GRAVITY CLASSES

"Come Gravity Feel Success"

11th & 12th BOARD (NEET & JEE)

5th - 10th (All Subject)

NOTES

CHEMISTRY

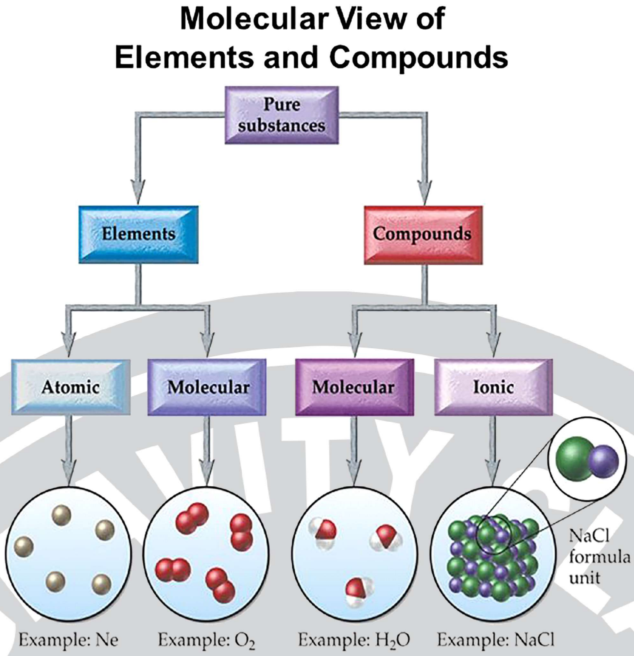
Directors
ER. AMIR SIR
ER. ASAD SIR

7004166363
7717752909

Address:
Blue star campus,
patther ki masjid, patna - 6

ATOMS AND MOLECULES

➢ **Matter:-** Anything that has mass and occuping space is called matter.



- **Constituent Particles of Matter:-** All matter is composed of small invisible particle called atoms.

➢ **Atom:-** The smallest particles of an element which may or may not exist, independently and can take part in chemical reaction.

→ Maharshi Kanad (Indian Philosopher) → Gold

→ Democritus and Leucippus (Greek) → Indivisible particle → Atomos.

→ John Dalton (England) → Derived from Atomos "Atom"

→ Atoms are very small in size. The size of an atom is indicated by its radius which is called atomic radius (radius of an atom). Atomic radius is measured in nanometer (nm).

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

Hydrogen atoms is the smallest atom of all having an atomic radius is 0.037 nm. Atoms are so small that we can't see them under the most powerful optical microscope.

Q. How do atoms occur ?

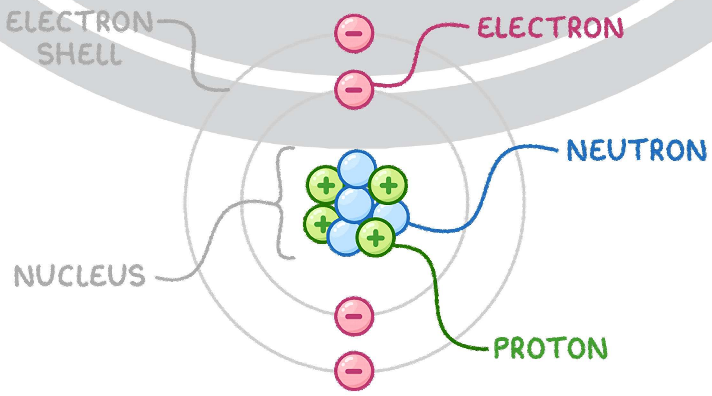
→ They exist in combination with the atoms of the same elements or another element. Ex.- O_2, CO_2, H_2O.

→ The atoms of only a few element called Noble gases (such as Helium, Neon, Argon and Krypton etc). Which are chemically unreactive and exist in the free stable state (as single atom).

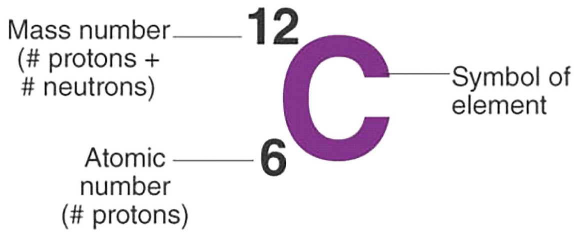
→ Atoms of most of the elements are very reactive and don't exist in the free state (as single atom).

- **Sub-Atomic Particles of Atom:-**

→ The three main subatomic particles that form an atom are Protons, Neutron and Electrons.

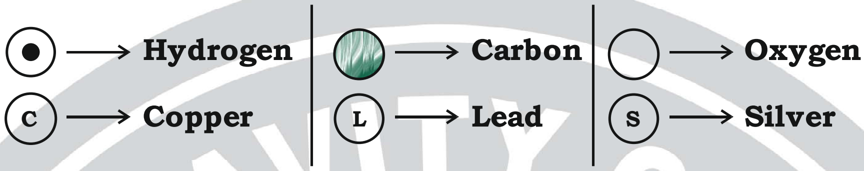


- **Representation of atom:-**



- **Modern day symbols of atoms of different Elements:-**

→ Dalton was the 1st Scientist who introduced symbols are representing elements for the first time.



→ J.J. Berzilius suggested symbol may be defined as the abbreviation used for the name of an element.

The First 20 Elements of the Periodic Table

H Hydrogen Atomic Number: 1 Protons: 1 Atomic Mass: 1.0079	**He** Helium Atomic Number: 2 Protons: 2 Atomic Mass: 4.0026	**Li** Lithium Atomic Number: 3 Protons: 3 Atomic Mass: 6.941	**Be** Beryllium Atomic Number: 4 Protons: 4 Atomic Mass: 9.0122	**B** Boron Atomic Number: 5 Protons: 5 Atomic Mass: 10.811
C Carbon Atomic Number: 6 Protons: 6 Atomic Mass: 12.0107	**N** Nitrogen Atomic Number: 7 Protons: 7 Atomic Mass: 14.0067	**O** Oxygen Atomic Number: 8 Protons: 8 Atomic Mass: 15.9994	**F** Fluorine Atomic Number: 9 Protons: 9 Atomic Mass: 18.9984	**Ne** Neon Atomic Number: 10 Protons: 10 Atomic Mass: 20.1797
Na Sodium Atomic Number: 11 Protons: 11 Atomic Mass: 22.9897	**Mg** Magnesium Atomic Number: 12 Protons: 12 Atomic Mass: 24.305	**Al** Aluminum Atomic Number: 13 Protons: 13 Atomic Mass: 26.9815	**Si** Silicon Atomic Number: 14 Protons: 14 Atomic Mass: 28.0855	**P** Phosphorus Atomic Number: 15 Protons: 15 Atomic Mass: 30.9738
S Sulfer Atomic Number: 16 Protons: 16 Atomic Mass: 32.065	**Cl** Chlorine Atomic Number: 17 Protons: 17 Atomic Mass: 35.453	**Ar** Argon Atomic Number: 18 Protons: 19 Atomic Mass: 39.948	**K** Potassium Atomic Number: 19 Protons: 19 Atomic Mass: 39.0983	**Ca** Calcium Atomic Number: 20 Protons: 20 Atomic Mass: 40.078

1. The symbol of the following elements are the first letter (Capital) of the name of that elements.

Symbol	Element
B	Boron
C	Carbon
F	Fluorine
H	Hydrogen
I	Iodine
N	Nitrogen
O	Oxygen

2. Some symbols derived from the first two letters of the names of the elements capital and 2nd small letter.

Symbol	Element
Li	Lithium
Be	Berylium
Al	Aluminium
Si	Silicon
Ne	Neon
Ar	Argon
Ca	Calcium
Ba	Barium

3. Some symbol derived from the first (Capital) and the third (Small) letter of the names of the element.

Symbol	Element
Mg	Magnesium
Mn	Manganese
Zn	Zinc
Cr	Chromium

4. There are certain symbols which seen to here no relationship to their names. The symbol of these elements are derived from their Latin names and Greek name.

Sodium	(Na – Natrium)
Potassium	(K – Kalium)
Iron	(Fe – Ferrum)
Copper	(Cu – Cuprum)
Silver	(Ag – Argentum)
Tin	(Sn – Stannum)
Antimony	(Sb – Stibium)
Tungsten	(W – Wolfram)
Gold	(Au – Aurum)
Mercury	(Hg – Hydrargyrum)
Lead	(Pb – Plumbum)

Q. Who give authorization to this Element names ?

A. IUPAC (International Union of Pure and Applied Chemistry).

➢ **Laws of Chemical Combination:-**

→ Chemistry is an experimental science and deals mainly with the reaction carried out time to time (Physically and Chemically change).

→ In 18th century, chemists made several experiments and observed that all the chemical reactions always take place in accordance to certain laws.

i. Law of Conservation of Mass.

ii. Law of Constant Proportions/Law of definite Proportions.

iii. Law of multiple Proportions.

➢ **Law of conservation of Mass:-** (Lavoisier - 1798)

→ A french chemist (Antoine L. Lavoisier the father of chemistry) proposed a very significant law known as law of conservation of mass.

→ **The law can be stated as follow:-** "The total mass of the products obtained during any physical or chemical change is always equal to the total mass of reactants taken at the beginning of the change".

→ The matter is neither created nor destroyed during any physical or chemical change. However, it may change from one form to another.

Ex.- (i)
$$\underset{\substack{\text{Calcium Carbonate} \\ 100\,g}}{CaCo_3} \xrightarrow{\text{Strongly Heat}} \underset{\substack{\text{Calciumoxide} \\ 56\,g}}{CaO} + \underset{44\,g}{Co_2}$$

$$\text{(ii)}\quad \underset{12\,g}{C} + \underset{16\times 2 = 32\,g}{O_2} \longrightarrow \underset{12+32=44\,g}{CO_2} \quad \left[\begin{array}{c}\text{Combustion}\\ \text{Reaction}\end{array}\right]$$

→ The total mass of the reactants is exactly the same as the mass of the product.

➢ **Law of constant proportion or Law of definite proportion (Proust 1799):-**

→ A french chemist, Proust in 1799 proposed the law of constant proportion or L.O.D.P.

→ "A chemical water (H_2O) is comprised of two elements hydrogen and oxygen in the ratio 1:8 by mass. Pure water obtained from any source (river, sea, lake) always contain hydrogen and oxygen in the same fixed ratio 1:8 or 2:16 by mass."

➢ **Law of multiple proportion:-**

→ It was given by Dalton in 1808. A/c to it. "When one element combines with the other element to form two or more different compounds the mass of one element, which combines with a constant mass of the other bear a simple ratio to one another."

$$C_{12} + O_{16} \rightarrow CO\,(\text{Carbon Monoxide}) \mid C + O \rightarrow C_{12}O_{32}\,(\text{Carbon Dioxide})$$

➢ **Dalton's Atomic Theory (1808):-** (DAT)

→ Keeping in view the law of chemical combination and the work of Greek philosphers, a meaningful atomic theory was finally proposed by John Dalton in 1808.

➢ **The basis postulates (pt.) of Dalton's theory are as follows:-**

(i) All matter is made of very tiny particle called atoms.
(ii) Atoms are indivisible particles, which can't be created or destroyed in a chemical reaction.
(iii) Atoms of a given element are identical in mass and chemical properties.
(iv) Atoms of different elements have different masses and chemical properties.
(v) Atoms combine in the ratio of small whole numbers to form compounds.
(vi) The relative number and kinds of atoms are constant in a given compound.

➢ **Merits of Dalton's Atomic Theory (DAT):-**

→ Dalton's theory provides us a conceptional picture of matter. Atoms are the basic building blocks matter. They are the smallest units of an element that can combine with other elements in a chemical reaction. In compounds the atom of two or more element combine in definite arrangement.

→ The postulates of Dalton's (DAT) that "**Atoms can neither be created nor destroyed**" was the result of law of conservation of mass.

→ The postulates of DAT that "**the element consist of atom having fixed mass**" and that the number and kind of atom in a given compound is fixed came from the law of constant proportions.

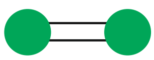
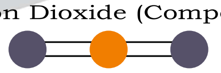
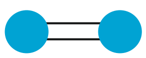
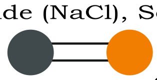
➢ **Limitations of Dalton's Atomic Theory (DAT):-**

i. **Distinction between atoms and molecules:-** According to Dalton the smallest particle of an element as well as of compound was atom, however he called 'compound atoms' to be smallest particle of compound. Later on '**Amedeo Avogadro**' used the term molecules for the 'compound atom' i.e. molecule is the smallest particle of compound.

ii. It could not explain why do atoms combine to form a molecule.

iii. It could not explain the nature of forces which hold the atoms and molecules in solid, liquid and gaseous state.

iv. The theory fails to explain the existence of isotopes and isobars.

Molecules	**Compound**
A molecule is formed when two or more atoms join together	A compound is a molecule that contains at least two different elements
Ex.- Oxygen Gas (Molecules (O_2)) 	Ex.- Carbon Dioxide (Compound) (Co_2) 
Hydrogen Gas (H_2) 	Sodium Chloride (NaCl), Sodium Chlorine 

Note:- All compounds are molecules but not all molecules are compound.

➢ Atomic Mass:-

→ AMU (Atomic Mass Unit) or U (Unified Mass) is the standard unit for measurement of Atomic Mass.

Mass of Proton (1p)

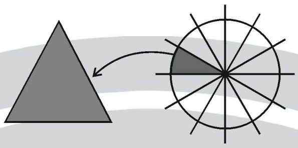
$$\boxed{1 amu = 1.67 \times 10^{-27} kg}$$

Mass of Newton (1n)

→ Carbon -12 (C_{12}) isotope was choosen as the standard reference for measuring atomic masses.

$$\frac{1}{12} \times C - 12 = 1 amu \Leftarrow (1 amu) \Leftarrow$$

(mass)



→ One atomic mass unit is a mass unit equal to exactly one twelth $\left(\frac{1}{12}\right)^{th}$ the mass of one atom of carbon-12.

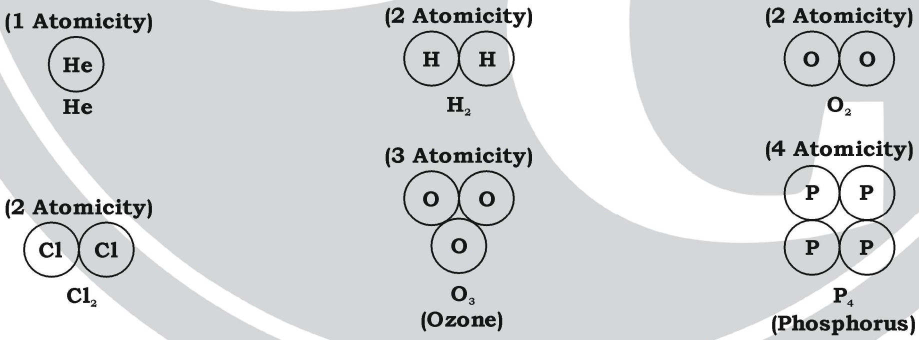
Element	Relative At Mass
Hydrogen	1
Helium	4
Carbon	12
Nitrogen	14
Oxygen	16
Sodium	23
Magnesium	24
Aluminum	27

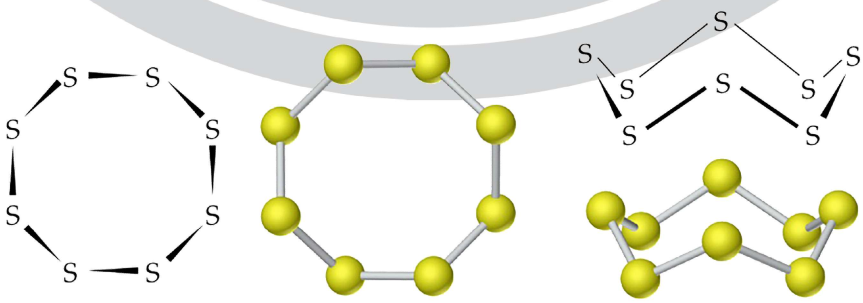
➢ Molecule:-

→ It is defined as the smallest particle of an element (H, O, He) or a compound that is capable of an independent existance and shows all the properties of that substance.

→ It is a group of two or more atoms that are chemically bonded together, that is tightly held together by attractive forces.

- The molecules of an element are constituted by the same type of atoms. Ex.- Molecules of Elements.
- The number of atoms constituting a molecules is known as atomicity.





Top View Side View

- Molecule of some element contain only one atom known as Monoatomic.
- Molecules of some element contain two atoms known as Diatomic.
- Molecules of some element contain three atoms known as Triatomic.
- Molecules of some element contain three atoms known as Polyatomic.

➢ **Molecules of Compounds:-**

→ Atoms of different elements join together in definite proportions to form molecules of compound.

Compound	Combining Elements	Ratio by Mass of Atoms	Ratio by Number of Atoms
Water (H_2O)	Hydrogen, Oxygen	1:8	2:1
Ammonia (NH_3)	Nitrogen, Hydrogen	14:3	1:3
Carbon dioxide (CO_2)	Carbon, Oxygen	3:8	1:2
Carbon Monoxide (CO)	Carbon, Oxygen	3:4	1:1
Hydrogen Peroxide (HO_{22})	Hydrogen, Oxygen	1:16	1:1

➢ **IONS:-**

→ Compounds composed of metals and non-metals contain changed species. The charged species are known as ions.

→ An ion is a charged particle and can be negatively or positively charged.

→ A negatively changed ion is called an '**anion**' and positively charge ion is called an '**cation**'.

→ Ions may consist of a single charged atom or a group of atoms that have a net charge on them. Ex.- Ca^{2+}, Na^{+}, $(H_3O)^{+}$, $(OH)^{-}$

→ A group of atoms carrying a charge is known as Polyatomic ions.

Ex.- Na^{+} × H_3O^{+} ✓

➢ **Valency:-**

- The combining power (or capacity) of an element is known as its valency.
- Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound.

Writing Chemical Formula (Tab. 3.6 NCERT)

(i) Calcium Carbone	(ii) Magnesium Hydroxide	(iii) Ammonium Sulphate
Ca^{2+} $(Co_3)^{2-}$	Mg^{2+} $(OH)^{-1}$	$NH_4{}^{1+}$ $(So_4)^{2-}$
$Ca_2(Co_3)_2 \rightarrow CaCo_3$	$Mg(OH)_2$	$(NH_4)_2So_4$

➢ **Molecular Mass:-**

→ The molecular mass of a substances is the sum of the atomic masses of all the atoms in a molecule of the substance.

Molecular mass of (H_2O) = 18 u

$$\underset{1u}{H}\ \underset{16u}{O} \Rightarrow H_2O \Rightarrow (1)\times 2 + 16 \Rightarrow 2 + 16 \Rightarrow 18u$$

Molecular mass of (HNO_3) = 63u

$$\underset{1u}{H}\ \underset{14u}{N}\ \underset{16u}{O} \Rightarrow HNO_3 \quad = 1u + 14u + (16u)3 \quad = 1u + 14u + 48u \quad = 63u$$

➢ Formula Unit Mass:-

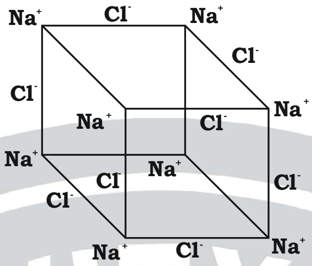
→ Formula unit mass is calculated in the same manner as we calculate the molecular mass. The only difference is that we use the word formula unit for those substances whose constituent particles are ions.

→ Sodium chloride has a formula unit NaCl. Its formula unit mass can be calculated.

Ex.- NaCl

(1u)23 + (1u) 35.5

= 58.5u



Avogadro Number (NA) = (6.022 × 10^{23})

1 pair = 2 units

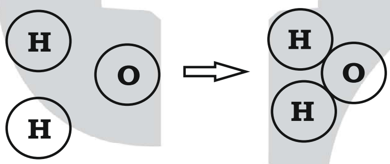
1 Dozen = 12 units

1 Mole = 602200000000000000000000 units

1 Mole of Na - atoms ⇒ 6.022 × 10^{23} Na - Atoms

1 Mole of H_2O-Molecules ⇒ 6.022 × 10^{23} H_2O-Molecules

1 Mole of c - atom ⇒ 6.022 × 10^{23} C - Atoms.

Atomic Mass (amu/u)	**Molecular Mass (1 amu = 1.67 × 10^{-27} kg)**	**Molar Mass (MM) or Gram Atomic Mass (GAM)**	
Mass of 1 atom of any given element	Mass of 1 molecules of any given compound	Mass of 1 mole of any given chemical (atoms, molecules or ions)	
H → 1u		H = 1 g N = 14 u × 1 mole = (14u × 6.022 × 10^{23}) = 84.308 × 10^{23} u = 14 u = 14 g Cl = 35.5 g Ca = 40 g	G A M
C → 12u			
N → 14u			
O → 16u			
Na → 23u			
Mg → 24u			
Al → 27u			
P → 31u	H_2O → (1u)2 + (16u) = 18u		
S → 32u	CO_2 → (12u) + (16u)2 = 44	CO_2 → 44u → 44g H_2O → 18u → 18g	Gram Molecular Mass (GMM)
Cl → 35.5u	CH_4 → (12u) + (1u)4 = 16u		
K → 39u	HCL → (1u) + (35.5u) = 36.54		
Ca → 40u	H_2SO_4 → (1u)2 + (32u) + (16u)4 = 97u		

Q. 1 mole of any atoms/molecule = (6.022 × 10^{23}) number of atoms = (MM,GAM, GMM)

Q. If Cost of 30 pens is 150 Rs, Calculate cost of 5 pens

Sol. 30 pen → 150 Rs.

1 pen → $\frac{150}{30}$ Rs. = 5Rs.

5 pen = 5 × 5 Rs. = 25 Rs.

30 pen → 150 Rs.

3 pen → x

$\frac{30}{5} = \frac{150}{x}$

$x = \frac{150 \times 5}{30}$, $\boxed{x = 25}$

Q. If mass of 1 mole of sodium atoms in 23 g. Calculate mass of 0.2 mole of sodium atoms.

Sol. 1 mole → 23 g $\qquad \frac{1}{0.2} = \frac{23}{g}$

0.2 mole → x.g $\qquad x.g = 23 \times 0.2 \qquad \boxed{x = 4.6\,g}$

Q. Calculate mass of 0.8 moles of Nitrogen Atoms.

Sol. 1 mole → 14 g $\qquad x = 14 \times 0.8\,g$

0.8 mole → x.g $\qquad \boxed{x = 8.2\,g}$

Q. Calculate mass of 0.4 moles of oxygen Atom.

Sol. $0.4\,\text{moles} = x.g \qquad \frac{0.4}{1} = \frac{x}{16}g$

$1\,\text{moles} = 16\,g \qquad x = 0.4 \times 16\,g \qquad \boxed{x = 6.4\,g}$

Q. Calculate number of atoms present in 0.6 g of carbon atoms.

Sol.
$$\text{Carbon atom} \rightarrow \begin{cases} \text{Molar Mass} = 12\,g \\ \text{Moles} = 1\,\text{mole} \\ \text{Particles of atom} = 6.022 \times 10^{23} \end{cases}$$

$0.6\,g \rightarrow x - \text{oxygen atom}$

$12\,g \rightarrow 6.022 \times 10^{23}$ oxygen atom

$$\frac{0.6}{12} = \frac{x}{6.022 \times 10^{23}} \qquad x = \frac{0.6 \times 6.022 \times 10^{23}}{12} \qquad = 0.3011 \times 10^{23}$$

✳ **Formula:-**

i. $\boxed{\text{No. of Moles(m)} = \frac{\text{Given Mass}}{\text{Molar Mass}}}$

ii. $\boxed{\text{No. of Atoms / Molecules} = \frac{\text{Given Mass}}{\text{Molar Mass}} \times N_A}$

Q. Calculate number of moles in:-

Sol. (i) $46\,g$ of Sodium $\Rightarrow \frac{\text{Given Mass}}{\text{Molar Mess}} = \frac{46\,\not{g}}{23\,\not{g}} = 2\,\text{moles}$

(ii) $230\,g$ of Sodium $\Rightarrow \frac{230\,g}{23\,g} = 10\,\text{moles}$

(iii) $2.3\,g$ of Sodium $\Rightarrow \frac{2.3\,g}{230\,g} = \frac{1}{10}\,\text{mole} = 0.1\,\text{mole}$

(iv) $0.46\,g$ of Sodium $\Rightarrow \frac{0.46\,g}{2300\,g} = \frac{2}{100} = 0.02\,\text{mole}$

(v) $7.2\,g$ of Carbon $\Rightarrow \frac{7.2}{120} = \frac{6}{10} = 0.6\,\text{moles}$

(vi) $2.2\,g$ of Carbon dioxide $\Rightarrow \frac{2.2\,g}{440\,g} = \frac{1}{20} = 0.05\,\text{moles}$

Q. Calculate mass of :

(i) $4 \text{ moles of Sodium} \Rightarrow 4 \times 23\,g = 92\,g$

(ii) $0.4 \text{ moles of Sodium} \Rightarrow 0.4 \times 23\,g = 0.92\,g$

(iii) $5 \text{ moles of } CO_2 \Rightarrow 5 \times 44\,g = 220\,g$

(iv) $10 \text{ moles of } O_2 \Rightarrow 10 \times 32\,g = 320\,g$

$O - \text{atom} \Rightarrow 16\,g$

$O_2 \text{ atom} \Rightarrow 32\,g$

(v) $20 \text{ moles of } N_2 \Rightarrow 20 \times 28\,g = 560\,g$

$N \text{ atom} \Rightarrow 14\,g$

$N_2 \text{ atom} \Rightarrow 28\,g$

$$\text{No. of Atoms / Molecules} = \left(\frac{\text{Given Mass}}{\text{Molar Mass}}\right) \times N_A$$

$$\boxed{\text{No. of Atoms / Molecules} = [\text{No. of Moles (n)}] \times N_A}$$

Q. Calculate Number of Atoms/Molecules

(i) 0.4 moles of sodium

Sol. $\text{No. of Atoms / Molecules} = [\text{No. of Moles (n)}] \times N_A$

$= 0.4 \times 6.022 \times 10^{23}$

(ii) 5 Moles of CO_2

Sol. $\text{No. of Atoms / Molecules} = 5 \times 6.022 \times 10^{23}$

(iii) 2.3 g of Sodium

Sol. $\text{No. of Atoms / Molecules} = \left(\frac{\text{Given Mass}}{\text{Molar Mass}}\right) \times N_A$

$= \frac{2.3}{23} \times 6.022 \times 10^{23} \Rightarrow \frac{1}{10} \times 6.022 \times 10^{23} \Rightarrow 6.022 \times 10^{22} \text{ Na Atom}$

(iv) 2.2 g of Carbon dioxide

Sol. $\text{No. of Atoms / Molecules} = \frac{2.2}{44} \times 6.022 \times 10^{23}$

$= \frac{1}{20} \times 6.022 \times 10^{23} \Rightarrow 3.011 \times 10^{22}\ CO_2 \text{ Atom}$

Q. Calculate number of CO_2 molecules in 0.88 g of CO_2. Also calculate Number of O-atoms.

Sol. $\text{No. of Molecules} = \frac{G.M}{M.M} \times 6.022 \times 10^{23}$

$= \frac{0.88}{44} \times 6.022 \times 10^{23}$

$= 0.02 \times 6.022 \times 10^{23}$

$= 2 \times 10^{-2} \times 6.022 \times 10^{23}$

$= 12.044 \times 10^{21}\ CO_2 \text{ Molecule}$

So, if 1 molecules of CO_2 contain two (2) oxygen atom.

Then, 12.044×10^{21} CO_2 molecules contain

$$2 \times 12.044 \times 10^{21} \text{ O} - \text{atom}$$

$$24.088 \times 10^{21} \text{ O} - \text{atom}$$

Q. Which is containing more number of atom 10 gm of C or 10 gm of O.

Sol.

$$\text{No. of atom} = \frac{GM}{M.M} \times N_A$$

C: $\frac{10}{12} \times 6.022 \times 10^{23}$ O: $\frac{10}{16} \times 6.022 \times 10^{23}$

Since, Numerator is equal so less the Denominator more will be the value. So,
C-atom > O-atom

Q. Calculate number of moles and molecules present in 19.6 g of H_2SO_4. Also give count of H-atoms.

Sol. $\text{No. of moles} = \frac{19.6}{98} = 0.2 \text{ moles}$

$$= 0.2 \times 6.022 \times 10^{23}$$

$$= 1.2044 \times 10^{23} \ H_2SO_4 \text{ molecules}$$

$$\text{No. of H} - \text{atoms} = 2 \times 1.2044 \times 10^{23} \text{ H} - \text{atom}$$

$$= 2.4088 \times 10^{23} \text{ H} - \text{atom}$$