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1-What is the chemistry

Chemistry is a science deals with, the matter and how it interacts with other matter and/or energy.

Chemistry is often called the central science, because the basic information of chemistry is very important for students of physics, geology, biology, and many other subjects.

Indeed, it is central to our way of life; without it, we would be living shorter lives in what we would consider primitive conditions, without computers, automobiles, electricity, CDs, and many other everyday conveniences.

Figure .1. diagrams the relationship of chemistry and biological chemistry to some other fields of scientific study. Whatever the discipline in which you are most interested, the study of chemistry builds the necessary foundation.

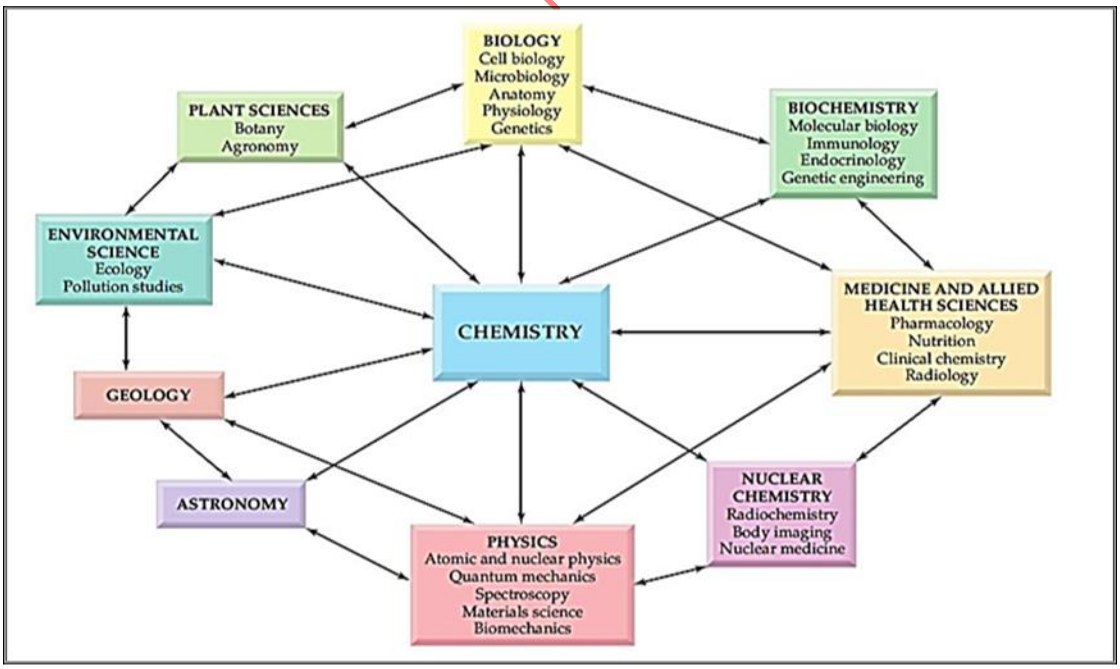

Figure. 1.Some relationships between chemistry, the central science, and other scientific and health-related disciplines.

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1-2Matter

We defined chemistry at the beginning of the chapter as the study of matter and the changes it undergoes.

Matter is anything that has mass and occupies space, Matter includes things we can see and touch (such as water, earth, and trees), as well as things we cannot (such as air), Thus, everything in the universe has a "chemical" connection.

We can describe matter in terms of physical properties, those characteristics that can be determined without changing the chemical composition of matter.

Examples:

Sugar is white, tastes sweet, and can be crushed into powder.

Crushing sugar does not change sugar into something else.

Matter is typically found in one of three different physical states or phases.

Solid: Solids have fixed shapes and volumes .

Liquid: Liquids have variable shapes and fixed volumes .

Gas: Gases have variable shapes and volumes .

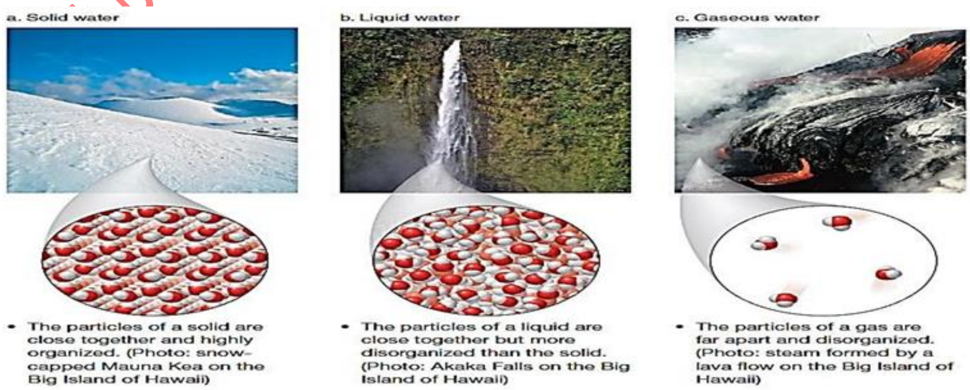

Fig.2. The three state of water: solid, liquid and gas

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1-3Substances and Mixtures

A substance is a form of matter that has a constant composition and distinct properties, Examples are water, ammonia, table sugar (sucrose), gold, and oxygen.

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.

Examples are air, soft drinks, milk, and cement, Mixtures do not have constant composition, Therefore, samples of air collected in different cities would probably differ in composition because of differences in altitude, pollution, and so on.

Mixtures are either homogeneous or heterogeneous.

When a spoonful of sugar dissolves in water we obtain a homogeneous mixture in which the composition of the mixture is the same throughout.

If sand is mixed with iron filings, however, the sand grains and the iron filings (remain separate (Figure 3).

This type of mixture **is called a heterogeneous mixture because the composition is not uniform.**

Any mixture, whether homogeneous or heterogeneous, can be created and then separated by physical means into pure components without changing the identities of the components.

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Thus, sugar can be recovered from a water solution by heating the solution and evaporating it to dryness, Condensing the vapor will give us back the water component.

To separate the iron-sand mixture, we can use a magnet to remove the iron filings from the sand, because sand is not attracted to the magnet [see Figure.3 (b)]. After separation, the components of the mixture will have the same composition and properties as they did to start with.

(a) (b)

Fig. 3. sand grains and the iron filings remain separate.

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1-4What is the Atom

The fundamental unit of a chemical substance is called **an atom**.

The word is derived from the Greek atoms, meaning "uncuttable."

An atom is the smallest possible particle of a substance.

Atoms are extremely small.

Measurements show that the diameter of a single carbon atom is approximately 0.0000000003 meters.

Any sample of matter large enough for us to see or feel contains an unfathomable number of atoms Molecules.

Atoms combine to make all the substances in the world around us, but they do so in very orderly ways.

Most substances that we encounter in day-to-day life are made up of small units called molecules.

A molecule is a combination of two or more atoms held together in a specific shape by attractive forces.

The simplest molecules contain just two atoms.

For example, a molecule of hydrogen is made up of two hydrogen atoms.

A molecule that contains two atoms is classified as a diatomic molecule.

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Figure.4. represents a diatomic hydrogen molecule as two spheres connected together.

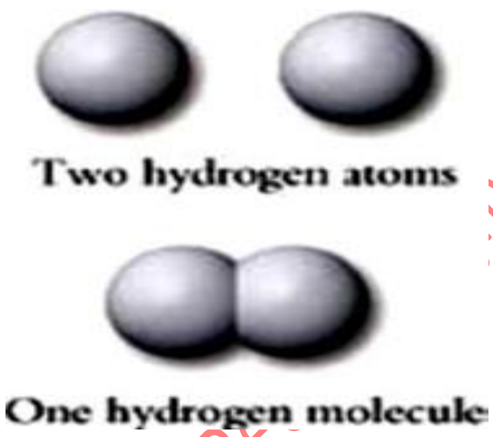

Fig. 4. Hydrogen atom and molecule.

The other types of molecules consist of more than two atoms.

For example, a molecule of water is made up of two hydrogen atoms and one oxygen atoms.

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1-5The structure of an atom

Although the word 'atom' comes from the Greek for indivisible, we now know that atoms are not the smallest particles of matter.

Atoms are made from smaller subatomic particles.

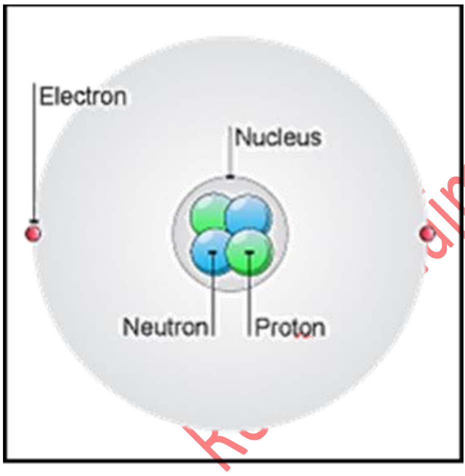

Fig. 5. The structure of an atom

At the center of an atom is nucleus containing <u>protons</u> and <u>neutrons</u>.

Electrons are arranged around the nucleus in energy levels or shells. Make sure you can label a simple diagram of an atom like this one Both protons and electrons have an electrical charge. Both have the same size of electrical charge, but the proton is positive and the electron negative, The neutron is neutral.

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The electrical charge of particle

particle	relative charge
proton	+1
neutron	0
electron	-1

The total number of electrons in an atom is always the same as the number of protons in the nucleus.

This means atoms have no overall electrical charge.

The number of protons in an atom is called its(atomic number -) also called the **proton number.**

Atoms are arranged in the periodic table in order of increasing **atomic number.**

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1-6Atomic Number, Mass Number, and Isotopes

All atoms can be identified by the number of protons and neutrons they contain.

The number of protons in the nucleus of each atom of an element is called the atomic number (Z).

In a neutral atom the number of protons is equal to the number of electrons (e = p), so the atomic number also indicates the number of electrons present in the atom.

The chemical identity of an atom can be determined solely by its atomic number.

For example, the atomic number of oxygen is 8; this means that each neutral nitrogen atom has 8 electrons and 8 protons.

Or viewed another way, every atom in the universe that contains 8 protons is correctly named “oxygen.

The 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 5 number of protons 1 number of neutrons 5 atomic number 1 number of neutrons.

$$\begin{aligned} \text{mass number} &= \text{number of protons} + \text{number of neutrons} \\ &= \text{atomic number} + \text{number of neutrons} \end{aligned}$$

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The number of neutrons in an atom is equal to the difference between the mass number and the atomic number, or (A-Z)

For example, if the mass number of a particular boron atom is 12 and the atomic number is 5 (indicating 5 protons in the nucleus), then the number of neutrons is (12 – 5 = 7).

Note that all three quantities (atomic number, number of neutrons, and mass number) must be positive integers, or whole numbers.

In most cases atoms of a given element do not all have the same mass.

Atoms that have the same atomic number but different mass numbers are called **isotopes**.

For example, there are three isotopes of hydrogen.

One, simply known as hydrogen, has one proton and no neutrons.

The deuterium isotope has one proton and one neutron, and tritium has one proton and two neutrons.

The accepted way to denote the atomic number and mass number of an atom of element X is as follows.

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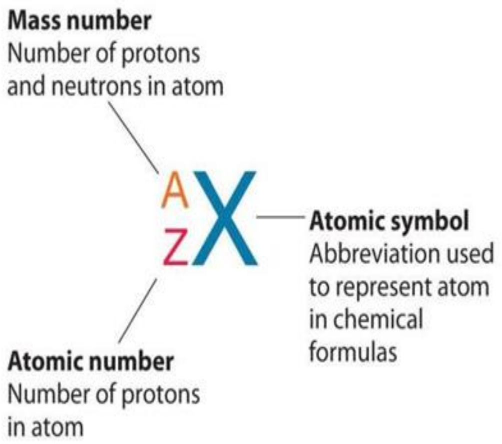
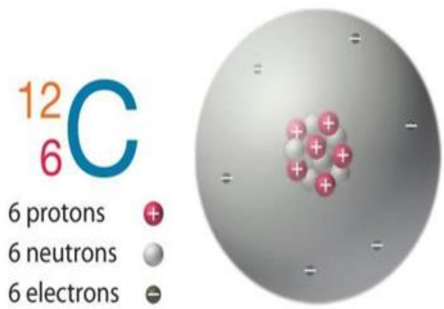

Mass number
Number of protons
and neutrons in atom
A
Z
X
Atomic symbol
Abbreviation used
to represent atom
in chemical
formulas
Atomic number
Number of protons
in atom


12
6
C
6 protons
6 neutrons
6 electrons

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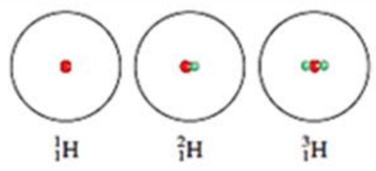
Thus, for the isotopes of hydrogen, we write

$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
hydrogen	deuterium	tritium



As another example, consider two common isotopes of uranium with mass numbers of 235 and 238, respectively.

$$^{235}_{92}U \qquad ^{238}_{92}U$$

The first isotope is used in nuclear reactors and atomic bombs, whereas the second isotope lacks the properties necessary for these applications. With the exception of hydrogen, isotopes of elements are identified by their mass numbers.

Thus, these two isotopes are called uranium-235 and uranium-238.

The chemical properties of an element are determined primarily by the protons and electrons in its atoms.

neutrons do not take part in chemical changes under normal conditions. Therefore, isotopes of the same element have similar chemistries, forming the same types of compounds and displaying similar reactivity's.

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Example: Give the number of protons, neutrons, and electrons in each of the following species:.

(a) $^{195}_{79}Au$, (b) $^{197}_{79}Au$, (c) ^{18}F, (d) carbon-13

Solution:

a) The atomic number of Au is(79)

so there are 79 protons.

The mass number of Au is 195.

so the number of neutrons is 195 – 79 = 116

The number of electrons is the same as the number of protons; that is, (79).

b)The atomic number of Au is the same as that in (a), or 79)

The mass number of Au is 197, so the number of neutrons is 195 – 79 = 118

The number of electrons is 79.

c)The atomic number of F (Fluorine) is 18, so there are 9 protons).

The mass number is 18, so there are 18 – 9 = 9 neutrons.

There are 9 electrons.

d)Carbon-14 can also be represented as 14C).

The atomic number of carbon is 6, so there are 14 - 6 = 8 neutrons

The number of electrons is 6.