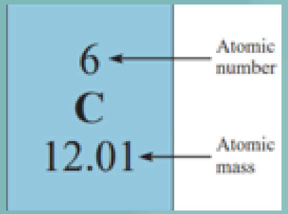
Number of moles of element (Ag^{+}) = $\frac{mass}{Atomic\ mass, for\ Ag^{+}} = \frac{mass}{108}$

عددالمولات للعنصر (الفضه)= $\frac{\text{الكتله}}{\text{الكتله الذريه}}$



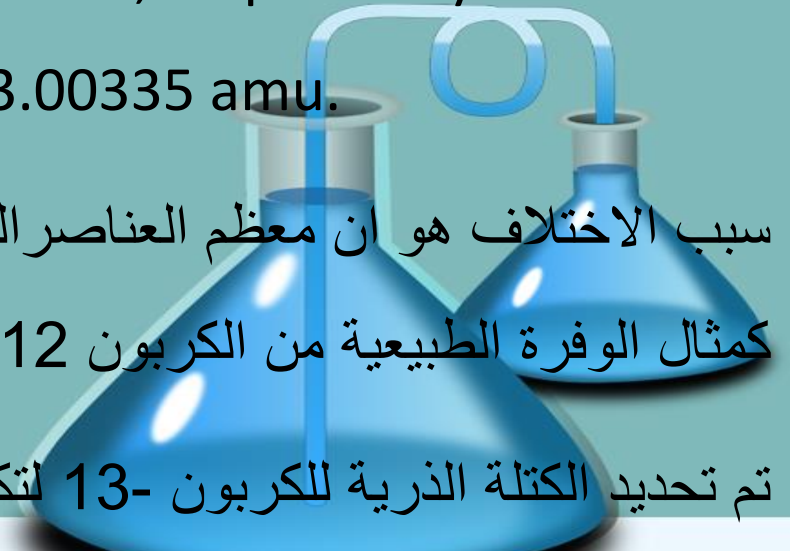
Average Atomic Mass
معدل كتله الذريه

- When you look up the atomic mass of carbon you will find that its value is not 12.00 amu but 12.01 amu.



عندما ننظر الى كتلة الذره للكاربون نجد ان القيمه ليست 12.00 ولكن 12.01

The reason for the difference is that most naturally occurring elements (including carbon) have more than one isotope. For example, the natural abundances of carbon-12 and carbon-13 are 98.90 percent and 1.10 percent, respectively. The atomic mass of carbon-13 has been determined to be 13.00335 amu.



سبب الاختلاف هو ان معظم العناصرالتي تحدث بشكل طبيعي (التي تحتوي الكاربون) لها اكثر من نظير واحد

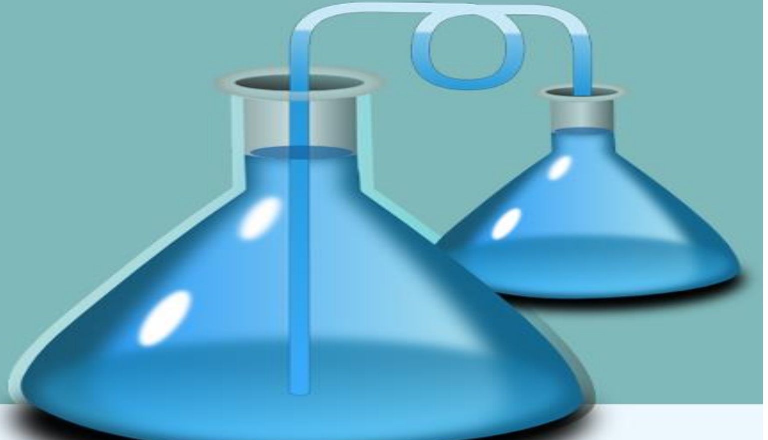
كمثال الوفرة الطبيعية من الكربون 12 و الكربون 13 هي 98.90 في المائة و 1.10 في المائة على التوالي.

تم تحديد الكتلة الذرية للكربون -13 لتكون 13.00335 amu.

Thus, the average atomic mass of carbon can be calculated as follows:

لذلك معدل كتله الذريه للكاربون يمكن حسابها كما يلي

$$\begin{aligned}\text{average atomic mass} & \\ \text{of natural carbon} &= (0.9890)(12.00000\text{ amu}) + (0.0110)(13.00335\text{ amu}) \\ &= 12.01\text{ amu}\end{aligned}$$



Molar mass (M.mass) of compound is the sum of the atomic mass of all the atoms in the molecular formula of the compound.

الكتله الموليه للمركب هي مجموع الكتل الذريه لكل الذرات في الصيغه الجزيئيه للمركب

For example:

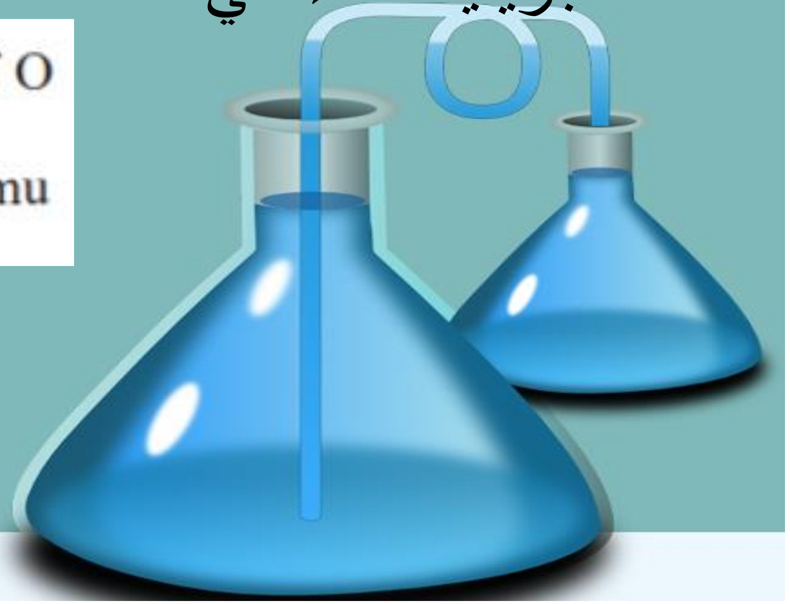
- The molecular mass of H_2O

الكتله الجزيئيه للماء هي

$$2(\text{atomic mass of H}) + \text{atomic mass of O}$$

or

$$2(1.008 \text{ amu}) + 16.00 \text{ amu} = 18.02 \text{ amu}$$



For example:

Number of moles of $(NH_2)_2CO = \frac{mass}{(14+(2\times1))\times2+12+16}$

- Finally, note that for ionic compounds like NaCl and MgO that do not contain discrete molecular units, we use the term formula mass instead.

اخيرا يلاحظ للمركبات الايونيه مثل كلوريد الصوديوم و اوكسيد المغنيسيوم لا تحتوي على وحدات جزيئيه منفصله بدلا من ذلك نستخدم مصطلح كتلة الصيغه

- The formula unit of NaCl consists of one Na^+ ion and one Cl^- ion. Thus, the formula mass of NaCl is the mass of one formula unit:

$$\text{formula mass of NaCl} = 22.99\ \text{amu} + 35.45\ \text{amu}$$
$$= 58.44\ \text{amu}$$

and its molar mass is 58.44 g.

- **Molarity (M):** symbol (M) is the number of moles of a substance per liter of solution. Such as "[H^+]" moles per liter (M), means the concentration of H^+.

المولاريه هي عدد مولات الماده لكل وحدة اللترمن المحلول و ان (مول/ لتر) تعني التركيز

$$M = \frac{number\ of\ moles\ of\ solute}{Volume\ of\ solution\ in\ liter}$$

المولاريه = عدد مولات المذاب / حجم المحلول في اللتر

$$M = \frac{n}{Vol.(L)}$$

المولاريه = عدد مولات المذاب / الحجم في اللتر

A liter (L): is the volume of a cube that is 10 cm on each edge.

$$M = \frac{density \times \% \times 1000}{Molar\ mass}$$ For Liquid

للسوائل المولاريه = الكثافه * النسبه المئويه للوزن*1000 / الكتله الموليه

Also, $$M = \frac{(mass)}{(M.mass)} \times \frac{1000}{Vol.(mL)}$$ For solid

للصلبه المولاريه = الكتله / الكتله الموليه × 1000 / الحجم(مل)

Notes: mass → means mass in gram unit (gm.), vol. → means volume of solution in milliliter unit (ml.)

Normality: symbol (N) is the number of milliequivalents of solute contained in 1 ml of solution, or the number of gram equivalents contained in 1 L.

النورماليه هي عدد ملي مكافىء للمذاب المحتواة في محلول 1 مل او عدد مكافئات الغرام في حجم 1 لتر

$$N = \frac{number\ of\ gram-equivalent\ mass\ of\ solute}{Volume\ of\ solution\ in\ liters}$$

النورماليه = عدد ملي مكافىء الكتله للمذاب / حجم المحلول في اللتر

$$\text{Number of gram-equivalent mass} = \frac{mass}{eq.mass}$$

عدد ملي مكافىء الكتله للمذاب = الكتله / كتلة مكافىء

eq.mass → means equivalent mass unit = ($\frac{gm}{gm.m.eq.}$)

$$N = \frac{mass}{eq.mass} \times \frac{1000}{vol.(mL.)}$$

$$N = \frac{density \times \% \times 1000}{eq.mass}$$

للسوائل النورماليه = الكثافه*النسبه المئويه للوزن*1000 / كتلة امكافىء

Calculation of equivalent mass (eq.mass)

حساب كتلة مكافىء

- The equivalent mass of acid, is that mass of acid which contains one –gram atom of replaceable hydrogen.

كتلة المكافىء للحامض هي كتلة للحامض الذي يحتوي على ذرة غرام واحد من الهيدروجين القابل للاستبدال.

Eq.wt of **acid** = $\frac{M.mass\ of\ acid}{number\ of\ replaceable(hydrogen)}$

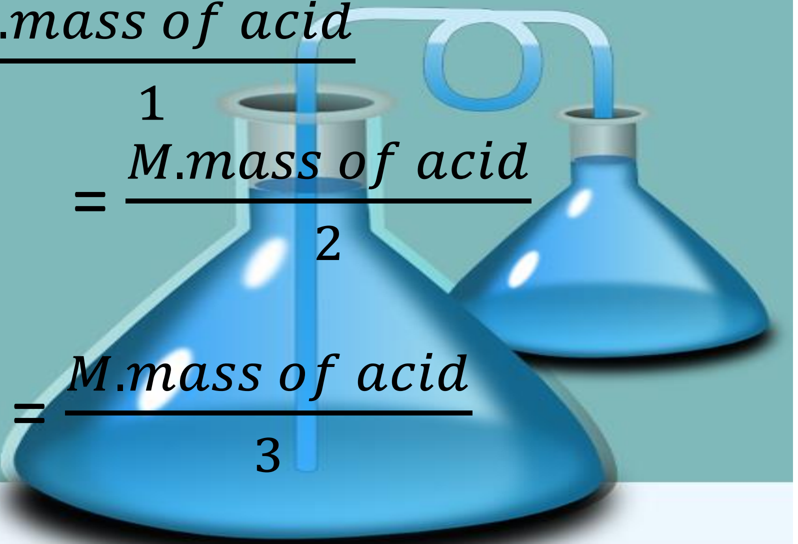
كتلة المكافىء للحامض = $\frac{\text{الكتله المولية للحامض}}{\text{عدد ذرات الهيدروجين القابله للاستبدال}}$

Example:

eq.wt of **HCl** = $\frac{M.mass\ of\ acid}{number\ of\ replaceable(hydrogen)} = \frac{M.mass\ of\ acid}{1}$

eq.wt of **H_2SO_4** = $\frac{M.mass\ of\ acid}{number\ of\ replaceable(hydrogen)} = \frac{M.mass\ of\ acid}{2}$

eq.wt of **H_3PO_4** = $\frac{M.mass\ of\ acid}{number\ of\ replaceable(hydrogen)} = \frac{M.mass\ of\ acid}{3}$



While, the equivalent mass of base is that mass of base which contains one replaceable hydroxyl group.

بينما الكتله المكافئه للقاعده هي كتلة القاعده التي تحتوي على مجموعة هايدروكسيل واحد القابله للاستبدال.

Eq.wt of base = $\frac{M.mass\ of\ base}{number\ of\ replaceable(hydroxyl)}$

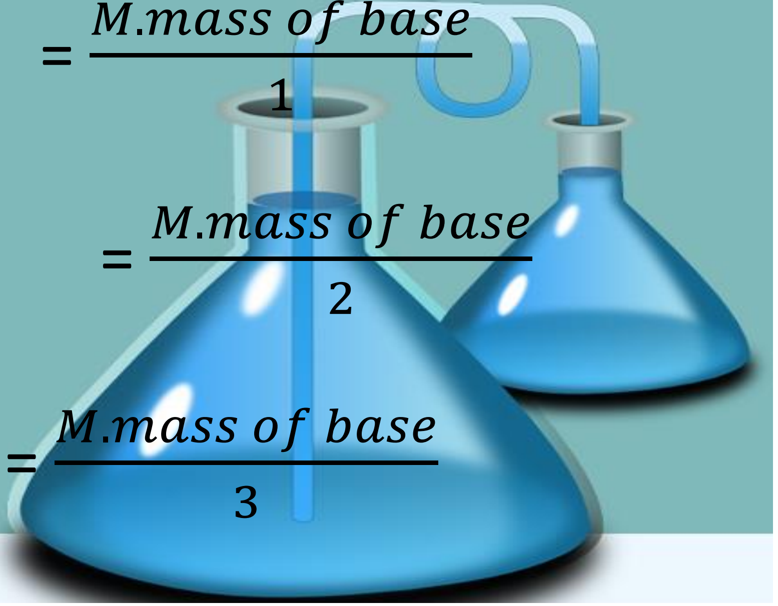
كتلة المكافىء للقاعده = $\frac{\text{الكتله المولية للقاعده}}{\text{عدد ذرات الهيدروكسيل القابله للاستبدال}}$

Example:

eq.wt of **NaOH** = $\frac{M.mass\ of\ base}{number\ of\ replaceable(hydroxyl)} = \frac{M.mass\ of\ base}{1}$

eq.wt of **$Ba(OH)_2$** = $\frac{M.mass\ of\ base}{number\ of\ replaceable(hydroxyl)} = \frac{M.mass\ of\ base}{2}$

eq.wt of **$Al(OH)_3$** = $\frac{M.mass\ of\ base}{number\ of\ replaceable(hydroxyl)} = \frac{M.mass\ of\ base}{3}$



The equivalent weight of the substance which contains or reacts with 1 gm. atm of a univalent cation M^+.

الوزن المكافىء للماده التي تحتوي او تتفاعل مع 1 غرام

$$\text{Eq.wt} = \frac{M.mass}{total\ charge\ of\ positive\ ions}$$

$$\text{كتلة المكافىء} = \frac{\text{الكتله المو ليه}}{\text{الشحنه الكليه للايون الموجب}}$$

Example:

eq.wt of **KCl** = $\frac{M.mass}{1}$

eq.wt of **Na_2CO_3** = $\frac{M.mass}{2}$

eq.wt of **$BaCl_2$** = $\frac{M.mass}{2}$

eq.wt of **$FeCl_3$** = $\frac{M.mass}{3}$

eq.wt of **$Ca(PO_4)_2$** = $\frac{M.mass}{6}$

3.1.2 Percent Composition of Compounds
نسبة المكونات في المركبات

- The percent composition is the percent by mass of each element in a compound. Percent composition is obtained by dividing the mass of each element in 1 mole of the compound by the molar mass of the compound and multiplying by 100 percent.

نسبة المكونات هي النسبه بواسطة الكتله لكل عنصر في المركب و يتم الحصول على نسبة المكونات عن طريق قسمة كتلة كل عنصر في مول واحد من المركب على الكتلة المولية للمركب والضرب بنسبة 100 بالمائة.

- Mathematically, the percent composition of an element in a compound is expressed as:

رياضيا ، يتم التعبير عن النسبة المئوية لتكوين عنصر في مركب على النحو التالي:

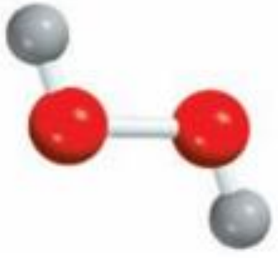
$$\text{percent composition of an element} = \frac{n \times \text{molar mass of element}}{\text{molar mass of compound}} \times 100\%$$

- Where n is the number of moles of the element in 1 mole of the compound. For example, in 1 mole of hydrogen peroxide (H_2O_2) there are 2 moles of H atoms and 2 moles of O atoms. The molar masses of H_2O_2, H, and O are 34.02 g, 1.008 g, and 16.00 g, respectively.

Therefore, the percent composition of H_2O_2 is calculated as follows:

$$\%H = \frac{2 \times 1.008\ g}{34.02\ g} \times 100\% = 5.926\%$$

$$\%O = \frac{2 \times 16.00\ g}{34.02\ g} \times 100\% = 94.06\%$$



H_2O_2

- The sum of the percentages is 5.926 percent + 94.06 percent =99.99 percent. The small discrepancy from 100 percent is due to the way we rounded off the molar masses of the elements. Note that the empirical formula (HO) would give us the same results.

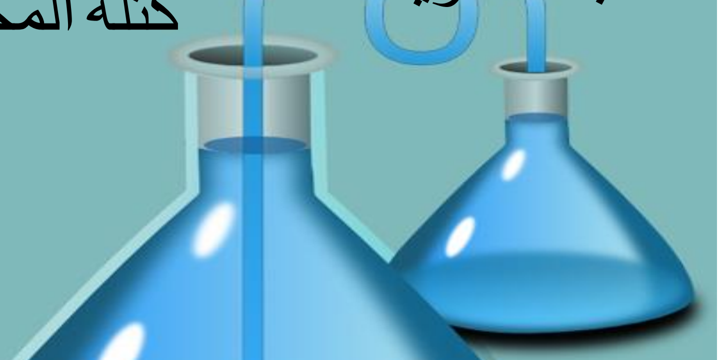
Percentage Composition (mass%):
النسبه المئويه للمكونات

The percentage of a component in a mixture or solution is usually expressed as a mass percent (mass %):

عادة ما يتم التعبير عن النسبة المئوية للمكون في المزيج أو المحلول كنسبة مئوية للكتلة (الكتلة٪):

$$\text{Mass percent}\,(\textbf{mass\%}) = \frac{mass\ of\ solute}{mass\ of\ solution\ or\ mixture} \times 100$$

$$\text{النسبه المئويه للكتله} = \frac{\text{كتلة المذاب}}{\text{كتلة المحلول او المزيج}} \times 100$$



Volume percent (vol %)
النسبه المئويه للحجم

is defined as:

يعرف بانه

Volume percent**(vol%)** = $\frac{volume\ of\ solute}{volume\ of\ solution\ or\ mixture} \times 100$

$$\text{النسبه المئويه للحجم} = \frac{\text{حجم المذاب}}{\text{حجم المحلول او المزيج}} \times 100$$

Mass- Volume percent%

النسبه المئويه للحجم - الكتله

$$\text{(mass/v)percent} = \frac{mass\ of\ solute\ (gm)}{volume\ of\ solution\ or\ mixture\ (ml)} \times 100$$

النسبه المئويه (الكتله/ الحجم) = $\frac{\text{كتلة المذاب(غرام)}}{\text{حجم المحلول او المزيج(مل)}}$ ×100

Density and specific gravity of solutions:

الكثافه و الكثافه النوعية للمحاليل

Density = $\frac{mass\ (g\ or\ kg)}{volume\ (ml\ or\ L)}$

الكثافه = الكتله(غرام او كغم) / الحجم(مل او باللتر)

Specific gravity (Sp.gr.) = $\frac{density\ of\ a\ substance}{density\ of\ water\ at\ 4°C}$

الكثافه النوعيه = كثافة الماده / كثافة الماء

- Because the density of water at 4°C is very close to 1 g/mL, specific gravity is nearly the same as density.

نظرًا لأن كثافة الماء عند 4 درجات مئوية قريبة جدًا من 1 غم / مل ، فإن الكثافه النوعية هي تقريبًا نفس الكثافه

Parts per Million (ppm):

جزء فى المليون

For very diluted solution, the concentration is more conveniently expressed is part per million (ppm), which mean grams of substance per million or billion grams of total solution or mixture.

بالنسبة للمحلول المخفف جدًا ، يتم التعبير عن التركيز بشكل أكثر ملاءمة وهو جزء لكل مليون (جزء في المليون) ، مما يعني غرامًا من المادة لكل مليون أو بليون غرام من المحلول أو المزيج الكلي.

ppm = $\frac{mass\ of\ solute\ (g)}{mass\ of\ solution}$ $*10^6$ mg / L **or** µg/ml

The relation between (ppm) and (molarity) is:

العلاقه بين ppm و المولاريه هي

ppm = molarity× M.mass × 1000

ppm=1000 × الكتله المولية ×المولاريه

The relation between (ppm) and (normality) is:

العلاقه بين ppm و النورماليه هي

ppm = normality× eq.mass × 1000

ppm= 1000 × النورماليه×الكتله المولية

Dilution of Solutions
تخفيف المحاليل

- Dilution is the procedure for preparing a less concentrated solution from a more concentrated one.

التخفيف هو إجراء لتحضير محلول بتركيز اقل من محلول ذات تركيز عالي .

Suppose that we want to prepare 1 L of a 0.400 M $KMnO_4$ solution from a solution of 1.00 M$KMnO_4$.

افترض أننا نريد تحضير 1 لتر من محلول 0.400 مولاري $KMnO_4$من محلول 1.00 مولاري $KMnO_4$

For this purpose, we need 0.400 mole of KMnO4. Because there is 1.00 mole of $KMnO_4$ in 1 L of a 1.00 M KMnO4 solution, there is 0.400 mole of KMnO4 in 0.400 L of the same solution:

$$\frac{1.00\text{ mol}}{1\text{ L soln}} = \frac{0.400\text{ mol}}{0.400\text{ L soln}}$$

- In other words, moles of solute before dilution = moles of solute after dilution Because molarity is defined as moles of solute in one liter of solution.

بمعنى آخر ، مولات المذاب قبل التخفيف = مولات المذاب بعد التخفيف لأن المولارية تعرف بأنها مولات المذاب في لتر واحد من المحلول

- we see that the number of moles of solute is given by

$$\underbrace{\frac{\text{moles of solute}}{\text{liters of soln}}}_{M} \times \underbrace{\text{volume of soln (in liters)}}_{V} = \text{moles of solute}$$

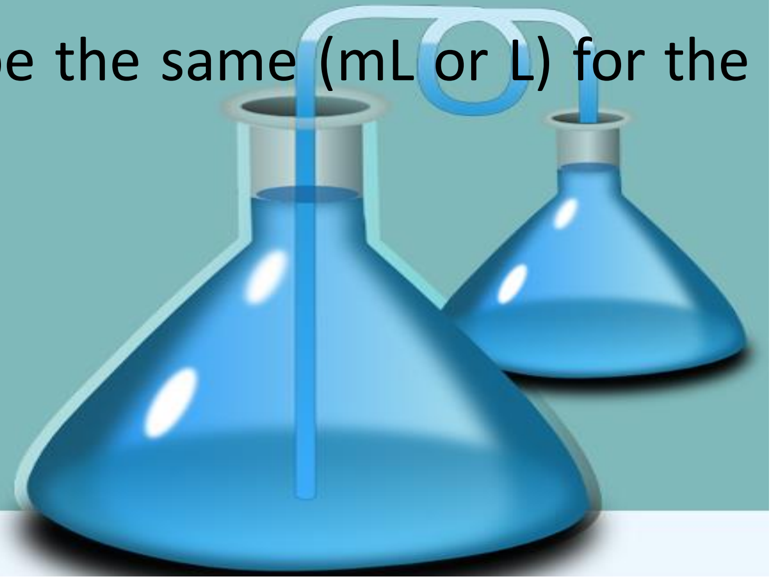
or

$$MV = \text{moles of solute}$$

$$M_i V_i = M_f V_f$$

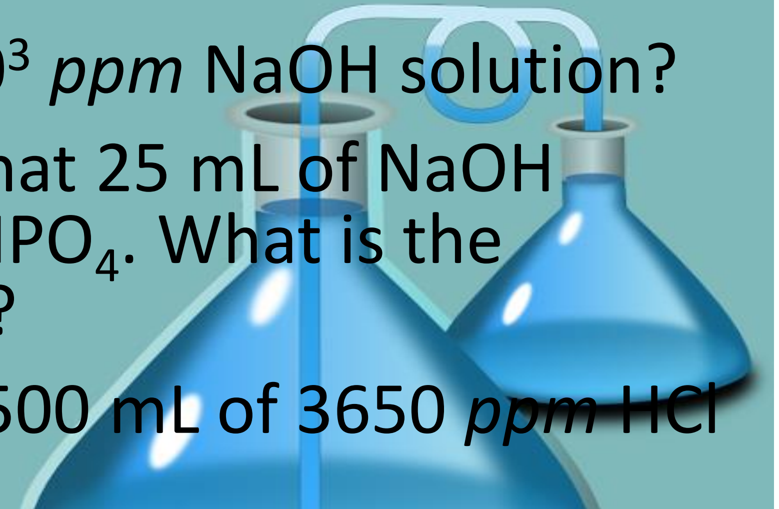
moles of solute before dilution = moles of solute after dilution

- Where M_i and M_f are the initial and final concentrations of the solution in molarity and V_i and V_f are the initial and final volumes of the solution, respectively. Of course, the units of V_i and V_f must be the same (mL or L) for the calculation to work.



Homeworks واجبات بيتيه

- **1)** How many grams of potassium dichromate ($K_2Cr_2O_7$) are required to prepare a 250-mL solution whose concentration is 2.16 *M* ?
- **2)** What is the molarity of an 85.0-mL ethanol (C_2H_5OH) solution containing 1.77 g of ethanol?
- **3)** In a biochemical essay, a chemist needs to add 3.81 g of glucose to a reaction mixture. Calculate the volume in milliliters of a 2.53 *M* glucose ($C_6H_{12}O_6$) solution she should use for the addition.
- **4)** How would you prepare 500 mL of a 1.75 *N* H_2SO_4 solution, starting with an 8.61 *N* stock solution of H_2SO_4?
- **5)** How would you prepare 250 mL of a 4 x 10^3 *ppm* NaOH solution?
- **6)** In a titration experiment, a student finds that 25 mL of NaOH solution are needed to neutralize 0.6 g of K_2HPO_4. What is the concentration (in *ppm*) of the NaOH solution?
- **7)** Calculate the volume required to prepare 500 mL of 3650 *ppm* HCl solution. (Sp. gr. =1.18, % = 36 %).



Thank you very much

General Chemistry- First Class

Homework Chapter3/ Solution

By Dr. Wafaa Al-Qayssi

Homeworks

1) How many grams of potassium dichromate ($K_2Cr_2O_7$) are required to prepare a 250-mL solution whose concentration is 2.16 *M* ?

2) What is the molarity of an 85.0-mL ethanol (C_2H_5OH) solution containing 1.77 g of ethanol?

3) In a biochemical essay, a chemist needs to add 3.81 g of glucose to a reaction mixture. Calculate the volume in milliliters of a 2.53 *M* glucose ($C_6H_{12}O_6$) solution she should use for the addition.

4) How would you prepare 500 mL of a 1.75 *N* H_2SO_4 solution, starting with an 8.61 *N* stock solution of H_2SO_4?

5) How would you prepare 250 mL of a 4×10^3 *ppm* NaOH solution?

6) In a titration experiment, a student finds that 25 mL of NaOH solution are needed to neutralize 0.6 g of K_2HPO_4. What is the concentration (in *ppm*) of the NaOH solution?

7) Calculate the volume required to prepare 500 mL of 3650 *ppm* HCl solution. (Sp. gr. =1.18, % = 36 %).

Homework

1) How many grams of potassium dichromate (**$K_2Cr_2O_7$**) are required to prepare a **250 mL** solution whose concentration is 2.16 *M* ?

mass? X

Vol.= 250 ml. √

M= 2.16 M √

$$M = \frac{(mass)}{(M.mass)} \times \frac{1000}{Vol.(mL)}$$

$M.mass$ of $K_2Cr_2O_7$ = 2*39+ 2*52 +7*16 = 294.185 g/ mol.

$$2.16\ M = \frac{mass}{294.185\ g/\ mol.} \times \frac{1000}{250\ mL}$$

mass = 158.86 g

Homework

2) What is the molarity of an **85.0 mL** ethanol (**C_2H_5OH**) solution containing **1.77 g** of ethanol?

mass = 1.77 g √

Vol. = 85.0 ml. √

M= ? X

$$M = \frac{(mass)}{(M.mass)} \times \frac{1000}{Vol.(mL)}$$

$M.mass$ of C_2H_5OH = 2*12+ 6*1 +1*16 = 46 g/ mol.

$$M = \frac{1.77}{46\ \text{g/ mol.}} \times \frac{1000}{85.0\ mL}$$

M = 0.452 M

Homework

3) In a biochemical essay, a chemist needs to add **3.81 g** of glucose to a reaction mixture. Calculate the volume in milliliters of a **2.53 *M*** glucose (**$C_6H_{12}O_6$**) solution she should use for the addition.

mass = 3.81 g √

Vol. = ? X

M= 2.53 √

$$M = \frac{(mass)}{(M.mass)} \times \frac{1000}{Vol.(mL)}$$

$M.mass$ of $C_6H_{12}O_6$ = 6*12+ 12*1 +6*16 = 180 g/ mol.

$$2.53 = \frac{3.81}{180\ \text{g/ mol.}} \times \frac{1000}{Vol.(mL)}$$

Vol. = 8.366 ml.

Homework

4) How would you prepare **500 mL** of a **1.75 *N*** H_2SO_4 solution, starting with an **8.61 *N*** stock solution of H_2SO_4?

V_1= 500 ml. √

N_1= 1.75 N √

V_2= ? X

N_2= 8.61 N √

$N_1 * V_1 = N_2 * V_2$

1.75 N * 500 ml.= 8.61 N * V_2

V_2 = 101.62 ml.

Homework

5) How would you prepare 250 mL of a 4×10^3 *ppm* NaOH solution?

ppm = 4×10^3 √

Vol. = 250 ml. √

mass = ? X

M.mass = 23*1+ 16*1+1*1 = 40 g/ mol.

ppm = M* M.mass * 1000

4×10^3 = M* 40 * 1000

M= 0.1 M

$$M = \frac{(mass)}{(M.mass)} \times \frac{1000}{Vol.(mL)}$$

$$0.1\ M = \frac{mass}{40\ g/mol.} \times \frac{1000}{250\ mL}$$

mass = 1 g

That mean, we weight 1 g of NaOH and dissolve in 250 ml. of H_2Oin volumetric flask.

Homework

6) In a titration experiment, a student finds that 25 mL of NaOH solution are needed to neutralize 0.6 g of K_2HPO_4. What is the concentration (in *ppm*) of the NaOH solution?

M = $\frac{number\ of\ moles\ of\ solute\ (NaOH)}{Volume\ of\ solution\ in\ liter}$ → M = $\frac{number\ of\ moles\ of\ solute}{0.025\ L.}$

First, we need to find the number of moles of NaOH:

K_2HPO_4 being "monoprotic" means that one mole of K_2HPO_4 is one equivalent. Basically, 1 molecule of K_2HPO_4 only donates 1 H^+ ion.

We also know that NaOH is a monoprotic base, because there's only one OH^- ion in its chemical formula.

Therefore, 1 mole of K_2HPO_4 will correspond to 1 mole of NaOH in a neutralisation reaction.
In other words, 1 mole of NaOH will neutralise 1 mole of K_2HPO_4.

M.mass for K_2HPO_4 = 2*39+ 1*1+1*32+4*16 = 175 g/ mol.

Number of moles for K_2HPO_4 = $\frac{mass}{Molar\ mass}$ → Number of moles for K_2HPO_4 = $\frac{0.6\ g}{175\ g/mol}$ → 0.003429 mol.

Because the mole ratio of K_2HPO_4 to NaOH is 1:1, 0.003429 moles of NaOH

M = $\frac{number\ of\ moles\ of\ solute\ (NaOH)}{Volume\ of\ solution\ in\ liter}$ → M = $\frac{0.003429\ mol.}{0.025\ L.}$ → M = 0.13716 M

ppm = M * M.mass * 1000 → ppm = 0.13716 M * 40 * 1000 → ppm = 5.486

Homework

7) Calculate the volume required to prepare 500 mL of 3650 *ppm* HCl solution.

(Sp. gr. =1.18, % = 36 %).

$Vol._{dil.}$ = 500 ml. √

ppm= 3650 √

Sp. gr. =1.18 √

% = 36 % √

$Vol._{conc.}$ = ? X

$Molar\ mass$= 1*1+ 1*35.5 = 36.5 g /mol.

$$M_{conc.} = \frac{density \times \% \times 1000}{Molar\ mass}$$

$$M_{conc.} = \frac{1.18 \times 36/100 \times 1000}{36.5}$$

$M_{conc.}$ = 11.63 M

ppm = $M_{dil.}$ * M.mass * 1000

3650 = $M_{dil.}$ * 36.5 * 1000 → $M_{dil.}$ = 0.1 M

$M_{dil.} * V_{dil.} = M_{conc.} * V_{conc.}$

0.1 M * 500 ml.= 11.63 M * $V_{conc.}$

$V_{conc.}$ = 4.299 ml.

Thank you very much

Acids, Bases, pH

Acid-Base Properties

Acid-Base Properties

pH-A Measure

Ionization Constants

Volumetric analysis

Example

Example

Practice Exercise

Good Day Every One

General Chemistry- First Class

Review chapter4,-Acids, Bases, and pH

By: Dr Shurooq Badri Al-badri

Acids, Bases, and pH

Acids produce protons or the H^+ ion while bases accept protons or generate OH^-

pH is a measure of the hydrogen ion (H^+) concentration in an aqueous solution.

Strength of Acids and Bases

Strong acids 1	Weak acids 2	Strong bases 3	Weak bases 4
HCl	HF	NaOH	NH_4OH
HNO_3	CH_3COOH	KOH	CH_3NH_2

The Acid-Base Properties of Water

- Water is a very weak electrolyte and therefore a poor conductor of electricity, but it does undergo ionization to a small extent

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

- This reaction is sometimes called the autoionization of water

$$\underset{acid_1}{H_2O} + \underset{base_2}{H_2O} \rightleftharpoons \underset{acid_2}{H_3O^+} + \underset{base_1}{OH^-}$$

The Ion Product of Water

In the study of acid-base reactions, the hydrogen ion concentration is key; its value indicates the acidity or basicity of the solution. Because only a very small fraction of water molecules are ionized, the concentration of water, $[H_2O]$, remains virtually unchanged.

$$K_c = [H_3O^+][OH^-] = [H^+][OH^-]$$

Practice Exercise
Example
Example
Volumetric analysis
Ionization Constants
pH-A Measure

To indicate that the equilibrium constant refers to the autoionization of water, were place Kc by Kw

$$K_w = [H_3O^+][OH^-] = [H^+][OH^-\ ]$$

In pure water at 25℃,the concentrations of H^+ and OH^- ions are equal and found to be $[\mathrm{H}^+] = 1 \times 10^{-7}$M and $[\mathrm{HO}^-] = 1 \times 10^{-7}$M .

Thus, from Equation at 25℃

$$K_w = (1.0 \times 10^{-7})(1.0 \times 10^{-7}\ ) = 1.0 \times 10^{-14}$$

Whether we have pure water or a aqueous solution of dissolved species, the follow relation always holds at 25℃:

$$K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14}$$

Whenever $[\mathrm{H}^+] = [\mathrm{HO}^-]$the aqueous solution is said to be neutral. In an acidic solution, there is an excess of H+ ions and $[\mathrm{H}^+] > [\mathrm{HO}^-]$ In a basic solution, there is an excess of hydroxide ions, so $[\mathrm{H}^+] < [\mathrm{HO}^-]$.

Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Practice Exercise
Example
Example
Volumetric analysis
Ionization Constants

pH—A Measure of Acidity

Because the concentrations of H+ and OH¯ ions in aqueous solutions are frequently very small numbers and therefore inconvenient to work with. The pH of a solution is defined as the negative logarithm of the hydrogen ion concentration (in mol/L): $\mathrm{pH} = -\log[\mathrm{H_3O^+}]$ or $\mathrm{pH} = -\log[\mathrm{H^+}]$

and also $\mathrm{pOH} = -\log[\mathrm{OH^-}]$

pH scale

Acidic solutions

Neutral solutions

Basic solutions

$[H^+] = 10^{-pH}$

$[OH^-] = 10^{-pOH}$

$pH + pOH = 14$

Note:
Relation between Ka and Kb :
Ka × Kb = Kw

pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Acid and Base Ionization Constants

Acid Ionization Constant, K_a

$$CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$$

$$K_a = \frac{[H^+]\,[CH_3COO^-]}{[CH_3COOH]}$$

$$[H^+] = \sqrt{K_a . C_a}$$

Base Ionization Constant, K_b

$$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

$$K_b = \frac{[NH_4^+]\,[OH^-]}{[NH_3]}$$

$$[OH^-] = \sqrt{K_b . C_b}$$

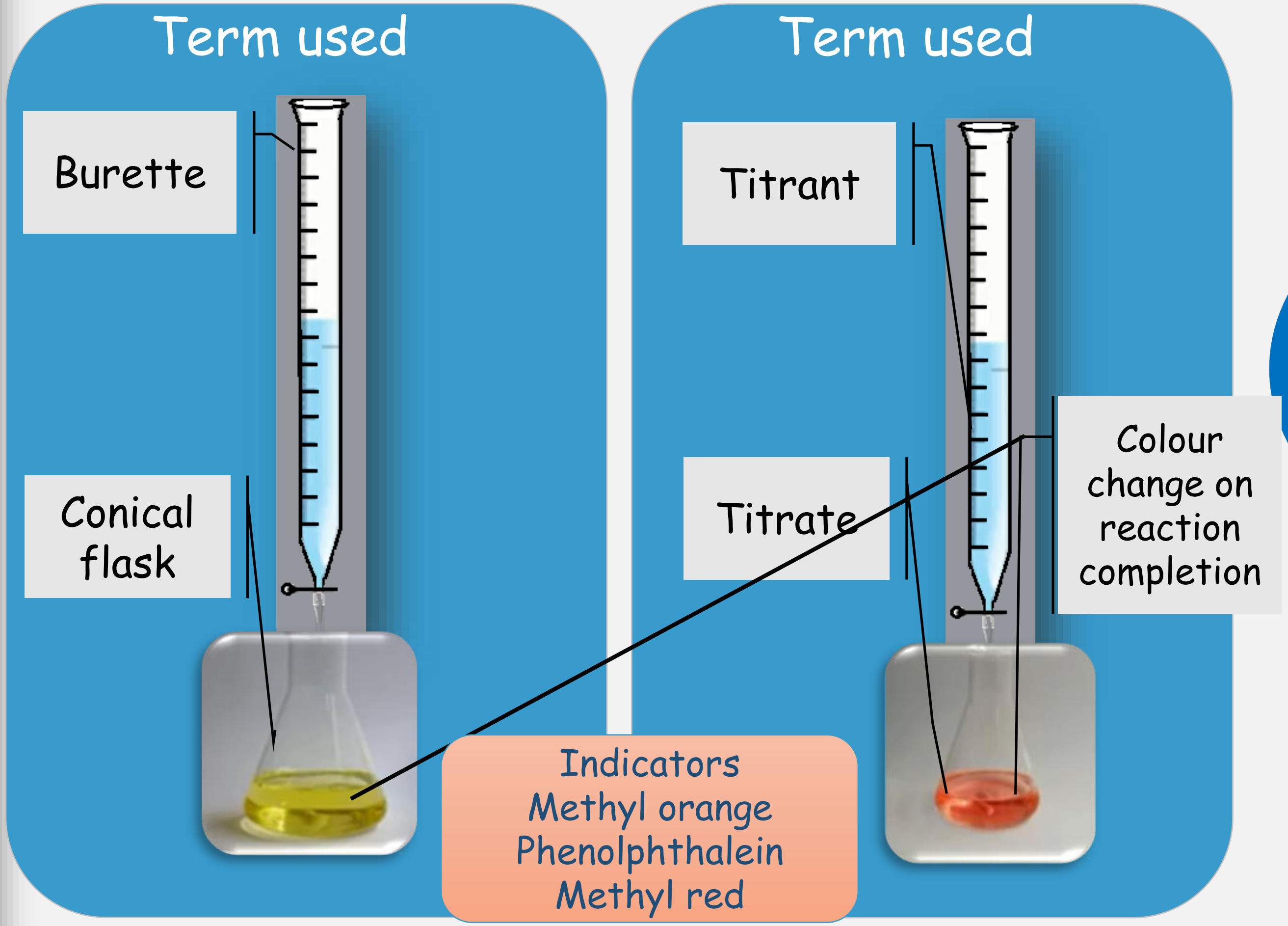
Percent ionization

$$\text{Percent ionization} = \frac{\text{ionized (acid or base) concentration at equilibrium}}{\text{initial concentration of (acid or base)}} \times 100\%$$

Practice Exercise
Example
Example

Volumetric or Titrimetric analysis

An important method for determining the amount of particular substance which is based on measuring the volume of reactant solution.



Volumetric analysis
Ionization Constants
pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Volumetric or Titrimetric analysis

An important method for determining the amount of particular substance which is based on measuring the volume of reactant solution.

Classification of Volumetric

- Acid -Base
- Redox
- Complexometric
- Precipitation
- No-aqueous

Practice Exercise
Example
Example
pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Example(1): Calculate the pH of

(a) a 1×10^{-3}M HCl solution and (b) a 0.020 M $Ba(OH)_2$ solution.

Notes: a means Initial concentrations

Strategy: Keep in mind that HCl is a strong acid and $Ba(OH)_2$ is a strong base. Thus, these species are completely ionized and no HCl or $Ba(OH)_2$ will be left in solution.

Solution(a) The ionization of HCl is

$$HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

The concentrations of all the species $(HCl, H^+$, and $Cl^-)$ before and after ionization can be represented as follows: $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

	$HCl(aq)$	$H^+(aq)$	$Cl^-(aq)$
$Initial\ (M)$:	1.0×10^{-3}	0.0	0.0
$Change(M)$:	-1.0×10^{-3}	$+1.0 \times 10^{-3}$	$+1.0 \times 10^{-3}$
$Final\ (M)$:	0.0	1.0×10^{-3}	1.0×10^{-3}

A positive (+) change represents an increase and a negative (-) change indicates a decrease in concentration. Thus,

$$[H^+] = 1.0 \times 10^{-3} M$$

$$pH = -\log(1.0 \times 10^{-3}) = 3.00$$

Example(1): Calculate the pH of

(a) a 1×10^{-3} M HCl solution and (b) a 0.020 M $Ba(OH)_2$ solution.

Notes: a means Initial concentrations

Strategy: Keep in mind that HCl is a strong acid and $Ba(OH)_2$ is a strong base. Thus, these species are completely ionized and no HCl or $Ba(OH)_2$ will be left in solution.

Solution(b) is a strong base; each $Ba(OH)_2$ unit produces two OH^- ions:

$$Ba(OH)_2(aq) \rightarrow Ba^{+2}(aq) + 2OH^-(aq)$$

The changes in the concentrations of all the species can be represented as follows:

	$Ba(OH)_2(aq) \rightarrow$	$Ba^{+2}(aq) +$	$2OH^-(aq)$
Initial (*M*):	0.020	0.000	0.000
Change (M):	−0.020	+0.020	+2(0.020)
Final (M):	0.00	0.020	0.040

$$[OH^-] = 0.040M$$

$$POH = -log0.040 = 1.40$$

Therefore, from $PH + POH = 14$

$$PH = 14 - POH$$

$$PH = 14 - 1.4 \rightarrow PH = 12.60$$

Practice Exercise
Example
Example
Volumetric analysis
Ionization Constants
pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Example(2): The pH of a 0.10 M solution of formic acid (HCOOH) is 2.39. What is the Ka of the acid?

Strategy: Formic acid is a weak acid. It only partially ionizes in water. Note that the concentration of formic acid refers to the initial concentration, before ionization has started. The pH of the solution, on the other hand, refers to the equilibrium state. To calculate K_a, then, we need to know the concentrations of all three species: $[H^+]$, $[CHCOO^-]$, and $[HCOOH]$ at equilibrium. As usual, we ignore the ionization of water. The following sketch summarizes the situation.

Major species at equilibrium

$$[HCOOH]_0 = 0.1M$$

$$HCOOH \rightleftharpoons H^+ + HCOO^-$$

H^+ $CHCOO^-$ $HCOOH$

$$pH = 2.39$$

$$[H^+] = 10^{-2.39}$$

Practice Exercise
Example
Example
Volumetric analysis
Ionization Constants
pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

Example(2): The pH of a 0.10 M solution of formic acid (HCOOH) is 2.39. What is the Ka of the acid?

Solution: We proceed as follows.

Step 1: The major species in solution are $HCOOH$, H^+, and the conjugate base $HCOO^-$.

Step 2: First we need to calculate the hydrogen ion concentration from the pH value

$$pH = -log[H^+] \Rightarrow \quad 2.39 = -log[H^+]$$

Taking the antilog of both sides, we get

$$[H^+] = 10^{-2.39} = 4.1 \times 10^{-3} \text{M}$$

$$HCOOH \ (aq) \rightleftharpoons \quad H^+(aq) + \quad HCOO^-(aq)$$

	$HCOOH$	H^+	$HCOO^-$
$Initial\ (M)$:	0.10	0.000	0.000
Change (M):	-4.1×10^{-3}	$+4.1 \times 10^{-3}$	$+4.1 \times 10^{-3}$
Final (M):	$0.10 - 4.1 \times 10^{-3}$	4.1×10^{-3}	4.1×10^{-3}

Step 3: The ionization constant of formic acid is given by

$$K_a = \frac{[H^+] \quad [HCOO^-]}{[HCOOH]}$$

$$\Rightarrow \frac{(4.1 \times 10^{-3}) \quad (4.1 \times 10^{-3})}{(0.10 - 4.1 \times 10^{-3})} = 1.8 \times 10^{-4}$$

Practice Exercise

1. Calculate the hydrogen ion concentration in moles per litre for each of these solutions: (a) a solution whose $pH\ is\ 5.20$, (b) a solution whose $pH\ is\ 16.00$;(c) a solution whose hydroxide concentration is 3.7×10^{-9}M.

2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b) $0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

3. The pOH of a solution is 9.40 Calculate the hydrogen ion concentration of the solution.

4. Calculate the number of moles of $KOH\ in\ 5.50\ ml$ of a $0.360\ m\ KOH$ solution. What is the pOH of the solution?

5. A $0.040 M$ solution of a monoprotic acid is 14 perc-
-entionized. Calculate the ionization constant of the acid.

6. (a) Calculate the percent ionization of a $0.20\ M$ solution of the monoprotic acetylsalicylic acid (aspirin)(K_a=3.0×10^{-4}).
(b) The pH of gastric juice in the stomach of a certain individual is 1.00. After a few aspirin tablets have been swallowed, the concentration of acetylsalicylic acid in the stomach is $0.20\ M$. Calculate the percent ionization of the acid under these conditions.

Practice Exercise
Example
Example
Volumetric analysis
Ionization Constants
pH-A Measure
Acid-Base Properties
Acid-Base Properties
Acids, Bases, pH

General Chemistry- First Class

Homework Chapter4/ Solution

By: Dr Shurooq Badri Al-badri

Practice Exercise

1.Calculate the hydrogen ion concentration in moles per litre for each of these solutions: (a) a solution whose $pH\ is\ 5.20$, (b) a solution whose $pH\ is\ 16.00$;(c) a solution whose hydroxide concentration is 3.7×10^{-9}M.

2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b)$0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

3.The$pOH$of a solution is9.40Calculate the hydrogen ion concentration of the solution.

4.Calculate the number of moles of $KOH\ in\ 5.50\ ml$ of a $0.360\ m\ KOH$ solution. What is the $pOH$of the solution?

5. A $0.040M$ solution of a monoprotic acid is 14 percentionized. Calculate the ionization constant of the acid.

6.(a) Calculate the percent ionization of a $0.20\ M$ solution of the monoprotic acetylsalicylic acid (aspirin)(K_a=3.0×10^{-4}).(b) The pH of gastric juice in the stomach of a certain individual is 1.00. After a few aspirin tablets have been swallowed, the concentration of acetylsalicylic acid in the stomach is $0.20\ M$. Calculate the percent ionization of the acid under these conditions.

HW1.Calculate the hydrogen ion concentration in moles per litre for each of these solutions: (a) a solution whose $pH\ is\ 5.20$, (b) a solution whose $pH\ is\ 16.00$;(c) a solution whose hydroxide concentration is 3.7×10^{-9}M.

Strategy: We are given the value of pH and asked to calculate the concentration of$[H^+]$per litre for both (a) and (b), While from (c) we given the concentration by moles and asked to calculate the concentration ofof$[H^+]$per litre. What is the definition of pH? and also ,what is the relationship between $[\mathrm{H}^+]$and $[\mathrm{HO}^-]$?

Solution: We use Equation $[H^+] = 10^{-pH}$ in order to solution (a) and (b), while we use Equation $[H^+]\ [OH^-] = 1.0 \times 10^{-14}$ in order to solution(c).

(a) $[H^+] = 10^{-5.20}$, we need to take the antilog of -5.20 Therefor for $[H^+]$=6.3× 10^6M
Or(يمكن الحل بطريقة اخرى)
we can change$10^{-5.20}$ to became $10^{-6} \times 10^{+0.8}$ (notes:عند الضرب تجمع الاسس اذا كانت الاساسات متشابهة) Therefor we need to take the antilog of +0.8 Therefor for $[H^+]$=6.3× 10^6M.

(b) $[H^+] = 10^{-16}$M.

(c) $[H^+] = \frac{1.0\times10^{-14}}{[OH^-]}$ Therefor for $[H^+] = \frac{1.0\times10^{-14}}{3.7\times10^{-9}}$

$[H^+]$=0.270×10^{-5} (notes :عند القسم تطرح الاسس اذا كانت الاساسات متشابهة)

HW2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b) $0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

Strategy: Keep in mind that HCl, and HNO_3 are strong acid while KOH, and $Ba(OH)_2$ are strong base. Thus, these species are completely ionized and no HCl, and HNO_3 or KOH, and $Ba(OH)_2$ will be left in solution.

Solution (a) The ionization of HCl is $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

The concentrations of all the species (HCl, H^+, and Cl^-) before and after ionization can be represented as follows:

	$HCl(aq)$	$\rightarrow$ $H^+(aq)$	$+$ $Cl^-(aq)$
$Initial\ (M)$:	1.0×10^{-3}	0.0	0.0
$Change(M)$:	-1.0×10^{-3}	$+1.0 \times 10^{-3}$	$+1.0 \times 10^{-3}$
$Final\ (M)$:	0.0	1.0×10^{-3}	1.0×10^{-3}

A positive (+) change represents an increase and a negative (-) change indicates a decrease in concentration. Thus,

$$[H^+] = 1.0 \times 10^{-3} M$$

$$pH = -\log(1.0 \times 10^{-3})$$

$$= 3.00$$

HW2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b) $0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

Strategy: Keep in mind that HCl, and HNO_3 are strong acid while KOH, and $Ba(OH)_2$ are strong base. Thus, these species are completely ionized and no HCl, and HNO_3 or KOH, and $Ba(OH)_2$ will be left in solution.

Solution (b) The ionization of KOH is $KOH(aq) \rightarrow OH^-(aq) + K^+(aq)$

The concentrations of all the species (KOH, K^+, and OH^-) before and after ionization can be represented as follows:

$$KOH(aq) \rightarrow OH^-(aq) + K^+(aq)$$

	$KOH(aq)$	$OH^-(aq)$	$K^+(aq)$
$Initial\ (M)$:	0.76	0.0	0.0
$Change(M)$:	−0.76	+0.76	+0.76
$Final\ (M)$:	0.0	0.76	0.76

A positive (+) change represents an increase and a negative (-) change indicates a decrease in concentration. Thus,

$$[OH^-] = 0.76M$$

$$pOH = -\log(76 \times 10^{-2}) = 0.12$$

Therefore, from $PH + POH = 14$

$$PH = 14 - POH$$

$$PH = 14 - 0.12 \rightarrow PH = 13.88$$

HW2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b) $0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

Strategy: Keep in mind that HCl, and HNO_3 are strong acid while KOH, and $Ba(OH)_2$ are strong base. Thus, these species are completely ionized and no HCl, and HNO_3 or KOH, and $Ba(OH)_2$ will be left in solution.

Solution(c) is a strong base; each $Ba(OH)_2$ unit produces two OH^- ions:

$$Ba(OH)_2(aq) \rightarrow Ba^{+2}(aq) + 2OH^-(aq)$$

The changes in the concentrations of all the species can be represented as follows:

$$Ba(OH)_2(aq) \rightarrow Ba^{+2}(aq) + 2OH^-(aq)$$

	$Ba(OH)_2(aq)$	$Ba^{+2}(aq)$	$2OH^-(aq)$
Initial (M):	2.8×10^{-4}	0.000	0.000
Change (M):	-2.8×10^{-4}	$+2.8 \times 10^{-4}$	$+2(2.8 \times 10^{-4})$
Final (M):	0.00	2.8×10^{-4}	5.6×10^{-4}

$[OH^-] = 5.6 \times 10^{-4} M$ Equation $[H^+][OH^-] = 1.0 \times 10^{-14}$

$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]}$ Therefor for $[H^+] = \frac{1.0 \times 10^{-14}}{5.6 \times 10^{-4} M}$, $[H^+] = 0.17 \times 10^{-10}$

$$pH = -\log(0.17 \times 10^{-10}) = -\log(17 \times 10^{-12})$$

$$pH = 10.77$$

HW2. Calculate the pH of each of these solutions: (a) $0.0010 M HCl$, (b) $0.76 M KOH$, (c) $2.8 \times 10^{-4} Ba(OH)_2$, (d) $5.2 \times 10^{-4} M\ HNO_3$.

Strategy: Keep in mind that HCl, and HNO_3 are strong acid while KOH, and $Ba(OH)_2$ are strong base. Thus, these species are completely ionized and no HCl, and HNO_3 or KOH, and $Ba(OH)_2$ will be left in solution.

Solution (d) The ionization of HNO_3 is $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

The concentrations of all the species (HNO_3, H^+, and NO_3^-) before and after ionization can be represented as follows:

	$HNO_3(aq)$	$\rightarrow H^+(aq)$	$+\ NO_3^-(aq)$
$Initial\ (M)$:	5.2×10^{-4}	0.0	0.0
$Change(M)$:	-5.2×10^{-4}	$+5.2 \times 10^{-4}$	$+5.2 \times 10^{-4}$
$Final\ (M)$:	0.0	5.2×10^{-4}	5.2×10^{-4}

A positive (+) change represents an increase and a negative (-) change indicates a decrease in concentration. Thus,

$$[H^+] = 5.2 \times 10^{-4} M$$

$$pH = -\log(5.2 \times 10^{-4})$$

$$= 3.283$$

HW3. The pOH of a solution is 9.40, Calculate the hydrogen ion concentration of the solution.

Strategy: We are given the value of pOH and asked to calculate the concentration of $[H^+]$, *therfore we have two way to solution due to we have two* Equation

$$pH + pOH = 14 \ or \ [H^+][OH^-] = 1.0 \times 10^{-14}$$

And also $[H^+] = 10^{-pH}$ or $[OH^-] = 10^{-pOH}$

Solution : POH=9.40 therefore PH=14-9.40,PH=4.6

$[H^+] = 10^{-4.6}$

$[H^+] = 10^{-4.6} \times 10^{+5} \times 10^{-5}$ (notes:عند الضرب تجمع الاسس اذا كانت الاساسات متشابهة)

$[H^+] = 10^{0.4} \times 10^{-5}$

therefore $[H^+] = 2.5 \times 10^{-5}$

HW4. Calculate the number of moles of $KOH\ in\ 5.50\ ml$ of a $0.360\ m\ KOH$ solution. What is the pOH of the solution?

Strategy: We are given the value solution 5.5ml and the initial concentration 0.360 and the equation of the calculate mole $=\frac{Wt}{Mwt} \times \frac{1000}{Vml}$ and also Mwt=∑(الوزن الجزيئي يساوي مجموع الاوزان الذرية),K=39,O=16,H=1

Mwt =K+O+H ,Mwt =$(39 \times 1) + (16 \times 1) + (1 \times 1)$,Mwt=56, mole=0.360M,v=5.5ml

Solution:mole $=\frac{Wt}{Mwt} \times \frac{1000}{\mathrm{Vml}}$, $0.36 = \frac{Wt}{56} \times \frac{1000}{5.5ml}$ Wt=$\frac{0.36\times56\times5.5}{1000}$ Wt=0.11088

N of Mole=$\frac{Wt}{\mathrm{Mwt}}$ N of M =1.98×10^{-3}

$$KOH(aq) \rightarrow OH^{-}(aq) + K^{+}(aq)$$

	KOH	OH^-	K^+
$Initial\ (M)$:	0.36	0.0	0.0
$Change(M)$:	-0.36	$+0.36$	$+0.36$
$Final\ (M)$:	0.0	0.36	0.36

A positive (+) change represents an increase and a negative (-) change indicates a decrease concentration. Thus,

$$[OH^-] = 0.36M$$

$$pOH = -\log(36 \times 10^{-2})$$

$$= 0.444$$

HW5. A $0.040M$ solution of a monoprotic acid is 14 percentionized. Calculate the ionization constant of the acid.

Strategy: Keep in mind equation

$$Percent\ ionization = \frac{ionized\ acid\ concentration\ at\ equilibrium}{initial\ concentration\ of\ acid} \times 100\%$$

Solution: $14\% = \frac{[H^+]}{0.040\text{M}} \times 100\%$, $[H^+] = 56 \times 10^{-4}$

	HA(aq) →	$\text{A}^-\text{(aq)}$ +	$\text{H}^+\text{(aq)}$
Initial (M):	0.04	0.0	0.0
Change (M):	$0.04 - X$	X	X
	$0.04 - 56 \times 10^{-4}$	56×10^{-4}	56×10^{-4}
Final (M):	0.0344	56×10^{-4}	56×10^{-4}

$K_a = \frac{[X]\ [X]}{[0.04 - X]}$, $K_a = \frac{[56\times10^{-4}]\ [56\times10^{-4}]}{[0.04 - 56\times10^{-4}]}$, $K_a = 91162.79$

HW6.(a) Calculate the percent ionization of a $0.20\ M$ solution of the monoprotic acetylsalicylic acid (aspirin)(K_a=3.0×10^{-4}).(b) The pH of gastric juice in the stomach of a certain individual is 1.00. After a few aspirin tablets have been swallowed, the concentration of acetylsalicylic acid in the stomach is $0.20\ M$. Calculate the percent ionization of the acid under these conditions.

Strategy: Keep in mind equation

$$Percent\ ionization = \frac{ionized\ acid\ concentration\ at\ equilibrium}{initial\ concentration\ of\ acid} \times 100\%$$

And also $[\,H^+\,] = 10^{-pH}$

Solution(a): $C_9H_8O_4\ (aq) \rightleftharpoons C_9H_7O_4^-\ (aq) + H^+\ (aq)$

	$C_9H_8O_4$	$C_9H_7O_4^-$	H^+
Initial (M):	0.20	0.0	0.0
Change(M):	$0.20 - X$	$+X$	$+X$
Equilibrium (M):	$0.2 - X$	X	X

$K_a = \frac{[X]\ \ [X]}{[0.20-X]}$, $3.0 \times 10^{-4} = \frac{[X]\ \ [X]}{[0.20-X]}$ *Because K_a is very small and the initial concentration of the base is large, wecan apply the approximation* $0.20 - X \approx 0.20$:

$, 3.0 \times 10^{-4} = \frac{X^2}{[0.20-X]} \approx 3.0 \times 10^{-4} = \frac{X^2}{0.20}, X = 0.77 \times 10^{-2}$

$$Percent\ ionization = \frac{ionized\ acid\ concentration\ at\ equilibrium}{initial\ concentration\ of\ acid} \times 100\%\ , Percent = 3.85\%$$

HW6.(a) Calculate the percent ionization of a $0.20\ M$ solution of the monoprotic acetylsalicylic acid (aspirin)(K_a=3.0×10^{-4}).(b) The pH of gastric juice in the stomach of a certain individual is 1.00. After a few aspirin tablets have been swallowed, the concentration of acetylsalicylic acid in the stomach is $0.20\ M$. Calculate the percent ionization of the acid under these conditions.

Solution(a): $[\ H^+\ ]=\ 10^{-pH}$, $[\ H^+\ ]$=0.1

$$C_9H_8O_4\ (aq) \rightleftharpoons C_9H_7O_4^-\ (aq) + H^+\ (aq)$$

Initial (M):	0.20	0.0	0.0
Change(M):	$-X$	$+X$	$+X$
Equilibrium (M):	$0.2 - X$	X	$0.1 + X$

$$K_a = \frac{[X]\quad[0.1+X]}{[0.20-X]},\ 3.0 \times 10^{-4} = \frac{[X]\quad[0.1+X]}{[0.20-X]}\ , X = 6.0 \times 10^{-4}$$

$$Percent\ ionization = \frac{ionized\ acid\ concentration\ at\ equilibrium}{initial\ concentration\ of\ acid} \times 100\%\ ,$$

$$Percent = \frac{6.0\times10^{-4}}{0.2} \times 100\%\ ,\ Percent = 0.30\%$$

CHAPTER 5

Introduction

to

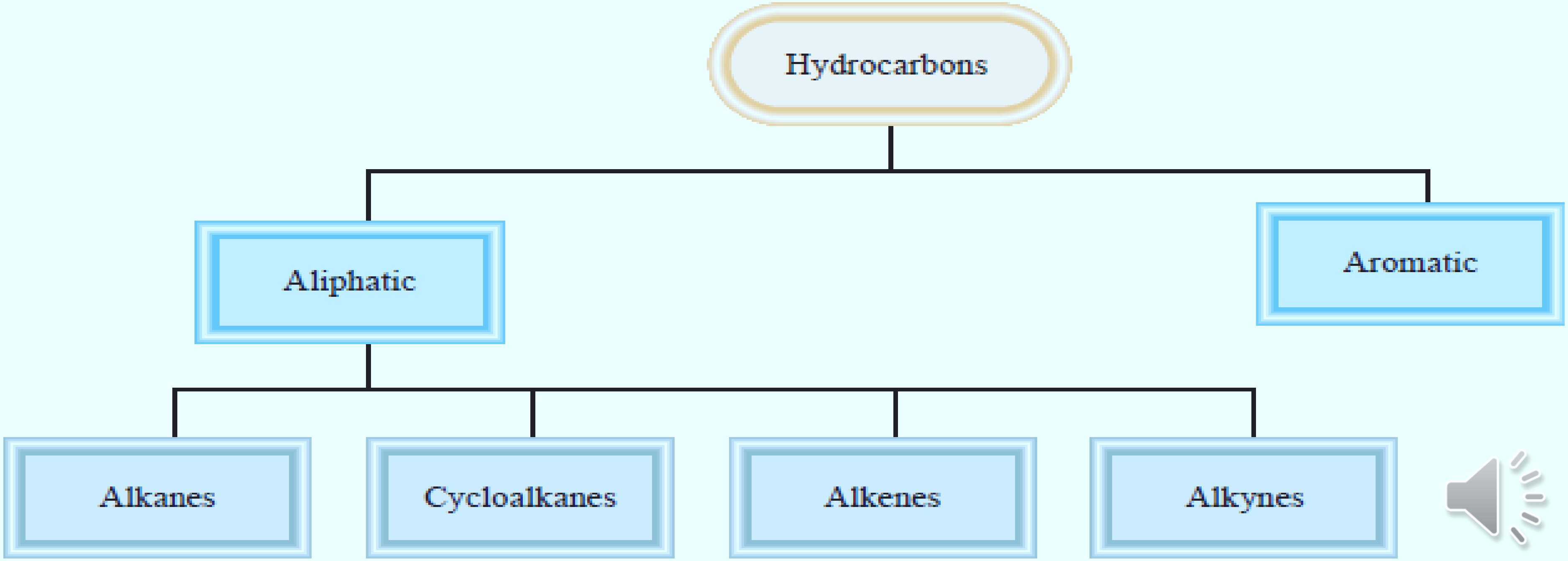
Organic Chemistry

5.1 Introduction to Organic Chemistry

The branch of chemistry that deals with carbon compounds is Organic Chemistry. The hydrocarbons are used as fuels for domestic and industrial heating, for generating electricity and powering internal combustion engines, and as starting materials for the chemical industry. Biomolecules such as proteins, carbohydrates, fats, and nucleic acids are organic compound. Wool, cotton and silk, in addition to nylon and acrylates, …etc. (the raw materials in cloths and furniture industry), are organic compounds. All plastic materials, and some dyes and paints are organic compounds. Detergents, drugs, and deferent pharmaceutical products and perfumes are basically organic compounds. Furthermore, some organic compounds with special structural properties, are recently incorporated in the industry of deferent electronic devices.

Hydrocarbons

The simplest type of organic compounds is the hydrocarbons, which contain only carbon and hydrogen atoms. Carbon can form more compounds than most other elements because carbon atoms are able not only to form single, double, and triple carbon-carbon bonds, but also to link up with each other in chains and ring structures. All organic compounds are derived from the *hydrocarbons* because they are made up of only *hydrogen and carbon.* On the basis of structure, hydrocarbons are divided into two main classes—aliphatic and aromatic. *Aliphatic hydrocarbons do not contain the benzene group, or the benzene ring*, whereas *aromatic hydrocarbons contain one or more benzene rings.*



Aliphatic Hydrocarbons

Aliphatic hydrocarbons are divided into alkanes, cycloalkanes, alkenes, and alkynes

Alkanes

Alkanes are hydrocarbons that have the general formula C_nH_{2n+2}, where n = 1, 2, 3. . . The essential characteristic of alkanes is that only single covalent bonds are present. The alkanes are known as saturated hydrocarbons because they contain the maximum number of hydrogen atoms that can bond with the number of carbon atoms present.

Structures of the first four alkanes. Note that butane can exist in two structurally different forms, called structural isomers.

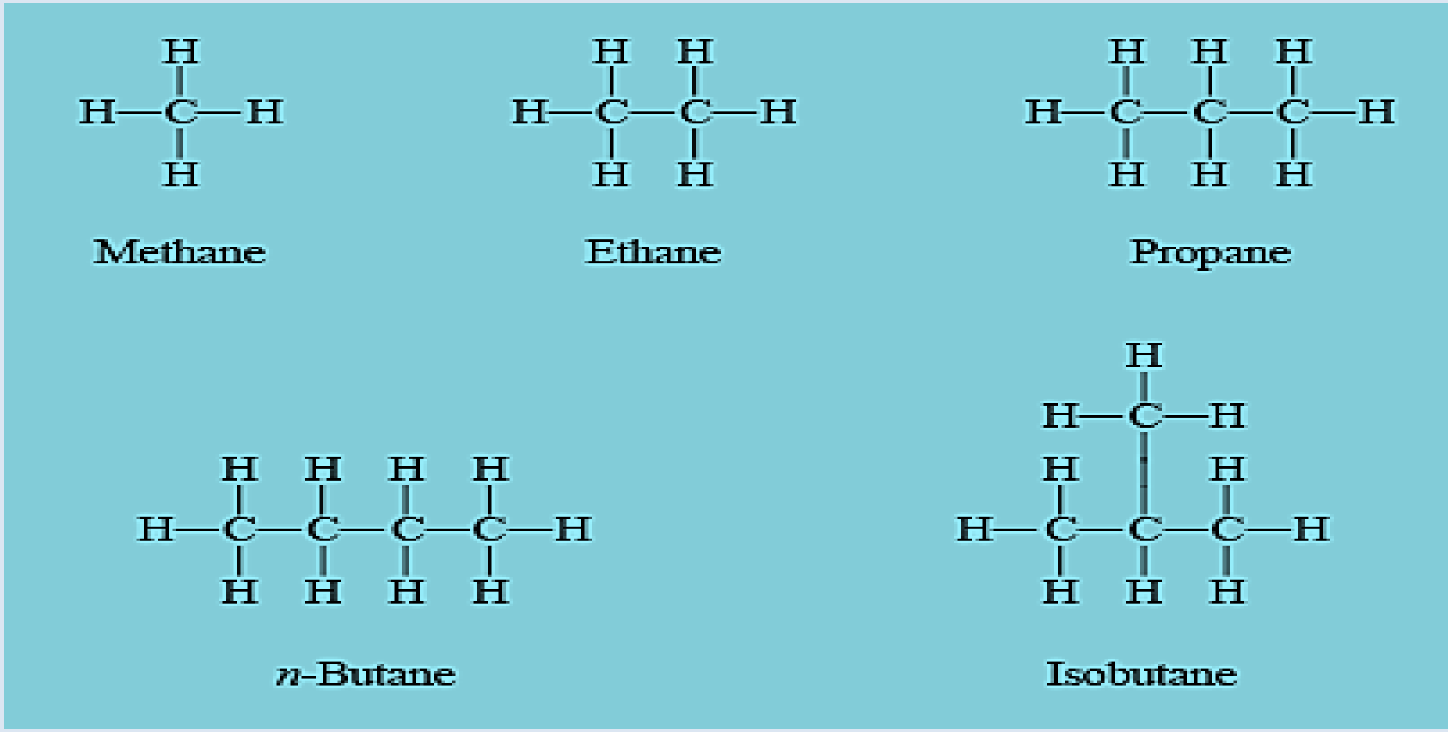


Table 5.1 shows the melting and boiling points of the straight-chain isomers of the first 10 alkanes. The first four are gases at room temperature; and pentane through decane are liquids. As molecular size increases, so does the boiling point.

Table 5.1

Name of Hydrocarbon	Molecular Formula	Number of Carbon Atoms	Melting Point (°C)	Boiling Point (°C)
Methane	CH_4	1	−182.5	−161.6
Ethane	$CH_3—CH_3$	2	−183.3	−88.6
Propane	$CH_3—CH_2—CH_3$	3	−189.7	−42.1
Butane	$CH_3—(CH_2)_2—CH_3$	4	−138.3	−0.5
Pentane	$CH_3—(CH_2)_3—CH_3$	5	−129.8	36.1
Hexane	$CH_3—(CH_2)_4—CH_3$	6	−95.3	68.7
Heptane	$CH_3—(CH_2)_5—CH_3$	7	−90.6	98.4
Octane	$CH_3—(CH_2)_6—CH_3$	8	−56.8	125.7
Nonane	$CH_3—(CH_2)_7—CH_3$	9	−53.5	150.8
Decane	$CH_3—(CH_2)_8—CH_3$	10	−29.7	174.0

Alkane Nomenclature

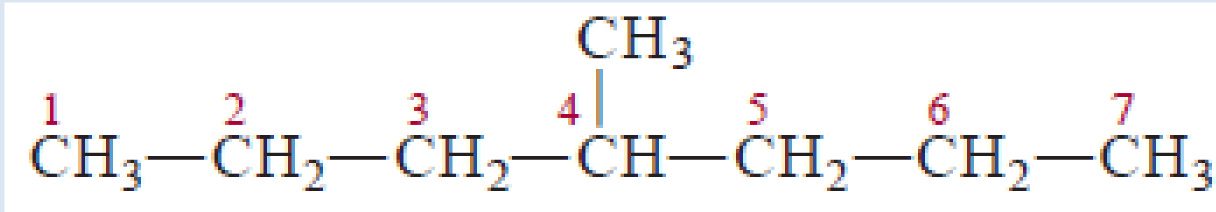
The nomenclature of alkanes and all other organic compounds is based on the recommendations of the International Union of Pure and Applied Chemistry (IUPAC). The first four alkanes (methane, ethane, propane, and butane) have nonsystematic names. As Table 5.2 shows, the number of carbon atoms is reflected in the Greek prefixes for the alkanes containing 5 to 10 carbons.

Table 5.2

Name of Hydrocarbon	Molecular Formula	Number of Carbon Atoms
Methane	CH_4	1
Ethane	$CH_3—CH_3$	2
Propane	$CH_3—CH_2—CH_3$	3
Butane	$CH_3—(CH_2)_2—CH_3$	4
Pentane	$CH_3—(CH_2)_3—CH_3$	5
Hexane	$CH_3—(CH_2)_4—CH_3$	6
Heptane	$CH_3—(CH_2)_5—CH_3$	7
Octane	$CH_3—(CH_2)_6—CH_3$	8
Nonane	$CH_3—(CH_2)_7—CH_3$	9
Decane	$CH_3—(CH_2)_8—CH_3$	10

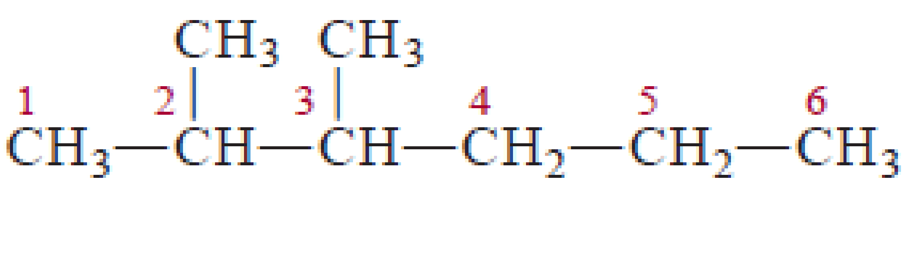
The IUPAC Rules for Alkane Nomenclature

1. نحدد السلسلة الام (وهي أطول سلسلة لذرات الكاربون في الجزيئة) و من ثم ترقم ذرات ال C مع مراعاة ان تأخذ ذرة C المتفرعة اصغر الارقام و يسمى المركب حسب عدد ذرات C المكونة لتلك السلسلة (راجع الجدول في السلايد السابق). فمثلا يسمى المركب التالي heptane لان السلسلة الأطول مكونة من سبعة ذرات C

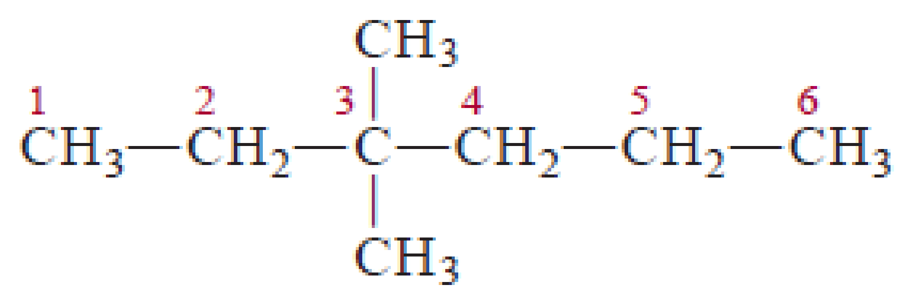


2. الالكان المتفرع: يسمى التفرع بمجموعة الالكيل (alkyl group) و حسب عدد ذرات C لذلك التفرع. فاذا كان مكون من ذرة C واحدة يسمى methyl واذا تكون من ذرتي C فيسمى ethyl .. وهكذا (أي يحذف المقطع –ane من نهاية اسم الالكان الأصلي و يستبدل بالمقطع –yl لينتج اسم مجموعة الالكيل المتفرعة من السلسة الام). وبذلك يصبح اسم المركب أعلاه 4-Methylheptane .

3. في حالة وجود اكثر من مجموعة الكيل فرعية و من نفس النوع نستخدم عندها البادئ (-di لمجموعتين) و (-tri لثلاث مجاميع) و (-tetra لأربع مجاميع) و (-penta لخمسة مجاميع) ... وهكذا وذلك قبل اسم المجموعة مع كتابة رقم ذرة C التي تحمل ذلك التفرع لتحديد موقعها على السلسلة الام. كما في المثالين الاتيين:

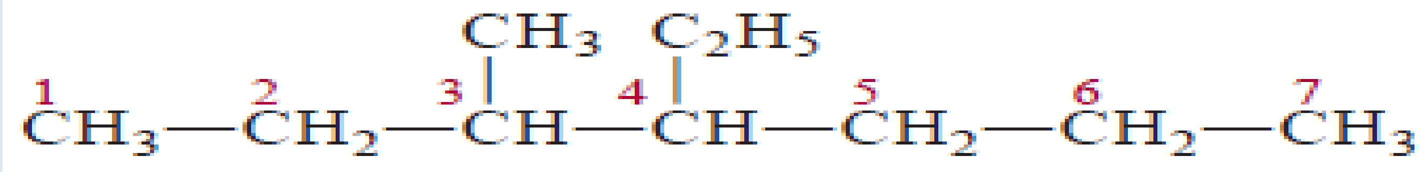


2,3-dimethylhexane



3,3-dimethylhexane

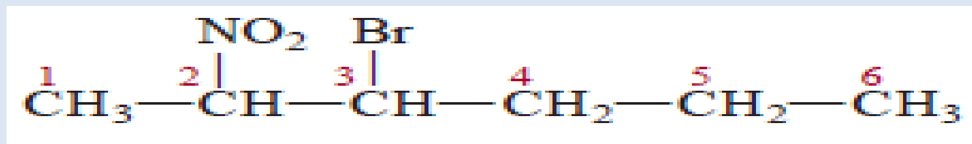
اما اذا كانت **التفرعات** عبارة عن **مجاميع الكيل مختلفة** فعندئذ يكتب اسم كل مجموعة مسبوقا بالرقم الدال على موقعها على السلسلة مع مراعاة التسلسل الابجدي للحروف في اسبقية كتابتها ، كما في المثال الاتي:



4-ethyl-3-methylheptane

4. في حالة وجود مجاميع معوضة على الالكان مثل NO_2, Br, Cl, F وغيرها ، فعندها يكتب اسم المجموعة المعوضة مسبوقا برقم ذرة C الحاملة لها مع مراعاة التسلسل الابجدي في اسبقية كتابتها ضمن الاسم (مع مراعاة القاعدة العامة في ان اتجاه الترقيم للسلسلة الام يجب ان يعطي المجاميع المعوضة اصغر الأرقام).

3-bromo-2-nitrohexane



Common Alkyl Groups

Name	Formula
Methyl	$-CH_3$
Ethyl	$-CH_2-CH_3$
n-Propyl	$-(CH_2)_2-CH_3$
n-Butyl	$-(CH_2)_3-CH_3$
Isopropyl	$-\underset{CH_3}{\overset{CH_3}{C}}-H$

Names of Common Substituent Groups

Functional Group	Name
$-NH_2$	Amino
$-F$	Fluoro
$-Cl$	Chloro
$-Br$	Bromo
$-I$	Iodo
$-NO_2$	Nitro

Reactions of Alkanes

Alkanes are generally not considered to be very reactive substances. However, under suitable conditions they do react.

1. **Combustion Reaction: Natural gas, gasoline, and fuel oil are alkanes that undergo highly exothermic combustion reactions:**

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H^\circ = -890.4\ \text{kJ/mol}$$
$$2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l) \qquad \Delta H^\circ = -3119\ \text{kJ/mol}$$

These, and similar combustion reactions, have long been utilized in industrial processes and in domestic heating and cooking.

2. Halogenation of alkanes: The replacement of one or more hydrogen atoms by halogen atoms. When a mixture of methane and chlorine is heated above 100°C or irradiated with light of a suitable wavelength, methyl chloride is produced:

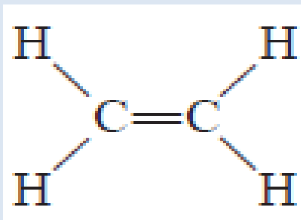
$$CH_4(g) + Cl_2(g) \longrightarrow \underset{\text{methyl chloride}}{CH_3Cl(g)} + HCl(g)$$

If an excess of chlorine gas is present, the reaction can proceed further:

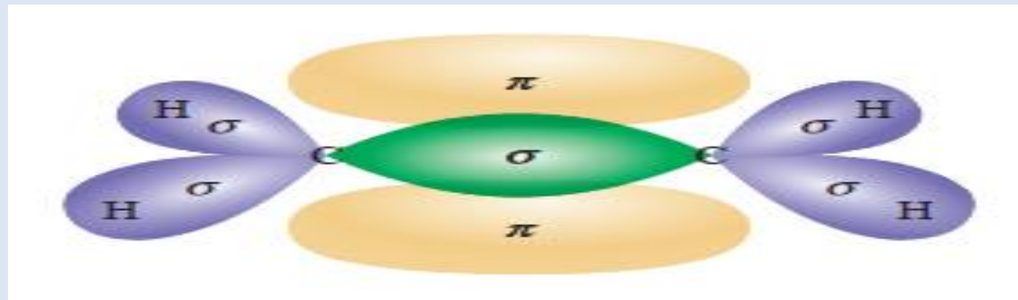
$$CH_3Cl(g) + Cl_2(g) \longrightarrow \underset{\text{methylene chloride}}{CH_2Cl_2(l)} + HCl(g)$$
$$CH_2Cl_2(l) + Cl_2(g) \longrightarrow \underset{\text{chloroform}}{CHCl_3(l)} + HCl(g)$$
$$CHCl_3(l) + Cl_2(g) \longrightarrow \underset{\text{carbon tetrachloride}}{CCl_4(l)} + HCl(g)$$

Alkenes

The alkenes (also called *olefins*) contain at least one carbon-carbon double bond. Alkenes have the general formula C_nH_{2n}, where n = 2, 3, ... The simplest alkene is ethylene C_2H_4, in which both carbon atoms are sp^2-hybridized and the double bond is made up of a sigma (σ) bond and a pi (π) bond.

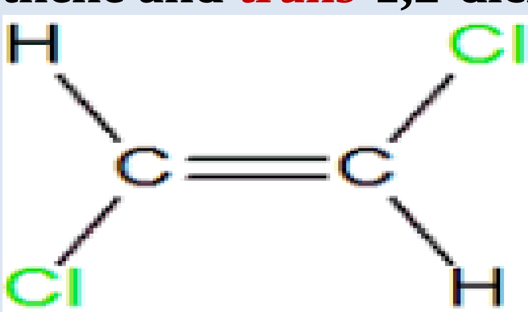


Ethylene

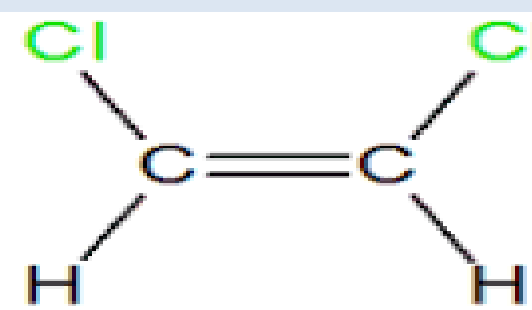


Geometric Isomers of Alkenes (الايزومرات الهندسية للالكينات)

Molecules containing carbon-carbon double bonds (that is, the alkenes) may have ***geometric isomers***, ***which have the same type and number of atoms and the same chemical bonds but different spatial arrangements.*** The molecule dichloroethene, ClHC=CHCl, can exist as one of the two geometric isomers called *cis*-1,2 dichloroethene and *trans*-1,2-dichloroethene:



trans-1,2-dichloroethene



cis-1,2-dichloroethene

cis means that two particular atoms (or groups of atoms) are **adjacent** to each other.

cis ذرتين او مجموعتين متشابهة تقع على جانب واحد من جزيئة الالكين

trans means that the two atoms (or groups of atoms) are **across** from each other.

trans ذرتين او مجموعتين متشابهة تقع على جانبي جزيئة الالكين

Alkene Nomenclature

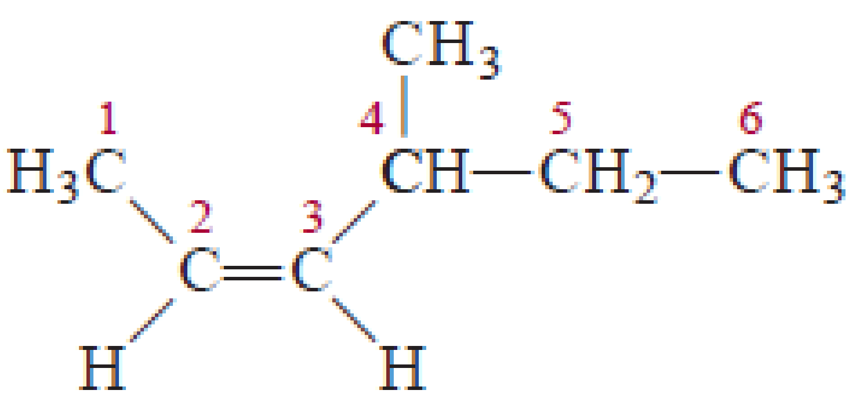
نتبع نفس قواعد تسمية الالكانات و يراعى عند ترقيم السلسلة الأطول **ان تأخذ الاصرة المزدوجة اصغر الأرقام** ويستبدل المقطع **(-ane)** في نهاية اسم الالكان بالمقطع **(-ene)** . ويجب تحديد نوع الايزومير الهندسي هل هو ***cis*** او ***trans*** لجزيئة الالكين. كما في الأمثلة الاتية:

$CH_2{=}CH{-}CH_2{-}CH_3$

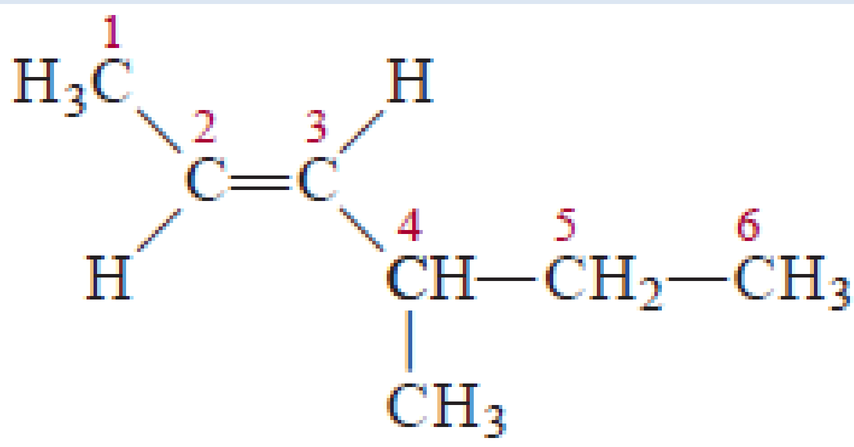
1-butene

$H_3C{-}CH{=}CH{-}CH_3$

2-butene



cis-4-methyl-2-hexene



trans-4-methyl-2-hexene

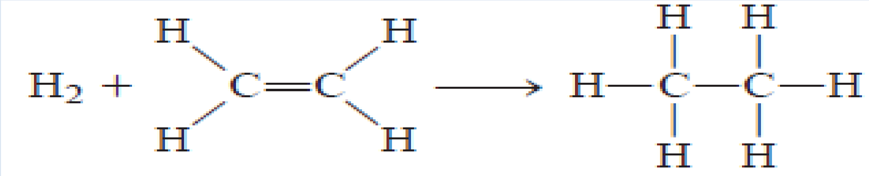
Properties and Reactions of Alkenes

Ethylene is an extremely important substance because it is used in large quantities in manufacturing organic polymers (very large molecules) and in preparing many other organic chemicals. Ethylene and other alkenes are prepared industrially by the *cracking* process, that is, the thermal decomposition of a large hydrocarbon into smaller molecules. When ethane is heated to about 800 °C in the presence of platinum it undergoes the following reaction. Other alkenes can be prepared by cracking the higher members of the alkane family.

$$C_2H_6(g) \xrightarrow[\text{catalyst}]{\text{Pt}} CH_2{=}CH_2(g) + H_2(g)$$

Alkenes are classified as ***unsaturated hydrocarbons***, ***compounds with double or triple carbon-carbon bonds***. Unsaturated hydrocarbons commonly undergo ***addition reactions*** in which ***one molecule adds to another to form a single product***, as follows:

1. Hydrogenation: addition of hydrogen gas to C=C
2. Halogenation: addition of halogen X_2 (X = F, Cl, Br, or I) to C=C
3. Addition of HX (X= F, Cl, Br, or I) to C=C



Hydrogenation

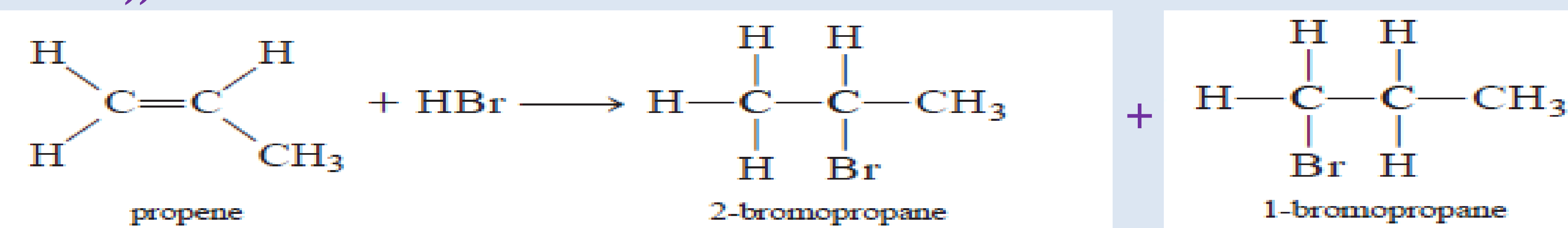
$$H_2C{=}CH_2 + X_2 \longrightarrow CH_2X{-}CH_2X$$

Halogenation

$$H_2C{=}CH_2 + HX \longrightarrow CH_3{-}CH_2X$$

Addition of HX

The addition of a hydrogen halide (HX) to an unsymmetrical alkene such as propene is obey *Markovnikov's rule* ((the addition of unsymmetrical (that is, polar) reagents to alkenes, the positive portion of the reagent (usually hydrogen) adds to the carbon atom in the double bond that already has the most hydrogen atoms)).



إضافة HX على الاصرة المزدوجة للالكين غير المتناظر تتم حسب قاعدة ماركوفنكوف حيث ((يضاف الجزء الموجب (H^+) على ذرة C الاصرة المزدوجة الحاملة لاكبر عدد من ذرات H ويضاف الجزء السالب (X^-) على ذرة C الأخرى)). لذلك تفاعل ال propene مع HBr يعطي ناتج واحد فقط وهو 2-bromopropane

Alkynes

Alkynes **contain at least one carbon-carbon triple bond** $C{\equiv}C$**. They have the general formula** C_nH_{2n-2}**, where n= 2, 3, ...**

لتسمية الالكاين تتبع نفس قواعد التسمية العامة في الالكانات وترقم أطول سلسلة في الجزيئة على ان تأخذ ذرة C الاصرة الثلاثية اصغر الأرقام في السلسلة وينتهي اسم الالكاين بالمقطع (-yne) بدلا من(-ane) في اسم الالكان المقابل. كما في الأمثلة :

$HC{\equiv}C{-}CH_2{-}CH_3$ — 1-butyne

$H_3C{-}C{\equiv}C{-}CH_3$ — 2-butyne

ملاحظة: لا توجد ايزومرات هندسية في الالكاينات أي ان الالكاينات لا تحتوي *cis* و *trans*

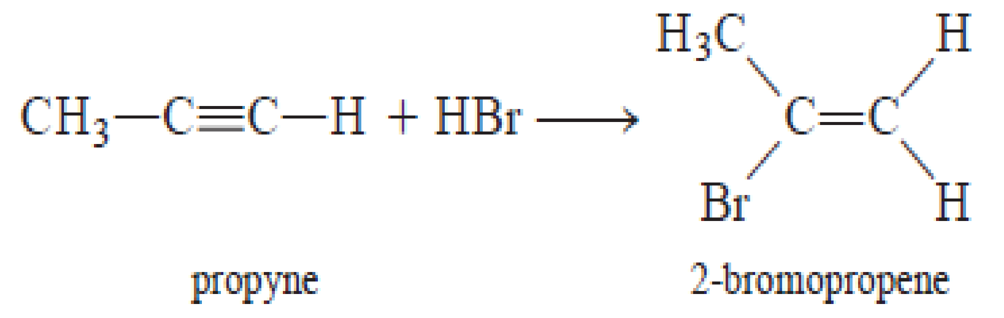
Reactions of Alkynes

1. $C_2H_2(g) + H_2(g) \longrightarrow C_2H_4(g)$ ***Hydogenation***

2. ***Halogenation***

$$CH{\equiv}CH(g) + X_2(g) \longrightarrow CHX{=}CHX(g)$$

$$CH{\equiv}CH(g) + 2X_2(g) \longrightarrow CHX_2{-}CHX_2(l)$$

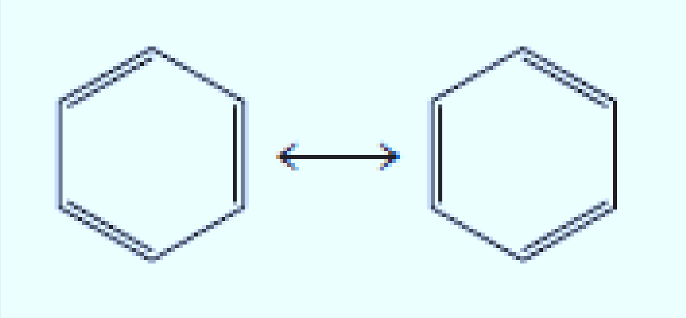
3. 

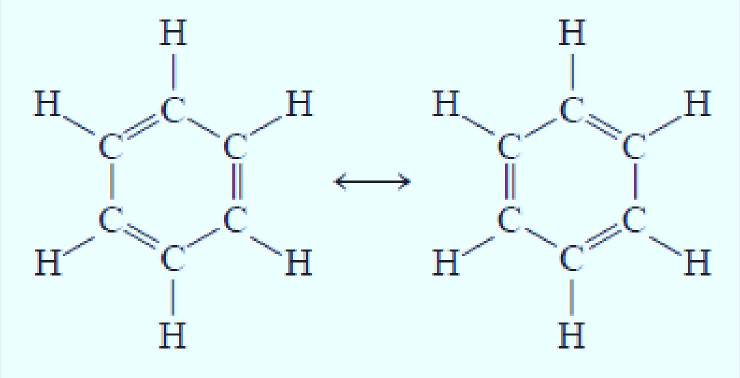
Addition of HX (Markovnikov's rule)

(X = F, Cl, Br, or I)

Aromatic Hydrocarbons

Benzene (C_6H_6) is the parent compound of this large family of organic substances. It is best represented by both of the following resonance structure:



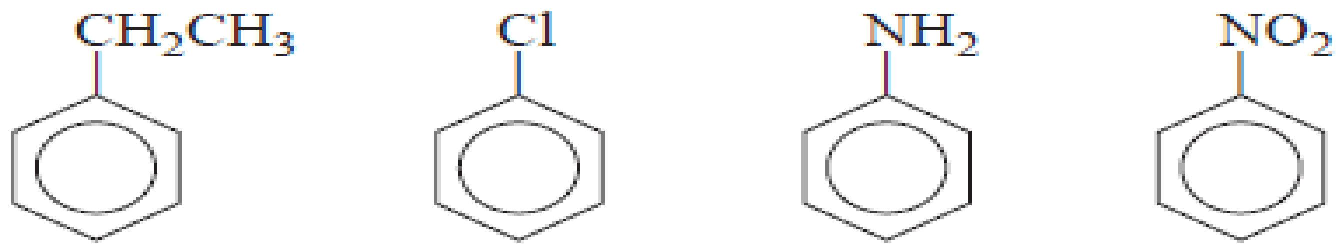


Benzene is a planar hexagonal molecule with carbon atoms situated at the six corners. All carbon–carbon bonds are equal in length and strength, as are all carbon–hydrogen bonds, and the CCC and HCC angles are all 120.

Benzene is a colorless, flammable liquid obtained chiefly from petroleum and coal tar. Perhaps the most remarkable chemical property of benzene is its relative inertness. Although it has the same empirical formula as acetylene (CH) and a high degree of unsaturation, it is much less reactive than either ethylene or acetylene. The stability of benzene is the result of electron delocalization.

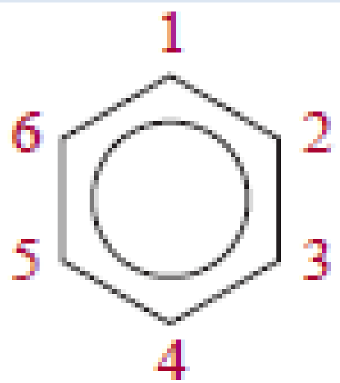
Nomenclature of Aromatic Compounds

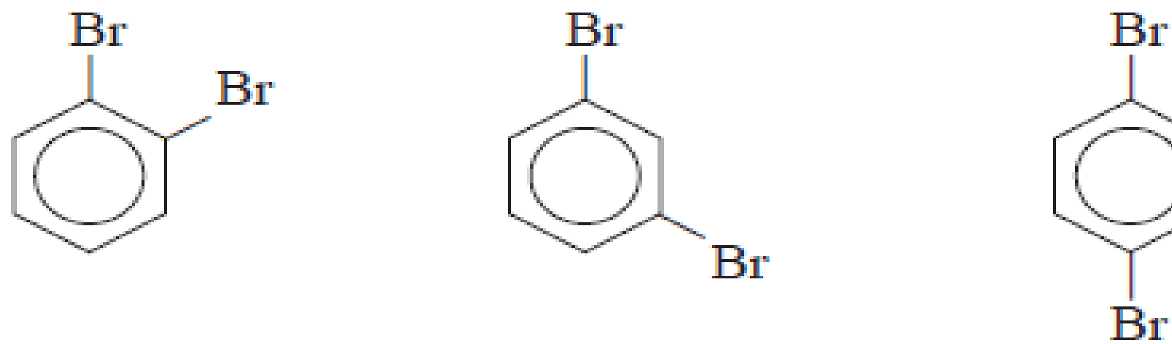
- The naming of **monosubstituted benzenes**, that is, benzenes in which one H atom has been replaced by another atom or a group of atoms, is quite straightforward, as shown next:



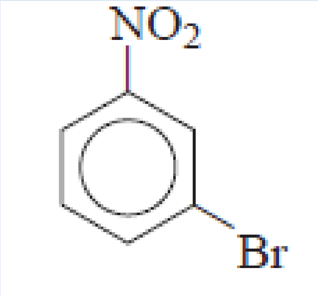
ethylbenzene | chlorobenzene | aminobenzene (aniline) | nitrobenzene

If **more than one substituent** is present, we must **indicate the location of the second group relative to the first**. The systematic way to accomplish this is to number the carbon atoms as follows: (The prefixes ***o-* (*ortho-*), *m-* (*meta-*), and *p-* (*para-*)** are also used to denote the relative positions of the two substituted groups)



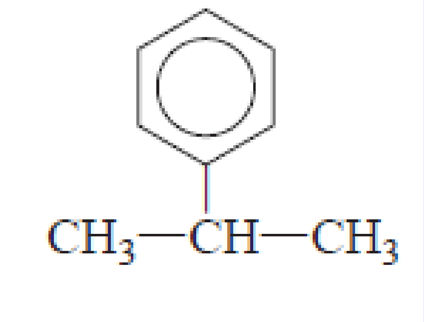


1,2-dibromobenzene (*o*-dibromobenzene) | 1,3-dibromobenzene (*m*-dibromobenzene) | 1,4-dibromobenzene (*p*-dibromobenzene)

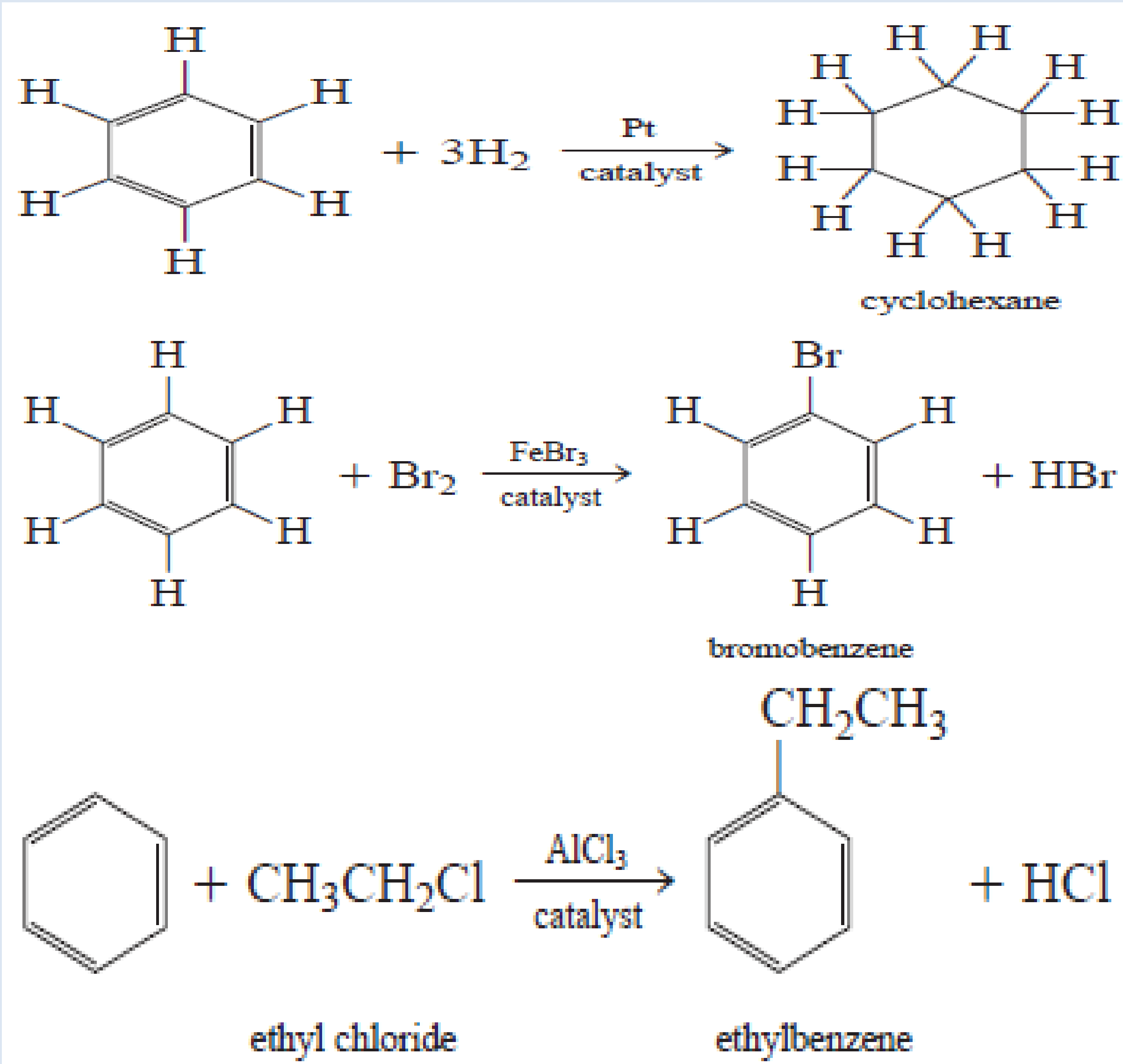
- **Compounds in which the two substituted groups are different are named accordingly. Thus,**  **is named 3-bromonitrobenzene, or *m*-bromonitrobenzene.**

- **Finally we note that the group containing benzene minus a hydrogen atom (C_6H_5) is called the *phenyl* group. Thus, the following molecule is called**

2-phenylpropane



Some Reactions of Aromatic Compounds



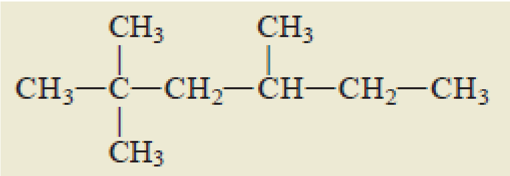
Hydrogenaton

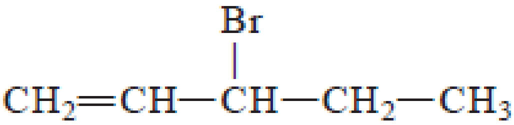
Halogenation

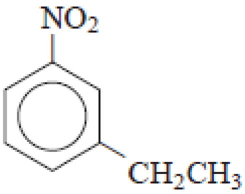
Alkylation

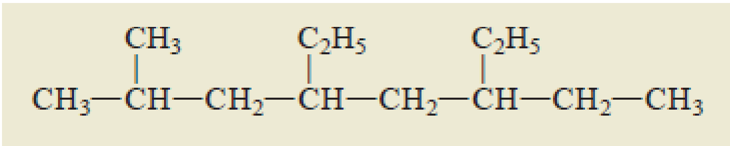
Homework (3)/ Introduction to Organic Chemistry

Q1) Give the IUPAC name of the following compounds:









Q2) Write the structure for each of the following compounds:

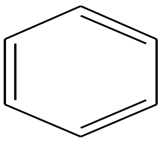
(a) 2,3-Dimethylpentane (b) 1-Bromo-3-methylbenzene

(c) cis-2-Butene

Q3) Complete the following chemical equations:

(a) $CH_3CH_3 + Br_2 \longrightarrow$

(b) $CH_3—C\equiv C—H + HCl \longrightarrow$

(c)  $+ CH_3Cl \xrightarrow[\text{catalyst}]{AlCl_3}$

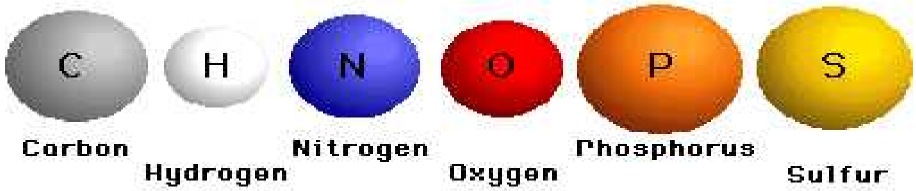
Biochemistry

Biochemistry is the study of chemical processes that relating to living organisms

الكيمياء الحياتية :هي دراسة العمليات الكيميائية المتعلقة بالكائنات الحية.

1. *The chemical elements of life*:

Although more than 25 types of elements can be found in biomolecules, six elements are most common. These are called the CHNOPS elements; the letters stand for the chemical abbreviations of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.



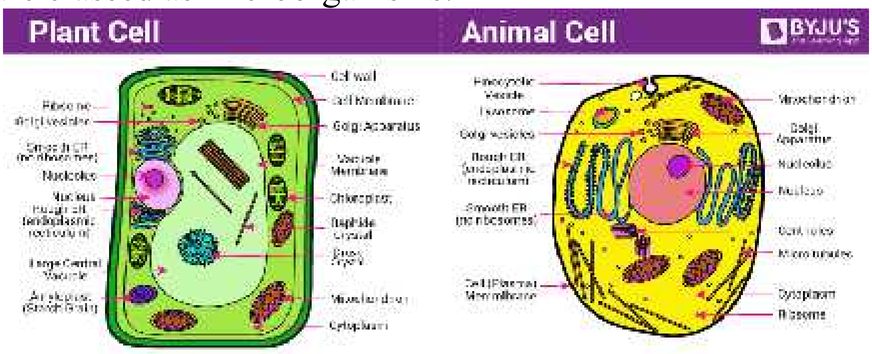
1. العناصر الكيميائية للحياة:

على الرغم من أنه يمكن العثور على أكثر من 25 نوعًا من العناصر في الجزيئات الحيوية ،لكن هنالك ستة عناصر هي الأكثر شيوعًا. هذه العناصر تسمى عناصر CHNOPS ؛ هذه الحروف تمثل الحرف الاول من العناصر التالية: الكربون والهيدروجين والنيتروجين والأكسجين والفسفور والكبريت

2. *Structure and composition of the cell:*

The cell is the basic structural, functional, and biological unit of all known organisms. A cell is the smallest unit of life. Cells are often called the "building blocks of life". Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as proteins and nucleic acids. Most plant and animal cells are only visible under a microscope, with dimensions between 1 and 100 micrometers.

Organisms can be classified as ***unicellular*** (consisting of a single cell such as bacteria) or ***multicellular*** (including plants and animals). Most unicellular organisms are classed as microorganisms.



2. تركيب ومكونات الخلية:

الخلية هي الوحدة التركيبية والوظيفية والبيولوجية الأساسية لجميع الكائنات الحية المعروفة... الخلية هي أصغر وحدة في الحياة و غالبا تسمى "لبنات الحياة".

تتكون الخلايا من سايتوبلازم موجود داخل غشاء الخلية و يحتوي على العديد من الجزيئات الحيوية مثل البروتينات والأحماض النووية. معظم الخلايا النباتية والحيوانية يمكن رؤيتها فقط تحت المجهر ذوالأبعاد مابين 1 و 100 ميكروميتر. يمكن تصنيف الكائنات الحية الى:

كائنات وحيدة الخلية : (تتكون من خلية واحدة مثل البكتيريا)

كائنات متعددة الخلايا (بما في ذلك النباتات والحيوانات).

معظم الكائنات الحية وحيدة الخلية تصنف على أنها كائنات مجهرية.

3.Biomolecules

The main classes of biomolecules are:

Carbohydrates , Lipids , Proteins , Nucleic acid

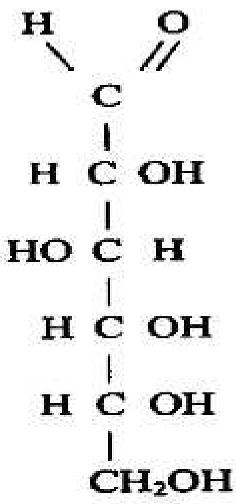
3. الجزيئات الحيوية

الفئات الرئيسية للجزيئات الحيوية هي:

الكربوهيدرات ، الدهون ، البروتينات ، الاحماض النووية.

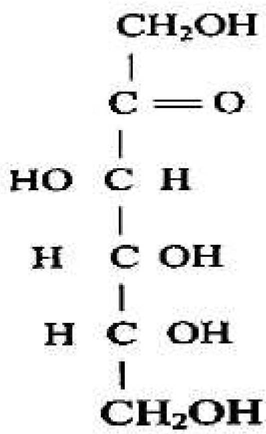
3-1. Carbohydrates

Carbohydrates are polyhydroxy aldehydes or ketones. Carbohydrates consists of **Carbon, Hydrogen and Oxygen**. The general formula of carbohydrates is $\mathbf{C_nH_{2n}O_n}$.



D- Glucose

سكر الديهايدي (يحوي مجموعة كاربونيل طرفية)



D - Fructose

سكر كيتوني (يحوي على مجموعة كاربونيل وسطية)

There are three major classes of carbohydrates that based on the number of forming units:

1) **Monosaccharides:** contain a single unit of polyhydroxyketone or aldehyde such as (glucose)

2) **Oligosaccharides:** contain 2-10 of monosaccharide units such as(succharose)

3) **Polysaccharides:** contain hundreds of monosaccharide units such as (starch)

3-1. الكربوهيدرات:

الكربوهيدرات هي متعدد هيدروكسي ألديهايدات أو كيتونات. تتكون الكربوهيدرات **من الكربون والهيدروجين والأوكسجين.** الصيغة العامة للكربوهيدرات هي $C_nH_{2n}O_n$

هنالك ثلاث فئات رئيسية من الكربوهيدرات اعتمادا على عدد الوحدات المكونة لها ،هي:

1) **السكريات الأحادية**: تحتوي على وحدة منفردة من متعدد هيدروكسي كيتون او الديهايد مثل (الكلوكوز)

2) **السكريات الثنائية او القليلة:** تحتوي 2-10 من وحدات السكريات الاحادية مثل (السكروز).

3) **السكريات المتعددة** : تحتوي على مئات من وحدات السكريات الاحادية مثل (النشا).

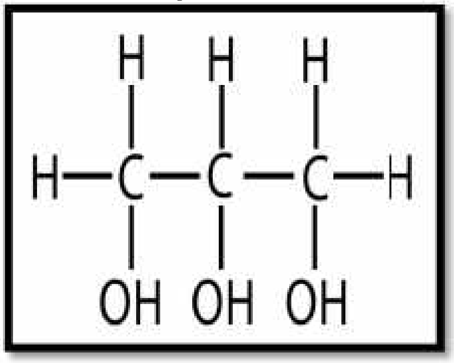
***3-2. Lipids*:**

In biology and biochemistry, a lipid is a biomolecule that is insoluble in aqueous solutions but soluble in nonpolar solvents such as benzene.

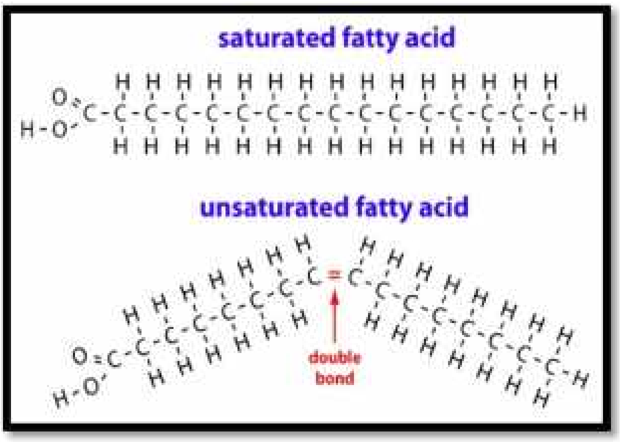
Classification of lipids:

1) Simple lipids: are fats /oils & Waxes.
2) Compound or Complex lipids: are Phospholipid, Glycolipid & Lipoprotein.
3) Derived lipids are fatty acids, glycerol, fat soluble vitamins,etc.

Glycerol



Fatty Acid



3-2. اللبيدات او الشحوم

في علم الاحياء او الكيمياء الحياتية ،الشحوم هي جزيئات حيوية لاتذوب في المحاليل المائية ولكنها تذوب في المذيبات غير القطبية كالبنزين.

تصنيف اللبيدات (الشحوم):

تصنف الى 3 انواع رئيسية:

1) اللبيدات البسيطة: تشمل الدهون، الزيوت، الشموع.

2) اللبيدات المركبة: تشمل مجاميع مرتبطة باللبيد وهي:

أ. فوسفولبيد: وتعني مجموعة فوسفات مرتبطة باللبيد

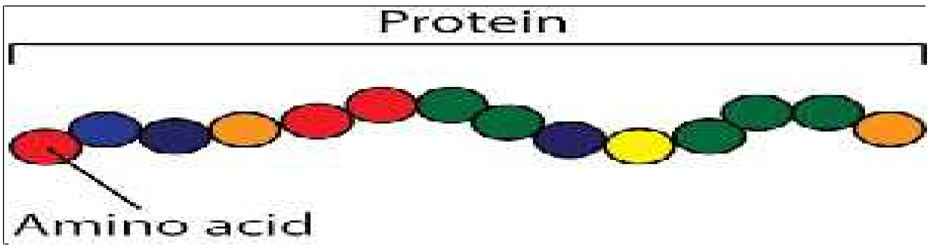
ب. كلايكولبيد: وتعني مجموعة سكر مرتبطة باللبيد

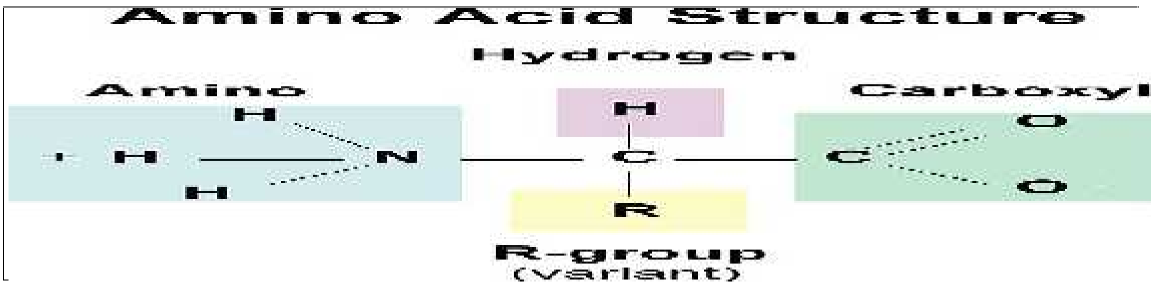
ج. ليبوبروتين: وتعني بروتين مرتبط باللبيد

3) اللبيدات المشتقة: وهي احماض دهنية، كليسيرول ، الفيتامينات الذائبة بالدهن

3-3. Proteins

Proteins are large size molecules . The basic units of protein structure is called **amino acids**. An amino acid consists of an α- carbon atom attached to an amino group($-NH_2$), a carboxylic acid group(–COOH), a simple hydrogen atom, and a side chain commonly denoted as (–R). The side chain (R) is different for each amino acid. A total of 20 amino acids exist in proteins. **Amino acids can be released from proteins by hydrolysis. (Hydrolysis is the cleavage of a covalent bond by addition of water in adequate conditions.)**



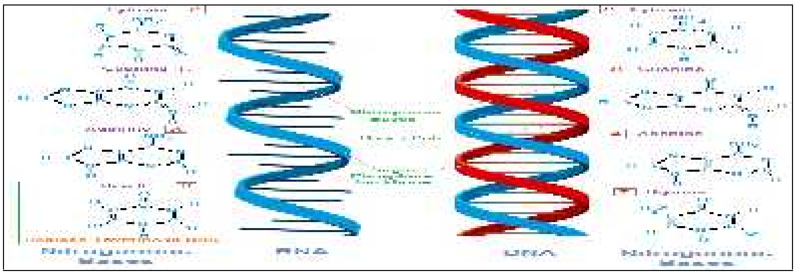


3-3 . البروتينات:

البروتينات هي جزيئات كبيرة الحجم ، الوحدة الاساسية لبناء البروتين تسمى (الأحماض الأمينية). يتكون الحامض الاميني من ذرة الفا كاربون ترتبط بها مجموعة الامين ومجموعة الكاربوكسيل وذرة الهيدروجين البسيطة وسلسلة جانبية عادة ما يشار اليها ب (–R). تختلف السلسلة الجانبية (R) لكل حامض اميني. يوجد ما مجموعه' 20 حامض اميني في البروتين. **يمكن إطلاق الأحماض الأمينية من البروتينات عن طريق التحلل المائي. (التحلل المائي هو انقسام الاصرة التساهمية بإضافة الماء في الظروف الملائمة.)**

3-4. Nucleic acids

The two main types of nucleic acids are **deoxyribonucleic acid** (DNA) and **ribonucleic acid** (RNA). DNA is the genetic material found in all living organisms. RNA, is mostly involved in protein synthesis.



4-3. الأحماض النووية:

النوعان الرئيسيان للأحماض النووية هما حامض الديوكسي رايبونيوكليك (DNA) وحامض الرايبونيوكليك (RNA).

DNA هو المادة الوراثية الموجودة في جميع الكائنات الحية. RNA ، تشارك في الغالب في تخليق البروتين.

4. The chemical origin of life:

The chemical origin of life refers to the conditions that might have existed and therefore promoted the first replicating life forms. It considers the **physical processes** and **chemical reactions** that could have led to early replicator molecules.

4. الاصل الكيميائي للحياة

يشير الأصل الكيميائي للحياة إلى الظروف التي قد وجدت ، وبالتالي روجت لأشكال الحياة المكررة الأولى. من الممكن ان نعتبر العمليات الفيزيائية والتفاعلات الكيميائية هي التي أدت إلى الجزيئات المتكررة المبكرة.

Questions:

Q1/What is Biochemistry?

Q2/How can classify organisms according to their cell?

Q3/ What are the main classes of biomolecules?

Q4/ Write the types of carbohydrates and give example of each type.

Q5/ Is lipid soluble in water? What are the main classes of it? write examples for each one.

Q6/ What is an amino acid consists of ?and how can release it from protein?

Q7 What are the types of nucleic acids?