Chapter 1: Mole Concept

Q1. **I[st] method**

Sol: Ozone has formula: O_3

So, its gm molecular weight = $16 \times 3 = 48$ g

Given mass = 48 g

$$\therefore \text{No. of moles of ozone} = \frac{\text{wt(given)}}{\text{Mol.wt.}} = \frac{48\,g}{48\,g} = 1\,\text{moles}$$

In 1 mole, there is Avogadro number of molecules.

No. of molecules of ozone = 6.023×10^{23}

Also in each molecule of O_3 there is three atoms of oxygen present,

So, total no. of Atoms $= 3 \times$ No. of molecule

$= 3 \times 6.023 \times 10^{23}$ atoms

$= 1.8066 \times 10^{24}$ atoms **Ans**

2[nd] method

Mol wt of ozone = $16 \times 3 = 48$ g

No. of atoms in any molecules

$$= \frac{\text{wt(given)}}{\text{Mol wt.}} \times \text{Avogadro no.} \times \text{Atomicity}$$

$$= \frac{48}{48} \times N_A \times 3 = 3N_A = 3 \times 6.023 \times 10^{23}\,\text{atoms}$$

$= 1.8066 \times 10^{24}$ atoms **Ans**

Note: Atomicity is the no. of atoms present in a molecule.

Q2.

Sol: From Avogadro's hypothesis, Volume is directly proportional to number of moles of gases at constant temperature & pressure.

$\therefore\ v \propto n$ (at const T & P)

Here, the nature of gas is not significant, only no. of moles matter.

i.e., no matter what are gases (but it should behave ideally).

$\therefore$ For equal no. of moles of O_2 & O_3.

$$\therefore \frac{V_{O2}}{V_{O3}} = \frac{n_{O2}}{n_{O3}} = \frac{1}{1}$$

Q3.

Sol: Gm Molecular weight of $CaCO_3$ = $40 + 12 + 3 \times 16 = 100$ gm.

$\therefore$ Weight of 5 moles of $CaCO_3$

= no. of moles $\times$ Mol. wt.

$= 5 \times 100 = 500$ g **Ans**

(Since no. of moles = $\frac{\text{wt.}}{\text{Mol.wt.}}$)

Q4.

Note:

$$\text{Vapour density} = \frac{\text{density of gaseous substance}}{\text{density of } H_2 \text{ gas}}$$

From ideal gas equation

$$PV = nRT$$

$$PV = \frac{w}{M}RT$$

$$PM = \frac{w}{V}RT = dRT \ (d = \text{density of gas} = \frac{\text{weight}}{\text{Volume}} = \frac{w}{v})$$

$\therefore PM = dRT$

$\therefore$ Density is directly proportional to constant temperature & pressure.

$$d \propto M \quad (\text{at same P \& T})$$

$$V.d. = \frac{d_{gas\,sub}}{dH_2} = \frac{M_{gas\,sub}}{M_{H_2\,gas}} = \frac{Mol.Wt._{gases}}{2}$$

$\therefore$ Mol. Wt. of gas $= 2 \times$ vapour density

Sol:

1st method:

A/q; V.d. = 11.2

$\therefore$ Mol. Wt. $= 2 \times$ V.d.

$= 22.4$ g

$\therefore$ Wt (given) = 11.2 g.

$$\therefore \text{no. of moles} = \frac{11.2}{22.4} = \frac{1}{2}$$

$\therefore$ volume - = molar volume $\times$ no. of moles

$$= 22.4 \text{ lit} \times \frac{1}{2} = 11.2 \text{lit}$$

Ans

2nd method:-

At STP/NTP: P = 1 atm

& T = 273 K.

$\therefore PV = nRT$

$$1 \text{ atm} \times V = \frac{1}{2} \times 0.0821 \times 273$$

$$V = \frac{0.0821 \times 273}{2} = 11.2 \text{lit}$$

Ans

Q5:

Sol: $Na_2CO_3.10H_2O$

In 1 molecule there is (3 + 10) = 13 oxygen atom.

No. of molecules of $Na_2CO_3.10H_2O$ = moles $\times N_A$

$= 0.02 \times 6.023 \times 10^{23}$

$= 1.56 \times 10^{24}$ oxygen atoms **Ans**

2nd method:-

No. of atoms in a molecule

= no. of moles of molecules $\times N_A \times$ Atomicity

$= 0.2 \times 6.023 \times 10^{23} \times 13 = 156 \times 10^{24}$ O -atoms. **Ans**

Q 6:

Sol: Molarity = $\dfrac{\text{no. of moles}}{\text{volume (in lit)}}$

Given, Molarity (M) = 1

Volume = 100 ml = $\dfrac{100}{1000}$ lit = 0.1 lit

$\therefore$ No. of moles = Molarity × volume (in lit) = 1 × 0.1 = 0.1 moles

No. of SO_4^{2-} ions = no. of molecules × no. of ions per molecule

$= 0.1 \times 6.023 \times 10^{23} \times 1 = 6.023 \times 10^{22}$ ions **Ans**

Q7:

Sol: 1st method

Nucleons are total no. of neutrons + no. of protons present in a nucleus.

In 1 atom of ^{12}C total 12 nucleons are present. Actually no. of nucleons is the mass no. of any atom.

No. of Atoms = $\dfrac{12}{12} \times N_A = 6.023 \times 10^{23}$

$\therefore$ Total no. of nucleons = No. of nucleons per atom × total no. of atom

$= 12 \times 6.023 \times 10^{23}$ **Ans**

2nd method

No. of nucleus = no. of moles × Avogadro no. × mass no.

$= \dfrac{12}{12} \times N_A \times 12 = 12 \times 6.023 \times 10^{23}$

Ans

Q8:

Sol: (i) Total no. of neutrons in 7 mg of ^{14}C.

$\therefore$ No of neutrons in 1 atom = mass no. – At no.

= 14 – 6 = 8

$\therefore$ Total no. of neutrons = no. of atoms no. of neutron per atom

$= \dfrac{7 \times 10^{-3}\,g}{14\,g} \times N_A \times 8 = 4 \times 6.022 \times 10^{23} \times 10^{-3}$

$= 4 \times 6.022 \times 10^{20} = 24.088 \times 10^{20}$ neutrons

(ii) Total mass of neutrons = Total no. of neutrons × mass of each neutron

$= 24.088 \times 10^{20} \times 1$ amu

$= 24.088 \times 10^{20} \times \dfrac{1}{6.022 \times 10^{23}}$ gm

$= 4 \times 10^{-3}$ g.

Q9:

Sol: 1st method

Volume = $1\,m^3 = 10^3$ lit

At NTP = P = 1 atm, T = 273 K

$\therefore$ PV = nRT

$n = \dfrac{PV}{RT} = \dfrac{1\,\text{atm} \times 10^3\,\text{lit}}{0.0821 \times 273} = 44.6$ moles

2[nd] method:-

no. of moles at N.T.P $= \dfrac{\text{Volume(given)}}{22.4\,\text{lit}} = \dfrac{1000}{22.4} = 44.6\,\text{moles}$

Q10:

Sol: Molality $= \dfrac{\text{no.of moles of solute}}{\text{wt.of solvent (in kg)}} = \dfrac{3/30}{250/1000\,\text{kg}} = \dfrac{1}{10} \times 4 = 0.4\ \text{m}$

Q11

Sol: Wt (given) = 5.25 g N_2

$\therefore$ No. of moles of $N_2 = \dfrac{\text{wt}}{\text{Mol.wt}} = \dfrac{5.25}{28}$

Temp = 26^0C = 273 + 26 = 299 K

P = 74.2 cm of Hg $= \dfrac{74.2}{76}$ atm.

$\therefore$ From Ideal gas equation

PV = nRT

$$V = \frac{nRT}{P} = \frac{\frac{5.25}{28}\times 0.0821\times 299}{\frac{74.2}{76}} = 4.71\ \text{lit}$$ **Ans**

Q12:

Sol: no. of molecules of $NH_3 = \dfrac{\text{wt}}{\text{Mol.wt}} \times N_A = \dfrac{1}{17}\times N_A$

no. of molecules of $N_2 = \dfrac{\text{wt}}{\text{Mol.wt.}} \times N_A = \dfrac{1}{28}\times N_A$

$\therefore$ Ratio of molecules of NH_3 & $N_2 = \dfrac{\frac{1}{17}N_A}{\frac{1}{28}N_A} = \dfrac{28}{17}$

Q13:

Sol: Volume of CO_2 = 0.03 % of volume of air $= \dfrac{0.03}{100}\times 1\,\text{lit} = 3\times 10^{-4}$ lit at NTP

$\therefore$ No. of molecules = no. of moles × Avogadro's no.

$$= \frac{3\times 10^{-4}}{22.4}\times 6.023\times 10^{23} = 8.06\times 10^{18}$$ **Ans**

Q14:

Sol: No. of molecules of H_2 in 1 kg of H_2

$$= \frac{1\times 10^3\,g}{2\,g}\times 6.023\times 10^{23} = \frac{6.023}{2}\times 10^{26}$$

No. of molecules of O_2 in 1 kg mass

$$= \frac{1\times10^3\,g}{32\,g}\times6.023\times10^{23} = \frac{6.023\times10^{26}}{32}$$

$\therefore$ So, no. of molecules are different.

Let WH_2 is the weight of hydrogen & WO_2 is the weight of oxygen for which they have same no. of molecules.

$\therefore$ no. of molecules of H_2 = no. of molecules of O_2

$$\frac{WH_2}{2}\times6.023\times10^{23} = \frac{Wo_2}{32}\times6.023\times10^{23} \quad = \frac{WH_2}{Wo_2} = \frac{2}{32} = \frac{1}{16}$$ **Ans**

Q15:

Sol: **1st method**

Weight of 1 moles of actually the Mol. wt.

$\therefore PM = dRT$

$$M = \frac{dRT}{P} = \frac{1.78\times0.0821\times273}{1}$$

$= 1.78\times22.4 = 39.9$ g **Ans** **A**

2nd method

Wt of 1 moles =

Volume of 1 mole × density

$= 22.4$ lit × 1.78 g / lit

$= 39.9$ g **Ans**

Q16:

Sol: Molarity = 2 M

Volume = 2 litres

$\therefore$ no. of milimoles = volume (in mL) × molarity

$= 2\times10^3$ ml $\times 2$

$= 4\times10^3$ milimoles. **Ans**

Q17:

Sol: Volume of O_2 = 25% of air

$$= \frac{21}{100}\times1\,\text{lit} = 0.21\,\text{lit}$$

$$\therefore \text{moles of } O_2 = \frac{0.21}{22.4} = 0.0093$$ **Ans**

Q18:

Sol: If n is the no. of Hg-atoms present in molecule of Hg-vapour.

$\therefore$ Molecular formula of Hg-vapour = Hg_n

$\therefore$ Molecular weight of Hg = n × At. Wt of Hg = 200 n

Also, Mol. Wt. of air = 29 g/mole

$$A/q \;\therefore \frac{\text{density of Hg} - \text{vapour}}{\text{density of air}} = 6.92$$

$$\therefore \frac{\text{Mol.wt of Hg} - \text{vapour}}{\text{Mol. wt of air}} = 6.92 \quad (\because PM = dRT;\ \text{At const } P\,\&\,T,\ M\propto d)$$

$\therefore \frac{200n}{29} = 6.92 \quad \Rightarrow n = \frac{6.92 \times 29}{200} = \frac{200}{200} = 1.$

$\therefore$ No. of Hg atoms in Hg-vapour = 1 **Ans**

Q19:

Sol: Total no. of atoms in 1 molecules

$= 2 + 2 + 7 = 11$ atoms

$\therefore$ Total no. of atoms in 0.5 moles of molecules

= no. of molecules × no. of atoms per molecule

$= 0.5 \times 6.023 \times 10^{23} \times 11$

$= 5.5 \times 6.023 \times 10^{23} = 3.31 \times 10^{24}$ **Ans**

Q20:

Sol: 1st method

no. of moles in 6 gm of $H_2 = \frac{6}{2} = 3$ moles.

$\therefore PV = nRT$

$V = \frac{nRT}{P} = \frac{3 \times 0.0821 \times 273}{1} = 67.2$ lit **Ans**

2nd method

$T = 0\,^0C = 273$ K & P = 1atm; this is the STP condition.

$\therefore$ Volume = no. of moles × molar volume

$= 3 \times 22.4$ lit = 67.2 lit **Ans**

Q 21:

Sol: At NTP; Volume of 1 moles = 22.4 lit

Wt. of 1 mole = Mol. Wt. of oxygen = 32 g

$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{32}{22.4} = 1.429$ g/lit **Ans**

Q 22:

Sol: Volume of water (ℓ) = 18 ml (water is liquid at normal conditions)

density of water = 1 g /ml

$\therefore$ mass = volume × density = 18 g

$\therefore \text{moles} = \frac{18}{18} = 1$

$\therefore$ no. of electrons = no. of molecules × no. of electrons per molecule

$= 1 \times 6.023 \times 10^{23} \times 10 = 6.023 \times 10^{24}$ **Ans**

Q23:

Sol: 1 mole of 16 O^{2-} ion.

no. of ions = no. of moles × Avogadro's number.

$= 1 \times 6.023 \times 10^{23} = 6.023 \times 10^{23}$ ions.

$$\therefore \frac{200n}{29} = 6.92 \quad \Rightarrow n = \frac{6.92 \times 29}{200} = \frac{200}{200} = 1.$$

$\therefore$ No. of Hg atoms in Hg-vapour = 1 **Ans**

Q19:

Sol: Total no. of atoms in 1 molecules

= 2 + 2+ 7 = 11 atoms

$\therefore$ Total no. of atoms in 0.5 moles of molecules

= no. of molecules × no. of atoms per molecule

$= 0.5 \times 6.023 \times 10^{23} \times 11$

$= 5.5 \times 6.023 \times 10^{23} = 3.31 \times 10^{24}$ **Ans**

Q20:

Sol: 1st method

no. of moles in 6 gm of $H_2 = \frac{6}{2} = 3$ moles.

$\therefore PV = nRT$

$$V = \frac{nRT}{P} = \frac{3 \times 0.0821 \times 273}{1} = 67.2 \text{ lit}$$

Ans

2nd method

$T = 0\ ^0C = 273$ K & P = 1atm; this is the STP condition.

$\therefore$ Volume = no. of moles × molar volume

$= 3 \times 22.4$ lit = 67.2 lit **Ans**

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$$\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{32}{22.4} = 1.429 \text{ g/lit}$$

Ans

Q 22:

Sol: Volume of water (ℓ) = 18 ml (water is liquid at normal conditions)

density of water = 1 g /ml

$\therefore$ mass = volume × density = 18 g

$\therefore$ moles $= \frac{18}{18} = 1$

$\therefore$ no. of electrons = no. of molecules × no. of electrons per molecule

$= 1 \times 6.023 \times 10^{23} \times 10. = 6.023 \times 10^{24}$ **Ans**

Q23:

Sol: 1 mole of 16 O^{2-} ion.

no. of ions = no. of moles × Avogadro's number.

$= 1 \times 6.023 \times 10^{23} = 6.023 \times 10^{23}$ ions.

No. of electrons = 8 + 2 = 10 electrons

$\therefore$ Total no. of electrons = $6.023\times10^{23}\times10 = 6.0231\times0^{24}$. **Ans**

No. of neutrons per ions = mass no. − atomic no.

= 16 − 8 = 8

$\therefore$ Total no. of protons = $6.023\times10^{23}\times8$ **Ans**

$\therefore$ Total no. of neutrons = $8\times6.023\times10^{23}$ **Ans**

Q24:

Sol: (i) KNO_3 (wt given = 1 kg = 1000 g)

Weight of N in 1 mole of KNO_3 = 14 g

Wt of 1 mole of KNO_3 = 39 + 14 + 16×3= 101 g

$\therefore$ 101 g of KNO_3 contain 14 g of Nitrogen

$\therefore$ 1 ———————— $\frac{14}{101}$ ————

$\therefore$ 1000 ———————— $\frac{14}{101}\times1000=138.5g$ **Ans**

(ii) NH_4 NO_3.

1 moles contains 2 moles of Nitrogen

$\therefore$ 80 g of NH_4NO_3 contains 28 g of Nitrogen

$\therefore$ 1 ———————— $\frac{28}{80}$

$\therefore$ 1000 ———————— $\frac{28}{80}\times1000=350g$ **Ans**

(iii) $(NH_4)_2$ HPO_4.

In 1 moles of $(NH_4)_2$ HPO_4, no. of moles of N = 2

$\therefore$ 132 g of $(NH_4)_2HPO_4$ contains 28 g of N.

$\therefore$ 1 ———————— $\frac{28}{132}$ (124 g = mol.wt of $(NH_4)_2HPO_4$)

$\therefore$ 1000 ———————— $\frac{28\times1000}{132}=212.0g.$ **Ans**

Q25:

Sol:

Given mass = 7.84 g of $FeSO_4(NH_4)_2SO_4.6H_2O$

No. of moles = $\frac{7.84}{392}=0.02$

In 1 mole of compound, Wt of Fe = 56 g

$\therefore$ 0.02 ———————— $56\times\frac{2}{100}=1.12g$

In 1 mole of compound, wt of S = 64 g

$\therefore$ 0.02 ———————— $64\times\frac{2}{100}=1.28g$

In 1 mole of compound wt of O = 224 g

$\therefore$ 0.02 ——————— $= 224 \times 0.02 = 4.48$ g

In 1 mole of compound wt of H = 20 g

0.02 ——————— $= 20 \times \frac{0.02}{100} = 0.4$ g

In 1 mole of wt of N = 28 g

$\therefore$ 0.02 ———— $= 0.02 \times 28 = 0.56$ g

No. of oxygen atoms per molecule = 14

$\therefore$ No. of oxygen molecules that can be evolved from 1 molecule of compound $= \frac{14}{2} = 7$

no. of moles of compound = 0.02

$\therefore$ no. of moles of oxygen evolved $= 0.02 \times 7 = 0.14$ mole

$\therefore$ Volume of O_2 at NTP $= 0.14 \times 22.4 = 3.136$ lit **Ans**

Q26:

Sol: Density of AgCl = 5.56 g/cc

Mol. Wt. of AgCl = 108 + 35.5 = 143.5 g

$\therefore$ Volume of 1 mole of AgCl $= \frac{\text{Mol.wt} -}{\text{density}} = \frac{143.5}{5.56} \text{cm}^3$

If *a* is the side of cube (made of 1 mole of AgCl)

Then, volume $= a^3 = \frac{143.5}{5.56} \text{cm}^3$

$a = 2.95$ cm

If d is the spacing between cation & anion, then

No. of cations & anions along a side $= \frac{\text{side length (a)}}{\text{distance between cation \& anion}} + 1$

(See by keeping no. of ions along a line, it will come +1 there)

$= \frac{2.95 \text{cm}}{2.773 \times 10^{-8} \text{cm}} + 1 = 1.08 \times 10^8$

$\therefore$ No of cations and anions in whole volume

$= (1.08 \times 10^8)^3 = 1.26 \times 10^{24}$

$\therefore$ No. of molecules of AgCl $= \frac{\text{no.of catoin} + \text{no.of anion}}{2}$

(since 1 molecule of AgCl constains 1 ion of Ag^+ & 1 ion of Cl^-)

$= \frac{1.26 \times 10^{24}}{2} = 6.30 \times 10^{23}$

Q27:

Sol: no. of moles of Nitrogen in 1.86 gm of N $= \frac{1.86}{14} = 0.133$

$\therefore$ 2 atoms of Nitrogen combines with 3 atoms of Mg.

$\therefore$ 2 moles ——————— 3 moles of Mg.

$\therefore$ 1 ———————————— $\frac{3}{2}$ ————

$\therefore$ 0.133 ———————————— $\frac{3}{2}\times 0.133$ moles

$\therefore$ Wt of Mg $=\frac{3}{2}\times 0.133\times 24 = 4.78$g

Q28:

Sol: 1st method

600 ml of O_3 & O_2 weights 1 gm at NTP.

Let volume of ozone = x ml

$\therefore$ volume of oxygen = (600 – x) ml.

wt of mixture = wt of oxygen + wt of ozone

$$1 = \frac{600-x}{22400}\times 32 + \frac{x}{22400}\times 48$$

$$\left(\text{wt} = \text{moles}\times \text{Mol. wt} = \frac{\text{volume}}{\text{molar volume}}\times \text{Mol.wt}\right)$$

Calculating, we have

$\therefore$ x = 200 ml

$\therefore$ volume of ozone = 200 ml.

2nd method

Let wt of O_3 = x gm

Wt of O_2 = (1 – x) gm.

moles of ozone $= \frac{x}{48}$

moles of oxygen $= \left(\frac{1-x}{32}\right)$

$\therefore$ Volume of mixture = volume of O_3 + volume of O_2

Volume of mix $= \left(\frac{1-x}{32}\right)\times 22400 + \frac{x}{48}\times 22400$

$$\frac{600}{22400} = \frac{(1-x)}{32} + \frac{x}{48}$$

$$\frac{6}{224} = \frac{3-3x+2x}{96} = \frac{3-x}{96}$$

$$3-x = \frac{6\times 96}{224} = 2.57$$

x = 0.43

$\therefore$ Volume of $O_3 = \frac{0.43}{48}\times 22400 = 200$ ml

Ans

Q29:

Sol: V.d. of mixt of NO_2 & N_2O_4 = 38.3

$\therefore$ Mol wt of mix = $2 \times$ V.d.

$= 2 \times 38.3 = 76.6\,g$

If x is the wt of NO_2 in 100 g of mixture

Then (100 – x) is the wt of N_2O_4.

$\therefore$ moles of $NO_2 = \frac{x}{46}$

moles of $N_2O_4 = \frac{100-x}{92}$

$\therefore$ moles of mixture = moles of NO_2 + moles of N_2O_4

$$\frac{\text{wt. of mixt}}{\text{Mol. wt}} = \frac{x}{46} + \frac{100-x}{92}$$

$$\Rightarrow \frac{100}{76.6} = \frac{2x+100-x}{92} = \frac{100+x}{92}$$

$$x = \frac{100 \times 92}{76.6} - 100 = 20.1\,g$$

$$\therefore \text{moles} = \frac{20}{46} = 0.437\,g \text{ of } NO_2$$ **Ans**

Q30:

Sol: Specific gravity = $\frac{\text{density of substance}}{\text{density of water}}$

= density of substance (g / ml)

$\therefore$ density of water = 1 g / ml

Specific gravity of gold = 19.3 $\Rightarrow$ Density of gold = 19.3 g /cc

Specific gravity of quartz = 2.6 $\Rightarrow$ Density of quartz = 2.6 g/cc

Specific gravity of nugget = 6.4 $\Rightarrow$ Density of nugget = 6.4 g/cc

$\therefore$ (100 – x) is the wt of quartz in nugget

$\therefore$ Volume of nugget (mixture) = volume of gold + volume of quartz

$$\frac{\text{wt mix}}{\text{d mix}} = \frac{\text{wt gold}}{\text{d gold}} + \frac{\text{wt quartz}}{\text{d quartz}}$$

$$\Rightarrow \frac{100}{6.4} = \frac{x}{19.3} + \frac{100-x}{6.4}$$

Solving, x = 68.6 g. **Ans**

Q31:

Sol: Radius of nucleus = 5×10^{-13} cm

$$\text{Volume} = \frac{4}{3}\pi r^3 = \frac{4}{3} \times 3.14 \times (5 \times 10^{-13})\text{cm}^3$$

mass of nucleus = mass of nucleus

$= 19$ amu $= 19 \times 1.672 \times 10^{-24}$ g.

$\therefore$ Density = $\dfrac{19\times1.672\times10^{-24}\text{g}}{\frac{4}{3}\times3.14\times(5\times10^{-13})^3\text{cm}^3} = 6.02\times10^{13}\text{g/cc}$ **Ans**

Q32:

Sol: Let the oxides are Cu_2Ox & Cu_2Oy

Then valancies of Cu in these oxides are x & y.

(If M has valancy m & N has valancy n then formula of a compound is M_nN_m)

Since, oxygen has valancy 2 & Cu has X, So

Formula of 1st oxide = Cu_2Ox

Similarly, formula of 2nd oxide = Cu_2Oy.

A/q ; wt of oxygen in 1st oxide = 2 × wt of oxygen in 2nd oxide

$16X = 2\times16Y$

$\therefore \dfrac{x}{y} = \dfrac{2}{1}$ **Ans**

Q33:

Sol: Volume of water = 105 ml

Density of water = 1 g/ml

Mass of water = 105 × 1 = 105 g

Density solution = 0.9 g/ml

% by wt of NH_3 = 30%

$\therefore$ % by wt of H_2O = 100 – 30 = 70%

If W g is the wt of mixture, then

$W\times70\% = 105$ g

$W\times\dfrac{70}{100} = 105$

W = 150 g

$\therefore$ Volume of solution = Wt. of Solution/density of solution

= 150 / 0.9 = 166.67 ml; **Ans**

Q34:

Sol: Radius of bearing = 0.1 inch = 0.1×2.54 cm = 0.254 cm

Volume of bearing = $\dfrac{4}{3}\pi r^3 = \dfrac{4}{3}\times3.14\times(0.254)^3\text{cm}^3$

density of bearing = 7.75 gm/cc

$\therefore$ wt of bearing = volume × density = $\dfrac{4}{3}\times3.14\times(0.254)^3\times7.75\text{gm} = 0.532$ g

$\therefore$ Wt of iron present = 85.6% of total wt. = $\dfrac{85.6}{100}\times0.532 = 0.455$ g

$\therefore$ No. of atoms of Iron present = moles × N_A = $\dfrac{0.455}{56}\times6.023\times10^{23} = 4.91\times10^{21}$ **Ans**

Q35:

Sol: d = 1.5 g/cc

no. of molecules = 1×10^{25} $\Rightarrow$ no. of moles of $CCl_4 = \dfrac{1\times10^{25}}{6.023\times10^{23}}$

$\therefore$ Wt of $CCl_4 = \dfrac{1\times10^{25}}{6.023\times10^{23}}\times154\,g = 2556.86\,g$

$\therefore$ Volume $= \dfrac{wt}{density} = \dfrac{2556.86\,g}{1.5} = 1704.6$ ml $= 1.705$ lit; **Ans**

Q36:

Sol: 1 molecule of starch contains only are one atom of P.

1 atom of P has weight 31 amu.

A/q, 0.086 amu of P is present 100 amu of stanch

$\therefore$ 1 ———————— $\dfrac{100}{0.086}$

$\therefore$ 31 ———————— $\dfrac{100\times31}{0.086} = 3.6\times10^4$ amu. **Ans**

Q37:

Sol: Weight of dot = 1×10^{-6} gm

At. wt. of carbon = 12 gm

$\therefore$ Moles of carbon present in carbon dot $= \dfrac{10^{-6}}{12}$

$\therefore$ No. of atoms $= \dfrac{10^{-6}}{12}\times6.023\times10^{23} = 5.01\times10^{16}$ atoms. **Ans**

Q38:-

Sol: From dilution principle;

no. of moles before dilution = no. of moles after dilution

$V_1\times M_1 = V_f\times M_f$

$50\times3.5 = V_f\times2$

$V_f = \dfrac{50\times3.5}{2} = 87.5$ ml **Ans**

Q39:

Sol: **(a)** no; because wt = no. of moles × Mol.wt.

= 1 × Mol. wt

= At. wt. of S × Atomicity

At. wt. of S is same, but atomicity is different in different molecules so mass will be different

(b) Yes; no. of molecules = no. of moles × N_A

= 1 × N_A

N_A will be same in each case -so no. of molecules will be also same.

(c) No; mass of sulphur will be different due to different atomicity.

(d) No; Because atomicity is different

In, $S_8 \rightarrow$ atomicity = 8; $S_6 \rightarrow$ atomicity = 6

$S_4 \rightarrow$ atomicity = 4; $S_2 \rightarrow$ atomicity = 2

$S \rightarrow$ atomicity = 1

Q40:

Sol: Let x lb of Cu_2S contain same wt of Cu as that present in 125 lb of $CuFeS_2$.

Wt of Cu in x lb of Cu_2S (No need to convert lb in gm)

$$= \frac{127}{159} x lb$$

$\therefore$ 127 gm is present in 159 gm of Cu_2S

$\therefore$ 1 gm ——— $\frac{159 gm}{127 gm}$ (unitless)

$\therefore$ x lb ——— $\frac{159}{127} x lb$

Similarly, wt of Cu in 125 lb of $CuFeS_2 = \frac{63.5}{183.5} \times 125 lb$

$$\therefore \frac{127}{159} x = \frac{63.5}{183.5} \times 125$$

$$x = \frac{43.25 \times 159}{127} = 54.16 lb$$

Ans

Q41:

Sol: $Ru_2(CO_3)_3$

1 mole can give maximum 3 moles of CO_2

$\therefore$ 4 ——— 4×3 ———

= 12 moles of CO_2 **Ans:**

Q42:

Sol: 1 molecule of NaCl contain 2 ions (1 Na^+ & 1 Cl^-)

1 molecule of $MgCl_2$ contain 3 ions (1 Mg^{2+} & 2 Cl^-)

Total no. of ions in 245 g of $MgCl_2$

$$= \frac{245}{95} \times N_A \times 3.$$

If x is the wt of NaCl that contains same ions then, no. of ions in NaCl $\frac{x}{58.5} \times NA \times 2$

$$\frac{245}{95} \times NA \times 3 = \frac{x}{58.5} \times NA \times 2$$

$$X = \frac{245 \times 58.5 \times 3}{95 \times 2} = 226 gm$$

Ans

Q43: 1.22 g of MnO has wt of Mn = 2

Sol: $\therefore$ 1 mole of MnO contains 1 mole of Mn

$\therefore$ 71 g of MnO contains 55 g of Mn

(d) No; Because atomicity is different

In, $S_8 \rightarrow$ atomicity = 8; $S_6 \rightarrow$ atomicity = 6

$S_4 \rightarrow$ atomicity = 4; $S_2 \rightarrow$ atomicity = 2

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Ans

Q43: 1.22 g of MnO has wt of Mn = 2

Sol: ∴ 1 mole of MnO contains 1 mole of Mn

∴ 71 g of MnO contains 55 g of Mn

$\therefore 1$ ———— $\frac{55}{71}$

$\therefore 1.22$ ———— $\frac{55}{71} \times 1.22 = 0.945$

moles of Mn $= \frac{0.945}{55} = 0.0172$.------(1)

Similarly 1 mole of SO_3 contains 1 mole of S.

$\therefore$ 80 g of SO_3 contains 32 g of S.

$\therefore 1$ ———— $\frac{32}{80}$

$\therefore 1.38$ ———— $1.38 \times \frac{32}{80} = 0.552$

moles $= \frac{0.552}{32} = 0.0172$-----(2)

So (1) & (2) :- In the compound of Mn & S, equal moles of Mn & sulphur are present.

So, simplest formula = MnS. **Ans:**

Q44:

Sol: If 1 kg is brought (1000 g)

$\therefore$ Mol. wt of $ZnSO_4$ = 161.4 gm

$\therefore$ 161.4 g of $ZnSO_4$ contain 65.4 g of Zn

$\therefore 1$ ———— $\frac{65.4}{161.4}$

$\therefore 1000$ ———— $\frac{65.4 \times 1000}{161.4}$

$= 405.2$ g

Mol. wt of $(CH_3Coo)_2$ Zn = 183.4 g

$\therefore$ 183.4 g of $(CH_3Coo)_2$ Zn contains 65.49 mol Zn

$\therefore 1$ ———— $\frac{65.4}{183.4}$

$\therefore 1000$ ———— $\frac{65.4 \times 1000}{183.4}$

$= 356.6$ g

So, for the same price given for 1 kg of $ZnSO_4$ & 1 kg of $(CH_3COO)_2$ Zn, we get more Zn in case of $ZnSO_4$. So $ZnSO_4$ is the more economical source of Zn.

Q45:

Sol: Volume of HNO_3 sol-^{n} = 25 ml.

Molarity = 0.10 M

$\therefore$ no. of milimoles $= 25 \times 0.1 = 2.5$ m moles

$NaOH + HNO_3 \longrightarrow NaNO_3 + H_2O$

$\therefore$ 1mole of HNO_3 required to form 1 mole of H_2O

$\therefore$ 25 milimoles ———————— 2.5 milimoles of H_2O

$\therefore$ Moles of H_2O formed $= 2.5 \times 10^{-13}$ moles.

Q46:

In current atomic mass system C^{12} is assumed to have 12 amu mass

In New atomic mass system (later) Be^9 is assumed to have 9 amu mass.

(C^{12} is made of 6 protons & 6 neutrons And Be^9 is made of 4 protons & 5 neutrons).

$\therefore$ 1 amu on current scale $= \dfrac{6m_p + 6m_n}{12}$

1 amu on new-scale $= \dfrac{4m_p + 5m_n}{9}$

If we assume that the previous atomic mass unit (current unit) is larger mass.

$(1\ \text{amu})_{\text{current scale}} > (1\ \text{amu})_{\text{new scale}}$

$\dfrac{6m_p + 6m_n}{12} > \dfrac{4m_p + 5m_n}{9}$

$\dfrac{m_p + m_n}{2} > \dfrac{4m_p + 5m_n}{9}$

$9m_p + 9\ m_n > 8m_p + 10\ m_n$

$9m_p - 8m_p > 10m_n - 9\ m_n$

$m_p > m_n$

However we know that mass of neutron is greater than mass of proton

So, our assumption that 1 amu mass on current scale is larger, is wrong.

Hence mass of later scale (New scale) is larger.

Q47:

Sol: 1 lit of 1×10^{-6} M enzyme

$\therefore$ no. of moles of enzyme $= 1 \times 10^{-6} \times 1$ moles

$= 10^{-6}$ moles

1 moles of enzyme hydrated 10^6 roles of CO_2 / sec.

$\therefore$ no. of moles of CO_2 hydrated by 10^{-6} moles of

enzyme $= 10^{-6} \times 10^6$ moles of CO_2 / sec

$= 1$ moles of CO_2 / sec

$\therefore$ In 1 hr, no. of moles absorbed = 3600 moles of CO_2

$\therefore$ wt of CO_2 absorbed/hr $= 3600 \times 44$

$= 158400$ g $= 158.4$ kg **Ans**

Q48:

Sol: KBrOx

mol wt = 39 + 80 + 16x = (119 + 16x) g

A/q. % by wt of br = 52.92 &

$$\frac{80}{119+16x}\times 100 = 59.92$$

$X = 2$ **Ans**

Q49:

Sol: No. of α –particle disintegrated minute

$$= 2.24\times 10^{13}$$

In 420 days no. of He atoms formed when each α -particle takes $2e^-$ to become He atom

$$= 420 \text{ days} \times \frac{24\text{ hr}}{\text{days}} \times \frac{60\text{ min}}{\text{hr}} \times \frac{2.24\times 10^{13}}{\text{min}} \text{He}$$

$$= 420\times 24\times 60\times 2.24\times 10^{13} = 1.3547\times 10^{19} \text{ He atom}$$

$$\text{moles of He atom} = \frac{1.3547\times 10^{19}}{N_A} \qquad (N_A \rightarrow \text{we have to calculate})$$

Volume = 0.5 ml

$$= 0.5\times 10^{-3} \text{ lit} = 5\times 10^{-4} \text{ lit}$$

$T = 27^0C = 300k$

$$P = 750 \text{ mm of Hg} = \frac{750}{750} \text{atm}$$

$Pv = nRT$

$$n = \frac{PV}{RT} = \frac{\frac{750}{760}\times 5\times 10^{-4}}{0.0821\times 300}$$

$$\frac{1.3547\times 10^{19}}{NA} = \frac{75\times 5\times 10^{-4}}{76\times 0.0821\times 300}$$

$$NA = \frac{1.3547\times 10^{19}}{0.2\times 10^{-5}} = 6.77\times 10^{23} \quad \textbf{Ans}$$

Solution to Objective problems :-

1. Ans→ (c)

$$\frac{d_{cl_2}}{d_{air}} = \frac{M_{cl_2}}{M_{air}} = \frac{71}{29} = 2.44$$

(Since $d \propto M$ at constant temp. & pressure)

2. Ans→ (b)

100 g of oxide contain 30.4 g of Nitrogen.

Since 1 molecule contain one nitrogen atom

∴ 14 g of Nitrogen is contained by Mol. wt of oxide.

∴ 30.4 g of Nitrogen present in 100 g of oxide

$$\therefore 1 \text{ ———————— } \frac{100}{30.4}$$

$\therefore$ 14 ———————— $\frac{100\times14}{30.4.}$

$$\therefore \frac{\text{doxide}}{\text{doxygen}} = \frac{\text{Moxide}}{\text{Moxygen}} = \frac{\frac{1400}{30.4}}{32} = 1.44$$

3. No, because it depends on Mol. Wt. & which depends on atomicity also. In oxygen (O_2) atomicity is 2, where as in sulphur (S_8) atomicity is 8.

4. Ans → (c)

$$\text{Vapour density} = \frac{\text{density of gas}}{\text{density of } H_2} = \frac{\text{Mol.wt of gas}}{\text{Mol.wt } H_2} = \frac{29}{2} = 14.5$$

5. Ans → (C) moles $= \frac{\text{volume}}{\text{molar volume}} = \frac{5.6}{22.4} = \frac{1}{4}$

6. Ans → (d)

22.4 lit at NTP means 1 mole of water.

1 mole of water has wt = 18 g

Density of water = 1 g/cm^3

$$\therefore \text{Volume of liquid water} = \frac{\text{wt}}{\text{density}} = 18\,\text{mL.}$$

7. Ans → (d)

1 gm – atom of C → 12 gm = 1

$\frac{1}{2}$ mol of $CH_4 = \frac{1}{2}\times16 = 8\text{gm}$

10 ml of water = 10×1 gm

3.011×10^{23} atoms of oxygen $= \frac{3.011\times10^{23}}{6.023\times10^{23}}\times32 = 16$ g

8. Ans → (b) Volume = moles × molar volume

$$= \frac{6.022\times10^{22}}{6.022\times10^{23}}\times22.4\text{ lit} = 2.24\text{ lit}$$

9. Ans → (b)

1 g atom of Na means 1 mole of Na, which has mass = 23 g

10. Ans → (a)

PV = nRT (ideal gas equation)

$$\frac{2\times350}{1000} = \frac{\text{wt}}{\text{Mol.wt}}\times0.0821\times273$$

$$\frac{70}{100} = \frac{1\times22.4}{\text{Mol.wt}} \quad \Rightarrow \text{Mol.wt} = \frac{22.4\times10}{7}$$

$$\text{Diatomic molecule, so atomic wt} = \frac{\text{Mol.wt}}{2} = \frac{11.2\times10}{7}$$

Wt of one atom = $\frac{112}{7}$ amu $=16\times\frac{1}{N_A}g=\frac{16}{N_A}g$

11. Ans→d

no. of atom = $\frac{16}{32}\times6.023\times10^{23}\times2=6.023\times10^{23}$

[no. of atoms in a molecule = moles × N_A × atomicity]

12. Ans→ (d) ; $CO_2 \rightarrow 12+32 \rightarrow 44$ g

13. Ans→ (a)

PV = nRT

$$n=\frac{\frac{700}{760}\times\frac{0.76\text{ lit}}{100}}{0.0821\times273}=\frac{7}{224}$$

No. of atoms $=\frac{7}{224}\times N_A=\frac{6.023\times10^{23}}{32}=1.88\times10^{22}$.

14. Ans→ (b)

X_2 has 34 electrons & 40 neutrons

X has 17 electrons & 20 neutrons

& So it must have 17 Proton

∴ At. no. = 17

mass no. = 17 + 20 = 37

15. Ans→ (d)

2 moles of H-atoms means 1 mole of H_2 gas.

So at NTP, volume of 1 mole of H_2 = 22.4 lit

16. Ans→ (a)

V = 1.8 ml

d = 1 gm / cal

m = 1.8 gm

moles $=\frac{1.8}{18}=0.1$ mole

no. of molecule $=0.1\times N_A$

$=6.022\times10^{22}$

no. of e^- per molecule = 10

∴ total electrons $=6.023\times10^{23}$

17. Ans→ (b)

Wt of 11.2 lit = 14 gm

Wt of 22.4 lit = 28 gm = wt of 1 moles.

18. Ans→ (C)

Volume at NTP = 22.4 lit & density (given) = 0.1784 g / lit

∴ mass = volume × density = 4 g

19. Ans→ (d)

For HCl; Normality = Molarity = 0.1 (∴ v.f. of HCl as acid = 1)

Volume = 10 ml

no. of moles $=10\times10^{-3}\times0.1=10^{-3}\times6.023\times10^{23}$

$=6.023\times10^{20}$

20. Ans→ (c)

21. Ans→ (a)

For constant n & v; $P \propto T$

If T is increased twice, then pressure increases twice. It means, no. of moles remain constant = 5

22. Ans→ (d)

no. of atoms in 1 g of O = $\frac{1}{16} \times 6.023 \times 10^{23}$

no. of atoms in 1 gm of O_2 = $\frac{1}{32} \times 6.023 \times 10^{23} \times 2$

no. of atoms in 1 gm of O_3 = $\frac{1}{48} \times 6.023 \times 10^{23} \times 3$

All have same values

23. Ans→ (C)

1 amu × N_A = 1 g. [from general definition]

Wt of 1 mole of C^{12} = 12 g (No matter what you set the mass of are atom of C^{12})

If mass of one atom of C^{12} is set to be 24 amu then (mass of one atom × Avogadro no= mass of 1 mole of C^{12})

24 amu × N_A = 12 g

$$N_A' = \frac{12\,g}{24\,amu} = \frac{12\,g}{224 \times \frac{1}{6.023 \times 10^{23}\,g}}$$

$$= \frac{6.023}{2} \times 10^{23} = 3.11 \times 10^{23}$$

24. Ans → (a)

$$\text{no. of S} = \frac{wt}{\text{Mol.wt of S}} \times N_A = \frac{32}{32} \times 6.023 \times 10^{23} = 6.023 \times 10^{23}$$

25. Ans → (d)

Wt of 1 electrons = 9.11 × 10^{-31} kg

If n electrons have weight 1 kg then

$n \times 9.11 \times 10^{-31} = 1$

$$n = \frac{1}{9.11 \times 10^{-31}}$$

$$\text{no. of moles of electrons} = \frac{\text{no.of electrons}}{\text{Avogadro no.}} = \frac{1}{9.11 \times 10^{-31} \times 6.022 \times 10^{23}}$$

$$= \frac{1}{9.11 \times 6.023} \times 10^{8}$$