MDC MDC0100103

[Introduction to Natural and Physical Science]

CHEMISTRY

Element((अोन): An element is a substance made up entirely of one type of atom. They are pure substances.

For example, Hydrogen (H₂), Helium (He), Gold (Au).

Atom(**Panaj**): An atom is the smallest part of a matter that has all the characteristics of a chemical element. An atom consists of sub-atomic particles called protons, neutrons, and electrons.

For example, hydrogen atom (H), helim atom (He), copper atom (Cu)

Molecule(**aq**): A molecule is a substance that contains two or more atoms, from the same element, which are chemically joined.

For example, hydrogen molecule (H₂).Carbon di-oxide molecule (CO₂), water molecule (H₂O)

Compound: A compound is a substance that is made up of two or more different elements that are chemically joined.

For example, water (H₂O). carbon di-oxide (CO₂), sodium chloride (common salt) (NaCl).

IONS (আমূল)

- An ion is an atom or group of atoms that has an electric charge.
- Ions with a positive charge are called **cations**. Generally, metals form cations. e.g. Li⁺, Na⁺, Ca²⁺, Fe³⁺ etc. Hydrogen, a non metal, can form cation (H⁺)
- Ions with a negative charge are called anions. Generally non metals can form anions.
 e.g. H⁻, F⁻, Cl⁻, O²⁻ etc.
- Many normal substances exist in the body as ions. Common examples include sodium, potassium, calcium, chloride, and bicarbonate. These substances are known as <u>electrolytes</u>.

Essentials Elements (প্রয়োজনীয় মৌল) :

The human body is approximately 99% comprised of just six elements: Oxygen, hydrogen, nitrogen, carbon, calcium, and phosphorus. Another five elements make up about 0.85% of the remaining mass: sulfur, potassium, sodium, chlorine, and magnesium. All of these 11 elements are essential elements.

Atomic Number (পৰমানু ক্ৰমাংক) and Mass Number (পাৰমাণৱিক ভৰ)

When you study the periodic table, the first thing that you may notice is the number that lies above the symbol. This number is known as the **atomic number**, which identifies the number of protons in the nucleus of all atoms in each element. The symbol for the atomic number is designated with the letter \mathbf{Z} . For example, the atomic number (z) for sodium (Na) is 11. That

means that all sodium atoms have 11 protons. If you change the atomic number to 12, you are no longer dealing with sodium atoms, but magnesium atoms. Hence, the atomic number defines the element in question.

Recall that the nuclei of most atoms contain neutrons as well as protons. Unlike protons, the number of neutrons is not absolutely fixed for most elements. Atoms that have the same number of protons, and hence the same atomic number, but different numbers of neutrons are called **isotopes**. All isotopes of an element have the same number of protons and electrons, which means they exhibit the same chemistry. Because different isotopes of the same element have different number of neutrons, each of these isotopes will have a different **mass number(A)**, which is the sum of the number of protons and the number of neutrons in the nucleus of an atom.

Mass Number(A) = Number of Protons + Number of Neutrons

The element carbon (C) has an atomic number of 6, which means that all neutral carbon atoms contain 6 protons and 6 electrons. In a typical sample of carbon-containing material, 98.89% of the carbon atoms also contain 6 neutrons, so each has a mass number of 12. An isotope of any element can be uniquely represented as ${}^{A}{}_{Z}X$, where X is the atomic symbol of the element, A is the mass number and Z is the atomic number. The isotope of carbon that has 6 neutrons is therefore ${}^{12}{}_{6}C$. The subscript indicating the atomic number is redundant because the atomic symbol already uniquely specifies Z. Consequently, it is more often written as ${}^{12}C$, which is read as "carbon-12." Nevertheless, the value of Z is commonly included in the notation for nuclear reactions because these reactions involve changes in Z.



Figure : Formalism used for identifying specific nuclide (any particular kind of nucleus)

Atomic Mass Unit

The atomic mass unit (u or amu) is a relative unit based on a carbon-12 atom with six protons and six neutrons, which is assigned an exact value of 12 amu's (u's). This is the standard unit for atomic or molecular mass, and 1 amu is thus $1/12^{th}$ the mass of a ${}^{12}C$ atom. This is obviously very small

1 amu = $1.66054 \times 10^{-27} \text{kg} = 1.66054 \times 10^{-24} \text{g}$

As a result of this standard, the mass of all other elements on the periodic table are determined relative to carbon-12. For example, a Nitrogen-14 atom with 7 protons and 7 neutrons has been experimentally determined to have a mass that is 1.1672 times that of carbon-12. So, the mass of the Nitrogen-14 atom must be 14.00643 u's.

Isotopes(সমস্থালিক)

Although all atoms of a given element must have the same atomic number, they need not all have the same mass number. For example, some atoms of carbon (atomic number 6) have a mass number of 12, others have a mass number of 13, and still others have a mass number of 14. These different kinds of the same element are called isotopes. Isotopes are atoms that have the same atomic number (and are therefore of the same element) but different mass numbers. The composition of atoms of the naturally occurring isotopes of carbon are shown in the following table.

TABLE : The naturally occurring isotopes of carbon				
Isotope	Protons	Electrons	Neutrons	
$\frac{12}{6}$ C	6	6	6	
$\frac{13}{6}$ C	6	6	7	
$\frac{14}{6}$ C	6	6	8	

The various isotopes of an element can be designated by using superscripts and subscripts to show the mass number and the atomic number. They can also be identified by the name of the element with the mass number of the particular isotope. For example, as an alternative to

$$\frac{12}{6}$$
 C, $\frac{13}{6}$ C, and $\frac{14}{6}$ C

we can write carbon-12, carbon-13, and carbon-14.

Table : Some important elements, their symbols and atomic numbers :

Name of the Element	Symbol of the Element	Atomic Number/ number of protons/ number of electrons	
Hydrogen	Н	1	
Helium	Не	2	
Lithium	Li	3	
Beryllium	Be	4	
Boron	В	5	
Carbon	С	6	
Nitrogen	N	7	
Oxygen	0	8	
Fluorine	F	9	
Neon	Ne	10	
Sodium	Na	11	
Magnesium	Mg	12	
Aluminium	Al	13	
Silicon	Si	14	
Phosphorus	р	15	
Sulphur	S	16	

Chlorine	Cl	17
Argon	Ar	18
Potassium	K	19
Calcium	Са	20
Scandium	Sc	21
Titanium	Ti	22
Vanadium	V	23
Chromium	Cr	24
Manganese	Mn	25
Iron	Fe	26
Cobalt	Со	27
Nickel	Ni	28
Copper	Cu	29
Zinc	Zn	30

Molecular formulas (আণরিক সংকেত) for some common substances:

- Water: H₂O
- Common Salt: NaCl
- Sugar (Sucrose): C₁₂H₂₂O₁₁
- Ethanol: CH₃CH₂OH or C₂H₅OH
- Sodium bicarbonate/ baking powder : NaHCO3
- Carbon dioxide: CO₂
- Ammonia: NH₃
- Acetic acid/ vinegar : CHCOOH
- Glucose: C₆H₁₂O₆

- Methane: CH₄
- Silver chloride: AgCl
- Cellulose: $(C_6H_{10}O_5)_n$
- Magnesium hydroxide: Mg(OH)₂
- Sodium hydroxide : NaOH