

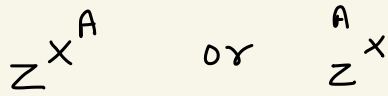
Stoichiometry-1

SAP-4



Atom \rightarrow Atom is a smallest fundamental particle of an element.

Representation of atom \rightarrow



X = Notation of atom

Z = Atomic no.

A = mass no. (no. of nucleons)



atomic no. = 11

mass no. = 23

* No. of protons in an atom = Z

* No. of neutrons in an atom = $A - Z$

* No. of electrons in a neutral atom = No. of protons

—, ————— in a charged species
= No. of protons — charge

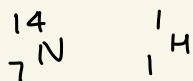


No. of protons = 8

No. of neutrons = $16 - 8 = 8$

$$\text{No. of electrons} = 8 - (-2) = 10$$

Ex. NH_4^+ (Ammonium ion)



$$\text{No. of Protons} = 7 + (4 \times 1) = 11$$

$$\text{No. of neutrons} = 7 + (4 \times 0) = 7$$

$$\text{No. of electrons} = 11 - 1 = 10$$

Ex. $\text{C}_2\text{O}_4^{2-}$ (oxalate ion) ${}^{12}_6\text{C} \quad {}^{16}_8\text{O}$

$$\text{No. of Protons} = 12 + 32 = 44$$

$$\text{No. of neutrons} = 12 + 32 = 44$$

$$\text{No. of electrons} = 44 - (-2) = 46$$

| Atomic No. | Notation of atom | mass no. |
|------------|------------------|----------|
| 1 | H | 1 |
| 2 | He | 4 |
| 3 | Li | 7 |
| 4 | Be | 9 |
| 5 | B | 11 |
| 6 | C | 12 |
| 7 | N | 14 |

| | | |
|----|----|------|
| 8 | O | 16 |
| 9 | F | 19 |
| 10 | Ne | 20 |
| 11 | Na | 23 |
| 12 | Mg | 24 |
| 13 | Al | 27 |
| 14 | Si | 28 |
| 15 | P | 31 |
| 16 | S | 32 |
| 17 | Cl | 35.5 |
| 18 | Ar | 40 |
| 19 | K | 39 |
| 20 | Ca | 40 |

mole \rightarrow It is collection of N_A Particles.
 $N_A = \text{avogadro no.} = 6.023 \times 10^{23}$
 $\approx 6 \times 10^{23}$

1 mole oxygen atoms = N_A oxygen atoms

1 mole H_2O molecules = N_A H_2O molecules

1 mole mangoes = N_A mangoes

Atomic mass \rightarrow mass of 1 atom of an element

$$\text{Atomic mass} = (\text{mass no.}) \text{ amu}$$

$$\underline{\text{Atomic mass unit (amu)}} = \frac{1}{12} \times (\text{mass of 1 atom of } {}^{12}_6\text{C})$$

Gram atomic mass (molar mass of atom) \rightarrow

It is the mass of 1 mole atoms of an element

$$* \quad 1 \text{ amu} = \frac{1}{N_A} \text{ gm}$$

Ex. ${}^{24}_{12}\text{Mg}$

$$\text{mass no.} = 24$$

$$\begin{aligned} \text{mass of 1 atom of Mg or atomic mass} \\ \text{of Mg} &= 24 \text{ amu} = \frac{24}{N_A} \text{ gm} \end{aligned}$$

Gram atomic mass of Mg

$$\begin{aligned} \text{or} \\ \text{mass of 1 mole Mg atoms} &= \frac{24}{\cancel{N_A}} \times \cancel{N_A} \text{ gm} \end{aligned}$$

$$\begin{aligned} \text{or} \\ \text{mass of } N_A \text{ Mg atoms} &= 24 \text{ gm} \end{aligned}$$

$$\begin{array}{c} \text{Gram atomic mass} \\ \text{or} \\ \text{molar mass of atom} \end{array} = (\text{mass no.}) \text{ gm}$$

Ex.



$$\text{mass no.} = 40$$

$$\text{atomic mass} = 40 \text{ amu} = \frac{40}{N_A} \text{ gm}$$

$$\text{molar mass} = 40 \text{ gm}$$

2. If we consider that $1/6$, in place of $1/12$, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will

(2005)

(A) decrease twice

(B) increase two folds

(C) remain unchanged

(D) be a function of the molecular mass of the substance

Solⁿ →

$$\begin{array}{ccc} \text{amu} & = & \frac{1}{12} \times (\text{mass of 1 atom of } C_{12}) \\ \downarrow & & \downarrow \\ 2 \text{ amu} & & \frac{1}{6} \end{array}$$

$$1 \text{ amu} = \frac{1}{N_A} \text{ gm} \Rightarrow$$

$$\text{amu} \times N_A = 1 \text{ gm (const.)}$$

amu → Double

N_A → Half

$$\frac{24}{12} \text{ mg}$$

mass of 1 atom of Mg = 24 amu
 $\rightarrow 48 \text{ amu}$

mass of 1 mol Mg atoms = $(24 \text{ amu}) \times N_A$
 $\downarrow \qquad \qquad \downarrow$
 $48 \text{ amu} \times \frac{N_A}{2}$

$$= 24 \text{ amu} \times N_A$$

$$= 24 \text{ gm}$$

molecular mass \rightarrow mass of 1 molecule

$$\text{molecular mass} = (\text{Total mass no.}) \text{ amu}$$

Gram molecular mass (molar mass of molecule) \rightarrow

mass of 1 mole molecules.

$$\text{molar mass of molecule} = (\text{Total mass no.}) \text{ gm}$$

Ex. CH_4 Molecular mass = 16 amu

molar mass = 16 gm

H_2SO_4 Molecular mass = 98 amu

molar mass = 98 gm

HNO_3 Molecular mass = 63 amu

molar mass = 63 gm

Average atomic mass (Atomic mass of mix.) →

$$M_{avg} = \frac{n_1 M_1 + n_2 M_2}{n_1 + n_2}$$

$n_1 \rightarrow$ % abundance of atom A
or
no. of moles of atom A

$M_1 \rightarrow$ atomic mass of atom A

$n_2 \rightarrow$ % abundance of atom B
or
no. of moles of atom B

$M_2 \rightarrow$ atomic mass of atom B

Naturally occurring chlorine is 75% Cl^{35} which has an atomic mass of 35 amu and 25% Cl^{37} which has a mass of 37 amu. Calculate the average atomic mass of chlorine -

(A) 35.5 amu

(B) 36.5 amu

(C) 71 amu

(D) 72 amu

Solⁿ →

$$M_{avg} = \frac{(75 \times 35) + (25 \times 37)}{75 + 25}$$
$$= 35.5 \text{ amu}$$

Average molecular mass (Molecular mass of mix) →

$$M_{avg} = \frac{n_1 M_1 + n_2 M_2 + \dots}{n_1 + n_2 + \dots}$$

The molar composition of polluted air is as follows :

| Gas | At. wt. | mole percentage composition |
|--------------------|---------|-----------------------------|
| Oxygen (O_2) | 16 | 16% |
| Nitrogen (N_2) | 14 | 80% |
| Carbon dioxide | - | 03% |
| Sulphurdioxide | - | 01% |

What is the average molecular weight of the given polluted air ? (Given, atomic weights of C and S are 12 and 32 respectively.)

Solⁿ →

$$M_{avg} = \frac{(16 \times 32) + (80 \times 28) + (3 \times 44) + (1 \times 64)}{16 + 80 + 3 + 1}$$
$$= 29.48 \text{ amu}$$

Calculation of no. of moles →

$$(1) \text{ no. of moles} = \frac{\text{given mass (gm)}}{\text{Molar mass}}$$

$$(2) \text{ no. of moles} = \frac{\text{No. of Particles}}{N_A}$$

$$(3) \text{ For ideal gases, no. of moles (n)} = \frac{PV}{RT}$$

$$\text{at NTP/STP} \rightarrow P = 1 \text{ atm} \approx 1 \text{ bar}$$

$$T = 273 \text{ K}$$

$$* \quad 0.0821 \times 273 = 22.4$$

$$* \quad 0.0821 \times 298 = 24.46$$

$$* \quad 0.0821 \times 300 = 24.63$$

$$\text{No. of moles at NTP/STP} = \frac{V_{\text{lit.}}}{22.4}$$

Q. If CH_4 gas occupies 2.446 ml vol. at 2 atm, 25°C . Then find

- (i) No. of moles
- (ii) No. of molecules
- (iii) No. of C-atoms
- (iv) No. of H-atoms
- (v) Total no. of atoms
- (vi) mass in mg

Solⁿ →

$$n = \frac{PV}{RT} = \frac{2 \times \frac{2.446}{1000}}{24.46}$$
$$= 2 \times 10^{-4} \text{ moles}$$

$$\text{no. of moles} = \frac{\text{no. of molecules}}{N_A}$$

$$\text{No. of molecules} = 2 \times 10^{-4} N_A$$

$$\text{Total No. of atoms} = 5 \times 2 \times 10^{-4} N_A$$

$$\text{No. of C-atoms} = 1 \times 2 \times 10^{-4} N_A$$

$$\text{No. of H-atoms} = 4 \times 2 \times 10^{-4} N_A$$

$$\begin{aligned} \text{mass (gm)} &= \text{mole} \times \text{molar mass} \\ &= 2 \times 10^{-4} \times 16 \text{ gm} \\ &= 2 \times 10^{-4} \times 16 \times 10^3 \text{ mg} \\ &= 3.2 \text{ mg} \end{aligned}$$

Q. Arrange the following in the increasing order of no. of atoms :

(a) 220 gm CO_2 (b) 1960 gm H_2SO_4

(c) 196 amu H_2SO_4 (d) 93 gm P_4

(e) 6.4 kg S_8

Solⁿ → (a) $\text{moles} = \frac{220}{44} = 5 \text{ mole}$

$$\text{molecules} = 5 N_A$$

$$\text{atoms} = 15 N_A$$

$$(b) \quad \text{moles} = \frac{1960}{98} = 20 \text{ mole}$$

$$\text{atoms} = 7 \times 20 N_A = 140 N_A$$

$$(c) \quad \text{moles} = \frac{\frac{196}{N_A}}{98} = \frac{2}{N_A}$$

$$\text{atoms} = 7 \times \frac{2}{N_A} \times N_A = 14$$

$$(d) \quad 93 \text{ gm } P_4$$

$$\text{mole} = \frac{93}{124} = 0.75$$

$$\text{atoms} = 4 \times 0.75 N_A = 3 N_A$$

$$(e) \quad 6.4 \text{ kg } S_8$$

$$\text{mole} = \frac{6.4 \times 10^3}{256} = 25$$

$$\text{atoms} = 8 \times 25 N_A = 200 N_A$$

$$c < d < a < b < e$$

Note →

(1) NO. of gram atoms of atom or NO. of gram moles of atom = NO. of moles

(2) No. of gram molecules of molecule
or
No. of gram moles of molecule = No. of moles

Ex. 2 gm molecules of H_2 = 2 moles of H_2
molecules

2 gm of H_2 molecules = 1 mole of H_2
molecules

Ex. 5 gm atoms of N } = 5 moles of N-atoms
5 gm moles of N }
5 gm of N atoms = $\frac{5}{14}$ moles of N-atoms

Q. calculate no. of gram atoms of C and
H in 5 gm molecules of C_2H_6 ?

Solⁿ → No. of moles of C_2H_6 = 5

| | | | | |
|----------|---|--------|---|--------|
| C_2H_6 | → | 2C | + | 6H |
| 1mole | | 2mole | | 6mole |
| 5mole | | 10mole | | 30mole |

No. of gram atoms of C = 10

No. of gram atoms of H = 30

Solution \rightarrow It is a homogeneous mix. of two or more components dispersed on a molecular scale.

major component \rightarrow solvent

minor component \rightarrow solute

Methods to express concentration of a solution \rightarrow

(1) mass Percentage ($\% \frac{w}{w}$) \rightarrow

Temp. independent

Sol^n
 $\swarrow \quad \searrow$
A B
mass \rightarrow w_A w_B

$$\left(\% \frac{w}{w}\right)_A = \frac{w_A}{w_A + w_B} \times 100 = \frac{w_A}{w_{\text{Sol}^n}} \times 100$$
$$\left(\% \frac{w}{w}\right)_B = \frac{w_B}{w_A + w_B} \times 100$$

(2) volume Percentage ($\% \frac{V}{V}$) \rightarrow

Temp. dependent

Sol^n
 $\swarrow \quad \searrow$
A B
Vol. \rightarrow V_A V_B

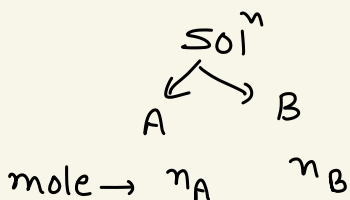
$$\left(\% \frac{V}{V}\right)_A = \frac{V_A}{V_A + V_B} \times 100 = \frac{V_A}{V_{\text{Sol}^n}} \times 100$$
$$\left(\% \frac{V}{V}\right)_B = \frac{V_B}{V_A + V_B} \times 100 = \frac{V_B}{V_{\text{Sol}^n}} \times 100$$

(3) mass by vol. Percentage ($\% \frac{w}{v}$) \rightarrow

$$\left(\% \frac{w}{v}\right)_A = \frac{w_A \xrightarrow{\text{gm}}}{V_A + V_B \xrightarrow{\text{ml}}} \times 100 \quad \text{Temp. dependent}$$

$$\left(\% \frac{w}{v}\right)_B = \frac{w_B}{V_A + V_B} \times 100$$

(4) mole fraction (χ) $\xrightarrow{\text{chi}}$



Temp. independent

$$\chi_A = \frac{n_A}{n_A + n_B}$$

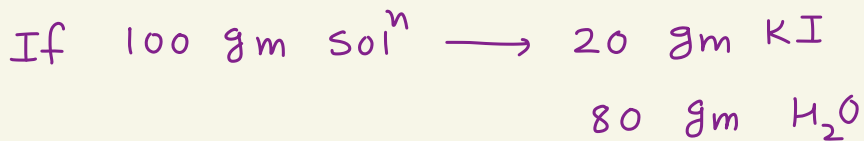
$$\chi_B = \frac{n_B}{n_A + n_B}$$

$$= 1 - \chi_A$$

(5) molarity (M) \rightarrow $\frac{\text{No. of moles of solute}}{\text{vol. of sol}^n \text{ in lit}}$

* Temp. dependent

* Unit \rightarrow mol/litre



$$m = \frac{(20/166)}{(80/1000)} = 1.506$$

Homework

Workbook- DTS I to II

Q. 1-15, 17, 18, 24, 26, 27, 29, 30, 31, 43-47, 53, 58, 68, 69, 86,
 98, 99, 108, 110, 116, 118, 130, 135