

Atoms and molecules

The atoms is the most fundamental unit of matter, making up everything that we see around us. It is extremely small measuring is in at less than 0.1 to 0.5 nanometre.

- Kanad was one of very small the first persons to perceive that matter (or padarth) is made up of very small particles called 'parmanu'.
- John Dalton called these particles by the name of atoms. The word 'atoms' means 'indivisible' — something which can't be divided further.

Laws of chemical combination

There are three important laws of chemical combination, there are:

- I. Laws of conservation of mass.
- II. Laws of constant proportions.

I. Laws of conservation of mass.

- According to the laws of conservation of mass, matter can neither be created or nor destroyed in a chemical reaction. It remains conserved.
- Mass of reactants will be equal to the mass of products.

$$M_R = M_P$$

Antoine Lavoisier : the scientist who gave the laws "L.C.M" laws of constant proportions.

- It states that in a chemical substances the elements are always present in definite proportions by mass.

for e.g. if we take the water from a river or from an ocean, both have oxygen and hydrogen in the same proportion.

Joseph Proust : the scientist who gave the laws of constant proportions in a chemical combination.

Dalton's Atomic theory

Postulates of the Dalton Atomic theory

- All the matter is made extremely small indivisible particles called atoms.
- Atoms is a indivisible particles, which cannot be created or destroyed in a chemical reaction.
- All the atoms of a given elements are identical in every respect, having the same mass, size and chemical properties.
- Atoms of a different elements combined in fixed ratio to form compound.
- the relative number and kinds of atoms are constant in a given compound.

Atoms

An atoms is the smallest particles of an elements that can take part in a chemical reaction.

Atoms are very very small in size.

The size of an atoms is indicated by the its radius which is called "atomic radius"

Atomic radius is measured in 'nanometre'

$$1 \text{ nm} = \frac{1}{10^9} \text{ metre}$$

$$\rightarrow 1 \text{ nm} = 10^{-9} \text{ m.}$$

→ hydrogen atom is the smallest atom. It is indicated by its radius which is the called atomic radius. The atomic radius of a hydrogen atom is 0.037 nm .

Atomic radius of some common elements

Elements	Atomic radius
hydrogen	0.037 nm
carbon	0.077 nm
Nitrogen	0.074 nm
Oxygen	0.073 nm
chlorine	0.099 nm
sulphur	0.104 nm
sodium	0.191 nm
magnesium	0.160 nm
calcium	0.197 nm
Iron	0.126 nm
Copper	0.128 nm
Gold	0.144 nm

Dalton's symbols of Elements

Elements	Dalton's Elements
hydrogen	○
Carbon	●
Oxygen	○
phosphorus	△
sulphur	⊕
platinum	P
Iron	I
Copper	C
Silver	S
Gold	G
lead	L
Mercury	Hg

In the beginning, the ~~mass~~ names of elements were derived from the name of place where they were formed found for the first time.

Eg: the name of copper was taken from cyprus.

Now a days, IUPAC [International Union of Pure and Applied chemistry] is an international scientific organisation which approves name of the elements, symbols and units.
for examples:

- i) Hydrogen, (H)
- ii) aluminium, (Al)
- iii) Cobalt, (Co).

→ symbols of the some elements are formed from the first letter of the name and a latter, appearing later in the name

→ Examples are: i) Chlorine (Cl), Zinc (Zn)
C-T-C.

→ the other symbols have been taken from the name of the elements in latin, German or Greek.

for examples: the symbols of Iron is Fe from its latin name Ferrum, Sodium is Na from Natrimum, Potassium is K from kalium.

Atomic Mass

- Atomic Mass is the masses of the electrons, neutrons, and protons in an atom, or in a group of atoms, the average mass.
- the mass of the atomic particle is called the Atomic mass.
- the atomic mass of an element is the numerical number which indicates how many times an atom of an element is heavier than $\frac{1}{12}$ of mass of an atom 12 of carbon-12.
- For examples: the atomic mass of magnesium (Mg) is 24 which indicates that one atom of Magnesium is 24 times heavier than $\frac{1}{12}$ of carbon-12 atoms.

Elements	Atomic Mass	Elements	Symbols
Hydrogen	1u	Phosphorus	31u
Carbon	12u	Sulphur	32u
Nitrogen	14u	Chlorine	35.5u
Oxygen	16u	Potassium	39u
Sodium	23u	Calcium	40u
Magnesium	24u	Iron	56u
Aluminum	27u	Copper	63.5u

How do Atoms Exist

Atoms usually exists in the two ways:

- In the form of molecules
- In the form of Ions

Molecules

A molecule is the smallest particles of a substance (elements or compound) which has the properties of that substance.

→ and can exist in the free states.
 → the molecules of an elements are constituted by the same types of atoms.
 For example : a molecules of oxygen consists of the atoms of oxygen and hence it is known as a diatomic molecules, O_2 .

Atomicity : the number of atoms presents in a molecules of an elements or a compound is known as Atomicity.
 Ex - the atomicity of a oxygen is 2 while the atomicity of ozone is 3.

→ the atomicity of noble metal elements like (sodium, magnesium, Al, Cu, Fe etc.) is also taken to be 1.
 → thus the metal are considered to be monoatomic.

Molecular Mass

Molecular Mass of an elements is defined as the sum of the masses of the elements presents in the molecules.

→ Molecular mass of a substance is the relative mass of its molecules as compared with the mass of a carbon-12 atom taken as 12 units.

Element	Symbol	Atomic mass	Molecular formula	Molecular mass
Hydrogen	H	1u	H_2	$2 \times 1 = 2u$
Nitrogen	N	14u	N_2	$2 \times 14 = 28u$
Oxygen	O	16u	O_2	$2 \times 16 = 32u$
Chlorine	Cl	35.5u	Cl_2	$2 \times 35.5 = 71u$

IONS

An ion is a positively or negatively charged atoms (or group of atoms.)

Eg: Na^+ , Mg^{2+} , Cl^- , O^{2-}

they are two types of Ions:

- I. A positively charged Ion is known as Cation.
- II. A negatively charged Ions is known as Anion.

I. Cations

A cations is formed by the loss of one or more electrons by an atom.

- A cations contains less electrons than a normal atom.
- the ions of the all metal elements are cations.
- Due to the more protons than electrons, a cation has a positive charge on it.
- Ex - H^+ , Na^+ , Ca^{2+} , e^+ , ~~e^-~~ , C^+

II. Anion

An Anion is formed by the gain of one or more electrons by an atom.

An Anion contains more electrons than a normal atom.

The ions of all the non-metal elements are Anions [except hydrogen ion and ammonium]

- Due to more electrons than protons, an anion has a negative charge on it.
- Ex - Cl^- , O^{2-} , C^- , F^- , CO_3^{2-} , e^- , C^-

Ionic compound

the compounds which are made up of ions are known as Ionic compound.

- some example of Ionic compounds are:

- NaCl, KCl, NaOH etc.

- Whenever we see a compound made up of a metal and a non-metal, we should at once say that it is an ionic compound.

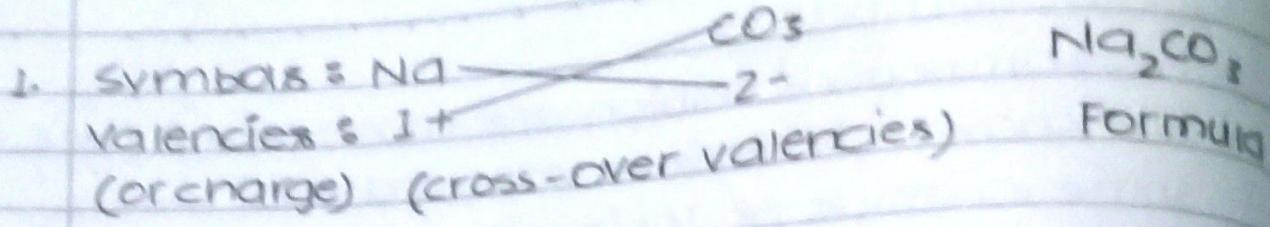
Valency of Ions

the combining power (or capacity) of an elements is known as its valency.

- Valency can be used to find out how the atoms of an elements will combine with the atoms of another elements to form a chemical compound.
- The valency of anions is equal to the charge on the charge on the ions.

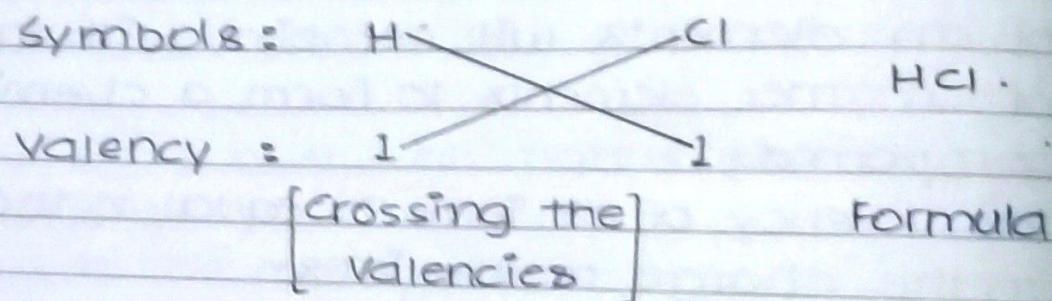
Writing the formulae of Ionic Compound

- the number of cations and anions is adjusted in such a way that the total number of positive valencies of cations becomes equal to the total no. of negative valencies of Anions.
 - the final formula of an ionic compound is written without showing the charges on the ions involved in it.
- suppose we have to write the formula of sodium carbonate.



→ A very important point to note here is that in the 'crossing-over' of valencies method of writing the formulae of ionic compounds, we usually do not write the charge (plus or minus) on the symbols of the ions.

2. Formula of hydrogen chloride



Mole Concept

Mole is a link between the mass of atoms (or molecules) and the number of atoms (or molecules).

One mole contains exactly $6.02214076 \times 10^{23}$, is an Avagadro number (L). The mole is the amount of the substance ~~that~~ of a system that contains $6.02214076 \times 10^{23}$ specified elementary entities.

1 mole [of anything] = 6.022×10^{23} in the ne

the symbol mol, mole, is the S.I of the amount of substance.

Mole of atoms

1 mole of atoms of an elements has a mass equal to the gram atomic mass of the elements.

the symbol of an elements represents 1 mole of atoms of that elements.

For example:

symbol of O represents 1 mole of oxygen atom.

and $2O$ represents 2 moles of oxygen atom.

Mole of molecules

1 mole of molecules of a substances has a mass equal to the gram molecular mass of the substances.

For examples :

Formula O_2 represents 1 mole of oxygen molecules

and $2O_2$ represents 2 mole of oxygen molecules.

* knowing the mass of 1 mole of a substances we can calculate the mass of any number of moles of that substances.

Substance	Symbol of formula	Mass of 1 mole	This mass (2 mole) contains
1 mole of Hydrogen atom	H	1g	6.022×10^{23} H_2 atoms
1 mole of H_2 molecules	H_2	$2 \times 1 = 2\text{g}$	" " H_2 molecules
1 mole of water molecules	H_2O	$2 + 16 = 18\text{g}$	" " water molecules
1 mole of ammonia	NH_3	$14 + 3 = 17\text{g}$	" " ammonia
1 mole of sodium atoms	Na	23g	" " sodium atoms

A mole represents two things:

1. A mole represents a definite amounts of the substances. It represents the amounts of substances equal to its gram atomic mass or gram molecular mass.
2. A mole represents a definite number of atoms, molecules or ions of a substance. It represents 6.022×10^{23} atoms, molecules or ions of a substance.

Formula on this concept

$$1. \text{ n.o of moles (n)} = \frac{\text{Given Mass}}{\text{Molar Mass}}$$

$$11. \text{ n.o of Atoms/molecules} = \frac{\text{Given Mass}}{\text{Molar Mass}} \times N_A$$

Gram atomic Mass:

the amount of a substance whose mass in Grams is numerically equal to its atomic mass, is called gram atomic mass.

For example :

- the atomic mass of oxygen, O = 16 u
- the Gram atomic mass of oxygen is 16 g.

Gram atomic molecular mass

the amount of a substance represents whose mass in gram is numerically equal to its molecular mass, is called gram molecular mass of that substance.

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