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ATOMS AND MOLECULES [Class 9th]

Atoms

⇒ Atoms are the building blocks of all matter.

⇒ Atoms are very small and which can't be seen even through very powerful microsopes.

⇒ Radius of atom = 1 nanometer = 10^{-9} m

Laws of Chemical Combination (Lavoisier and Joseph L. Proust)

- Law of Conservation of mass
- Law of constant Proportions

Law of Conservation of mass:

⇒ During a chemical ~~conservation~~ reaction, the total mass of reactants will be equal to the mass of product.

OR

Mass can ~~neg~~ neither be created nor destroyed.

Law of Constant Proportions:-

⇒ The elements in a pure chemical compound are always present in the same proportions by mass, regardless of how the compound is created.

→ It was given by Joseph Proust.

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Example:-

(i) 18 gm of H_2O = 2 gm of hydrogen + 16 gm of oxygen
⇒ Mass of hydrogen : mass of oxygen = 2:16 = 1:8.

(ii) 36 gm of H_2O = 4 gm of hydrogen + 32 gm of oxygen
⇒ Mass of hydrogen : mass of oxygen = 4:32 = 1:8

∴ The ratio of mass of hydrogen & oxygen is same.

Dalton's Atomic Theory:-

- Matter is made up of very tiny particles called atoms.
- Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction.
- Atoms of a given element are identical in mass and chemical properties.
- Atoms of different elements have different masses and chemical properties.
- Atoms combine in ratio of small whole number to form compounds
- The relative number & kinds of atoms are constant in a given compound.

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Drawbacks of Dalton's Atomic Theory:-

⇒ No Subatomic Particles:- Dalton's theory said atoms are indivisible, but we now know about electrons, protons, and neutrons.

⇒ Isotopes not defined:- ~~Dal~~ Dalton stated all atoms of an element have the same mass, but isotopes of elements have different masses.

⇒ No Isobars:- Dalton said atoms of different elements have different masses, but isobars have same masses.

Modern Day Symbols of Elements:-

⇒ Dalton firstly used symbols of elements.

⇒ Berzilius: suggested using one or ~~more~~ two letters from the element's name for its symbol.

⇒ IUPAC: Now responsible for approving element names, symbol, and units. Symbols typically use one or two letters from the element's English or latin or German name.

Atomic Mass

⇒ Daltons Atomic Theory: Introduced the concept of atomic mass, explaining the law of constant Proportions.

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⇒ Atomic mass: Mass of an atom of an element.

⇒ IUPAC (1961): Adopted term "atomic mass unit (amu)" to express atomic and molecular masses.

⇒ 1 atomic mass unit (amu) = 1/12 of the mass of a carbon-12 atom.

Atoms Existance

⇒ most elements' atoms are highly reactive.

⇒ Only noble gas atoms (He, Ne, Ar, Kr, Xe, Rn) are chemically inert and can exist as single atoms.

⇒ Atoms of all other elements combine to form molecules or ions.

Ions

⇒ Charged particles (either positively or negatively).

↓ Cations [Positively charged] Na^+, K^+, Ca^{2+}

↓ Anions [Negatively charged] S^{2-}, SO_4^{2-}

Simple Ions:- Single elements. Ex:- Mg^{2+}, Cl^-

Compound Ions:- more than one element. Ex:- NH^{4+}, OH^-

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Molecule

⇒ A group of two or more atoms chemically bonded together by attractive forces.

- Molecule of element
  - When atoms of same element combine to form a molecule.
  - Ex - O_2, O_3, H_2
- Molecule of Compound
  - When atoms of different element combine to form a molecule.
  - Ex - H_2O, NH_3

Atomicity

⇒ Atomicity refers to the number of atoms present in a single molecule of an element, substance or compound.

- Monoatomic - Consists of one atom: [Na, He, C, Al]
- Diatomic - Consists of two atoms. [H_2, O_2, F_2]
- Triatomic - Consists of three atoms. [O_3]
- Polyatomic - Consists of more than three atoms. [P_4, S_8]

- Generally metals are monoatomic.

Molecular Mass

⇒ Sum of all the atoms in a molecule of a substance.

Ex, $H_2O = 1 \times 2 + 16 = 2 + 16 = 18u$ [∵ mass of H = 1u, oxygen = 16u]

Formula Unit Mass

⇒ It is the sum of atomic mass of ions and atoms present in formula for a compound.

Example:- In NaCl,

Na = 23 a.m.u
Cl = 35.5 a.m.u
∴ Formula unit mass = 58.5 amu

Why do Atoms Combine?

⇒ The atoms combine to attain noble or inert gas electronic configuration in order to be stable.

⇒ Valency:-

- Valency is the combining capacity of an element.
- Valency equals the number of electrons gained, lost, or shared to achieve noble gas state.

Chemical Formulae

⇒ It is the symbolic representation of the composition of a compound.

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Example:-

① Formula of hydrogen chloride

Symbol: H Cl [cross multiple]
Valency: 1 1

∴ Formula = HCl

② Formula of hydrogen Sulphide

Symbol: H S
Valency: 1 2

∴ Formula = H_2S

③ Formula of Carbon tetrachloride

Symbol:- C Cl
Valency:- 4 1

Formula:- CCl_4

④ Magnesium Chloride

Symbol Mg Cl
Valency 2 1

Formula:- $MgCl_2$

⑤ Sodium Carbonate

Symbol:- Na CO_3
Valency:- 1 2

∴ Formula:- Na_2CO_3

⑥ Ammonium Sulphate

Symbol:- NH_4 SO_4
Valency:- 1 2

∴ Formula:- $(NH_4)_2SO_4$