

Atoms and Molecules

Date _____
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H_1	N_{14}	Sc_{45}
He_2	Mg_{12}	Ti_{48}
Li_3	Al_{27}	V_{51}
Be_4	Si_{14}	C_{52}
B_5	P_{15}	Mn_{55}
C_6	S_{16}	Fe_{56}
N_{14}	Cl_{17}	Co_{59}
O_8	Ar_{18}	Ni_{68}
F_9	K_{19}	Cu_{65}
Ne_{10}	Ca_{20}	Zn_{30}

From 1 to 20

1) If atomic number is even then

$$\text{Atomic mass} = 2 \times \text{Atomic number}$$

2) If atomic number is odd then

$$\text{Atomic mass} = 2 \times \text{Atomic number} + 1$$

From 21 to 30

3) Atomic number $\times 2 + \text{Phone number}$

Phone number - 3, 4, 5, 4, 5, 4, 5, 3, 5 or 6, 5

exception

Introduction

around 5000 BC Indian philosopher Maharishi
Vedic postulated the theory if we go
and divide matter (Padarth) we will
obtain smallest particle beyond which further

division cannot be possible which is known as permanence.

- Ancient greek philosophers Democritus and Leucippus called these particle as atom.
- Antoine L. Lavoisier laid the foundation of chemical science by establishing two important law of chemical combination.

Laws of chemical combination

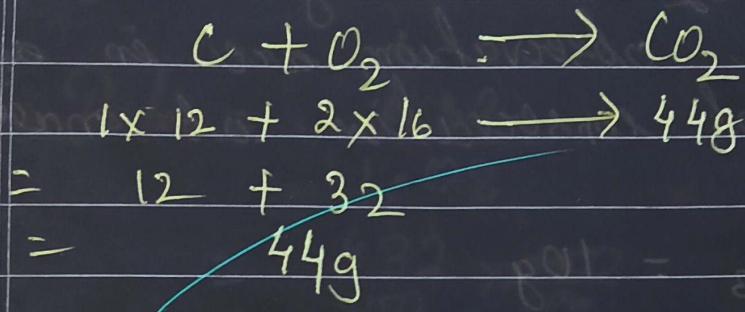
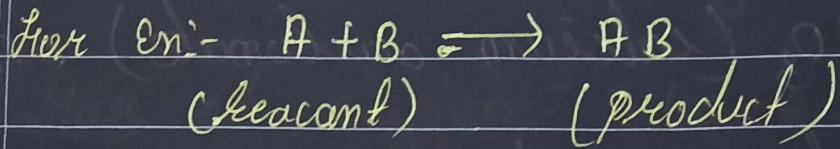
- This law establish after the experiment by Lavoisier and Joseph L. Prout.

The chemical reaction between two or more substances give rise to product which is governed by certain law called law of chemical combination.

Law of conservation of mass

This law of conservation of mass was given by L. Lavoisier in 1774. During chemical reaction the total mass of reactant will be equal to the total mass of the product. In other words, the law of conservation of mass mean that mass can neither be created nor be destroyed.

in a chemical reaction



Law of constant proportion

This law states that In a pure chemical substance the elements are always present in definite proportion by mass. This law is also known as the law of definite proportion.

For ex:- water obtain from any source will have the same element namely Hydrogen and oxygen present in it. 2 gram of hydrogen and 16 gram of oxygen form a molecule of water. The proportion of hydrogen and oxygen is $1:8$ by the mass this proportion will always remain the same irrespective of the source of water.

John Dalton's Atomic Theory

John Dalton provided the basic theory about the nature of matter. He took the name atom base the smallest particle of matter as given by the Greek. Based on the law of chemical combination he proposed a model of atom known as Dalton atomic theory.

The main postulate of Dalton Atomic theory are:

All matter is made up of very tiny particles called atom.

- Atoms are indivisible particles which can neither be created nor be destroyed in a chemical reaction.
- Atoms of some elements are identical in all respect such that shape, size, mass and property.
- Atoms of different elements have different size and mass and also possess of different properties.
- When atom of different elements combine together to form compound they do so in a simple whole number ratio.
- Atoms of same or of different elements combine together to form molecules or compounds.
- Atoms of two different elements make combine in different ratio to form one compound.

Drawback of Dalton atomic theory

- Atom is no longer considered as the smallest indivisible particle.
- Atoms of some elements may have different masses. For ex- there are two types of atom of chlorine with mass 35 and 37. Such atoms of the same element with different masses are called isotopes.

- Atoms of different elements may have same mass. For ex:- atoms of argon and calcium are known with the same mass number. Such atoms of different elements with same mass number are known as isotopes.
- Substances made up of the same kind of atom may have different properties. For ex:- Graphite and Diamond are all made up of carbon atoms but have different physical properties.

What is atom?

Atoms are the building block of matter. An atom is very small in size and consist of sub-atomic particles protons, electrons and neutrons. An atom is the smallest particle of an element that can take part in a chemical reaction. Atoms of most of the elements are very reactive and do not exist in free state. They exist in combination with the atoms of the same element or another element. Atoms can be seen with the powerful optical microscope.

- Atomic radius is measured in nanometre (nm). $1\text{nm} = 10^{-9}\text{m}$ or $1\text{m} = 10^9\text{nm}$

The size of an atom is indicated by its radius which is called atomic radius.

Symbols used to represent atoms of different elements.

Dalton was the first scientist to use symbols for elements. He used circles to represent symbols.

JJ Berzelius suggested that the symbol of the element can be made from one or two letters of the name of the element.

Now, we can use names and symbols as stated by IUPAC such that International Union of Pure and Applied Chemistry.

Many symbols are the 1st letter or the 1st two letters of the names of the elements.

The symbol of some elements are formed from the letter of the name and a letter appealing to the name.

The symbols for some elements were derived from Latin, German, Greek names.

English name of the element	Latin name of the element	Symbol
Sodium	Natrium	Na
Potassium	Kaliun	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Mercury	Hydroargyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn

Modern symbol of element

The modern symbol of elements are derived from their English or Latin name which are made up of either the 1st letter and a letter appearing later in the name of the element.

Atomic Mass

Dalton's atomic theory proposed the idea of atomic mass which explains the law of constant proportions.

The mass of an element atom or of an element is called its atomic mass. The atomic mass of an element is the relative mass of its atom as compared with the mass of an atom of carbon -12 isotope taken as 12 units.

Atomic mass unit (amu) may be defined as $\frac{1}{12}$ th of the mass of an atom of carbon-12 isotope on the atomic scale.

$$1 \text{ amu} (\text{u}) = \frac{1}{12} \text{ th} \times \text{mass of carbon -12 isotope}$$

How do atoms exist

The atoms of few elements such as noble gases like Helium, Neon, Argon, Krypton, Xenon, etc., exist in free state that is as single atom and chemically unreactive but most of the elements are chemically reactive, do not exist in the free state. They either exist in as molecular or ions.

Molecules

A molecule is a group of two or more atoms that are chemically bonded together. A molecule is the smallest particle of an element or a compound which has particle of the

element or the compound and can exist in a free state.

Molecule it can be formed by either by the combination of atoms of same element or of different elements. Thus there are two types of elements.

(i) Homonuclear Molecules

Homonuclear Molecules containing atom of same element.
For ex:- H_2 , O_2 , N_2 , Cl_2 , O_3 , etc.

(ii) Heteronuclear Molecules

Heteronuclear Molecules of a compound containing atom of different elements.

For ex:- CO_2 , H_2O , etc.

Molecules of an Element

A molecule of an element contains 2 or more similar atom combine together.

They are classified as monatomic, Diatomic, Triatomic, Tetraatomic, Polyatomic Molecules depending on the number of atoms present in it.

Atomicity

The number of atom present in one molecule of an element is called its atomicity.

Name	Formula	atomicity	
Helium	He	1	Monatomic (I)
Oxygen	O ₂	2	Diatomic
Ozon	O ₃	3	Triatomic
Phosphorus	P ₄	4	Tetraatomic
Sulphur	S ₈	8	Polyatomic (II)
water	H ₂ O	3	Triatomic

Molecules of compound

* A molecules of compound contains two or more different types of atom chemically combine together.

The atoms of different element join together in a definite proportion to form the molecules of compound.

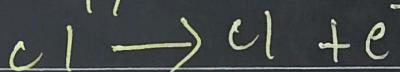
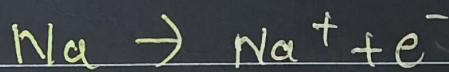
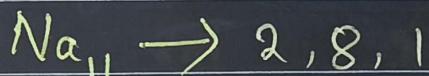
Compound Formaldehyde atomically combine simplest element ratio

water	H_2O	3	H & O	1 : 8
ammonia	NH_3	4	H & N	14 : 3
carbon dioxide	CO_2	3	C & O	3 : 8
Hydrochloric acid	HCl	2	H & Cl	1 : 35.5

J ions

An ion is defined as an atom or molecule which has gain or loss one or more of its balance electron given it a net positive or negative charge.

Positive charged ions are called cation.



Negative charged ions are called anion.

Atomic Number.

The number of protons present in the nucleus of an atom is the atomic number. It is represented by Z .

All atoms of an element have the same atomic number. The numbers of protons and electrons in an atom is equal. Thus the atom of an element is electrically neutral.

$$Z = \text{number of protons} / \text{electron}$$

Atomic mass

Atomic mass number is defined as the sum of number of protons and neutrons contain in the nucleus of an atom of that element.

It is represented by symbol A .

$$A = P + N$$

$$1, 8, 8 \leftarrow 1, 16 \\ 9 + 16 \leftarrow 16$$

Valency

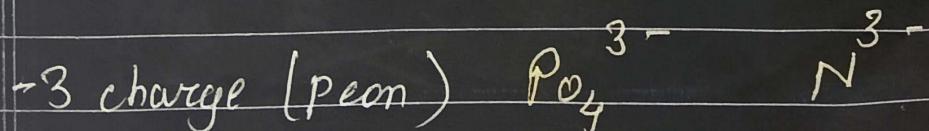
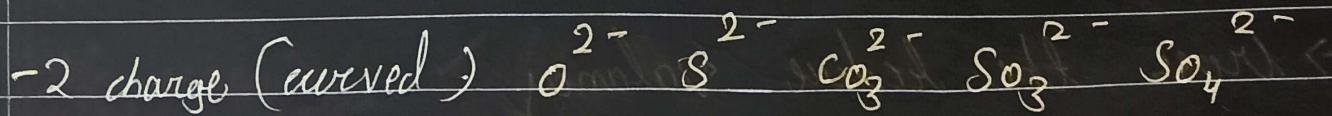
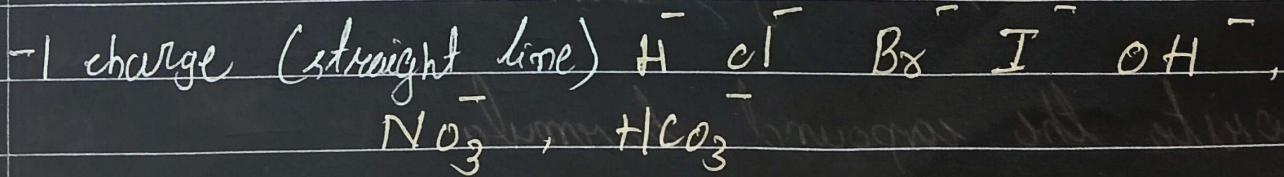
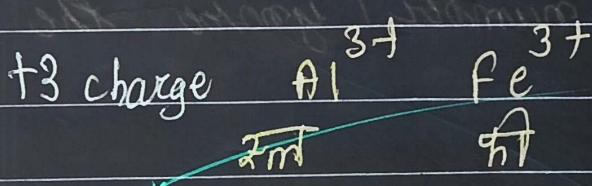
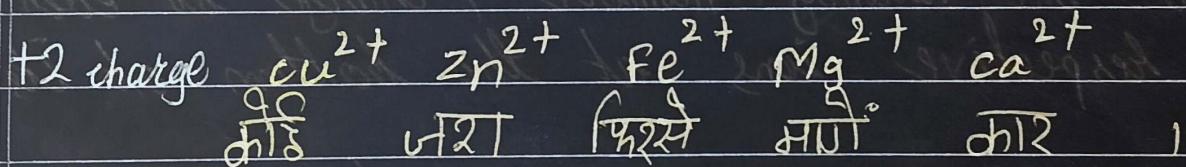
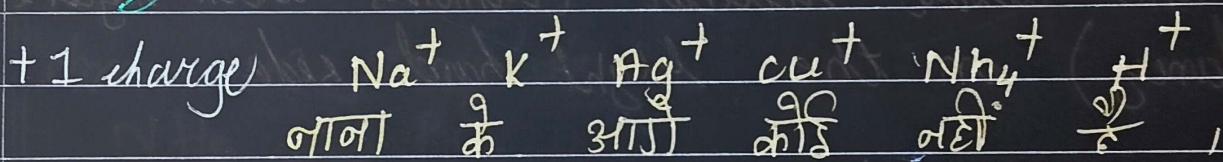
The valency of an atom is determined by its ability to loss, gain or share balance electron in order to complete its octet.

its valency.

Variable Valency

Sometimes the same valency may exhibit one valency and another valency in some other compound. This property is called variable valency.

~~Trick~~



chemical formula

It is the symbolical representation of the composition of a compound.

writing the chemical formula

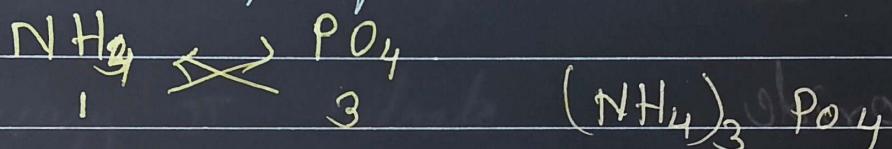
- write the symbol of basic radical elements with positive valency) on the left hand side and that of the acidic radical elements (with negative valency) on the right hand side.
- Write the valency number / charge of each of the respective ions at the bottom of its symbol.
- Interchange the valency number (ignore the +ve and -ve sign)
- write the interchange number
- write the compound formula
- cross the reduce valency

Characteristics of chemical formula

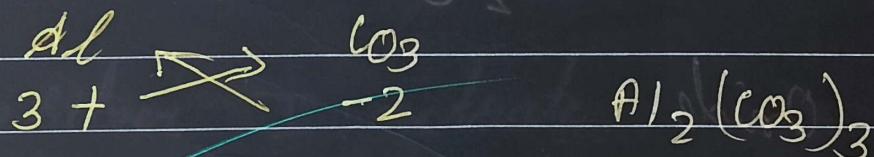
- The valency or charge on ions must be balance
- when a compound is formed of metal and non-metal symbol of metal comes first

when polyatomic ions are used the ions are enclosed in brackets before writing number.

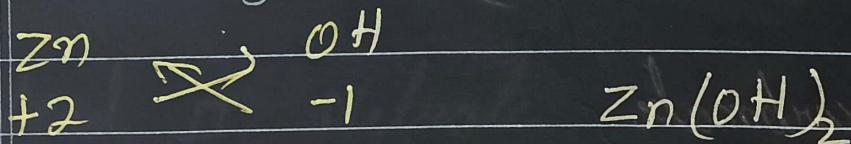
1) Ammonium phosphate



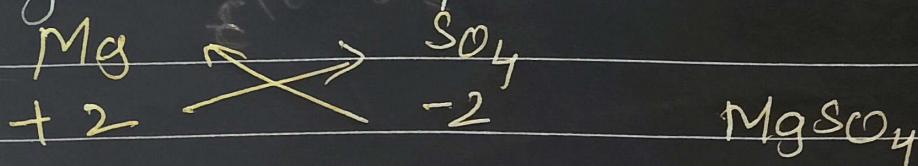
2) Aluminium carbonate



3) Zinc Hydroxide



4) Magnesium Sulphate



Molecular Mass

* It is the sum of the atomic mass of all the atoms in a molecule of a substance.

* It is expressed in atomic mass unit (u).

Example Magnesium Sulphate



$$24 + 32 + 4 \times 16$$

$$= 120 u$$

$$O_2H_2 \cdot H_2O_2$$

$$(16+16) + (16+16)$$

$$= 64 + 64$$