HINT & SOLUTIONS : MOLE CONCEPT

EXERCISE # S-I

1. 10^{10} grains are distributed in 1 sec

$\Rightarrow 6.023 \times 10^{23}$ grains are distributed in $\frac{6.023\times10^{23}}{10^{10}}$ sec

$= 6.023 \times 10^{13}$ seconds.

2. Mass of 6.023×10^{23} atom = 12 gm

$\Rightarrow$ Mass of 1 atom = $\frac{12}{6.023\times10^{23}}$ gm

$= 1.99 \times 10^{-23}$ gm

3. Weight of 6.023×10^{23} atoms = 12 gm

$\Rightarrow$ Weight of 12.046×10^{23} atom = $\frac{12\times12.046\times10^{23}}{6.023\times10^{23}}$ = 24 gm

4. (i) Number of moles of Cu atom in 10^{20} atoms of Cu = $\left(\frac{10^{20}}{N_A}\right)$ moles

(ii) Mass of 200 atoms of ${}^{16}_{8}O$ in amu $\rightarrow$ Mass of 1 atom = 16 amu

$\Rightarrow$ Mass of 200 atoms = 16 × 200 amu = 3200 amu

(iii) Mass of 100 atoms of ${}^{14}_{7}N$ in gm $\rightarrow$ Mass of 1 atom of ${}^{14}_{7}N$ in gm = $14\times1.66\times10^{-24}$ gm

$\Rightarrow$ Mass of 100 atom of ${}^{14}_{7}N$ = $14 \times 100 \times 1.66 \times 10^{-24}$gm i.e. $1400 \times 1.66 \times 10^{-24}$ gm

(iv) Number of molecules in 54 gm H_2O = $\left(\frac{54}{18}\times N_A\right)$ = $3N_A$

Number of atoms in 54 gm H_2O = $(3N_A) \times 3 = 9N_A$

(v) Number of atoms in 88 gm CO_2 = $\left(\frac{88}{44}\right)\times 3N_A$ i.e. $6N_A$

5. Mass of O atoms in 6 gm CH_3COOH = $n_{CH_3COOH} = \frac{6}{60}$ i.e. $\frac{1}{10}$

In 1 mole of CH_3COOH, mass of O atom = 32 gm

$\Rightarrow$ Mass of O atom in $\frac{1}{10}$ mole CH_3COOH = $\frac{32}{10}$ i.e. 3.2 gm

6. $n_{CuSO_4.5H_2O} = \frac{499}{249.5}$ = 2 mole

1 mole of $CuSO_4.5H_2O$ contains 90 gm H_2O

$\Rightarrow$ 2 mole of $CuSO_4.5H_2O$ contains (90 × 2) i.e. 180 ;gm H_2O.

7. 1 mole of $Na_2SO_4.7H_2O$ contains $11N_A$'O' atoms

$\Rightarrow$ 6.023×10^{22} atom of 'O' are present in $\dfrac{6.023\times10^{22}}{11\times N_A} = \dfrac{6.023\times10^{22}}{11\times6.022\times10^{23}} = \dfrac{1}{110}$ mole

i.e. 2.5 gm

8. Number of Nucleon present in 12 gm of ^{12}C atoms = 12 N_A
= $12 \times 6.023 \times 10^{23}$
= 7.227×10^{24}

9. In 1 mole of $^{16}O^{-2}$ ions
Number of Electrons = $10N_A$ i.e. $10 \times 6.023 \times 10^{23}$
Number of Protons = $8N_A$ i.e. $8 \times 6.023 \times 10^{23}$
Number of Neutrons = $8N_A$ i.e. $8 \times 6.023 \times 10^{23}$

10. Mass of liquid mercury = 13.6 gm

$\Rightarrow$ Moles of liquid mercury = $\dfrac{13.6}{200}$ i.e. 0.068

$\Rightarrow$ Moles of liquid mercury in 1 lit of the metal = 0.068×1000 = 68 mole

11. Mass of C_2H_6 sample = $\left(\dfrac{10^7}{N_A}\right)$ moles of CH_4 i.e. $\left(\dfrac{16\times10^7}{N_A}\right)$g

$\Rightarrow$ Mole of C_2H_6 sample = $\left(\dfrac{16\times10^7}{N_A\times30}\right)$

$\Rightarrow$ Number of C_2H_6 molecules in sample = $\left(\dfrac{16\times10^7}{N_A\times30}\right)\times N_A$ i.e. 5.34×10^6

12. Number of H-atom removed = $(30N_A + 10N_A) = 40\ N_A$
$\Rightarrow$ Number of H_2 molecules formed = $(20\ N_A)$

13. $MnO_{2(s)} + 4HCl \longrightarrow Cl_{2(g)} + MnCl_{2(aq)} + 2H_2O(l)$
1 mole Cl_2 is produced from 4 mole HCl
$\Rightarrow$ 142 gm Cl_2 or 2 mole Cl_2 is produced from 8 mole HCl i.e. (8×36.5) = 292 gm HCl

14. $C + O_2 \longrightarrow CO_2$

$n_C \rightarrow \dfrac{1.2\times10^3}{12}$ i.e. 100 mole.

Mole of O_2 needed for 1 mole C = 1 mole
$\Rightarrow$ Mole of O_2 needed for 100 mole C = 100 mole
$\Rightarrow$ Volume of O_2 needed = 100×22.7 = 2270 lits.

15. $C_5H_{12}O + \dfrac{15}{2}O_2 \longrightarrow 5CO_2 + 6H_2O$

$\Rightarrow$ Moles of O_2 required to burn 1 mole of this compound completely is 7.5 moles.

16. $Al_4C_3 + 12H_2O \longrightarrow 3CH_4 + 4Al(OH)_3$

$n_{CH_4} = \dfrac{11.35}{22.70} = \dfrac{1}{2}$ mole

3 mole CH_4 is produced from 1 mole Al_4C_3.

$\Rightarrow \dfrac{1}{2}$ mole CH_4 is produced from 1 mole $\left(\dfrac{1}{3}\times\dfrac{1}{2}\right)$ mole Al_4C_3

i.e. $\dfrac{1}{6}$ mole Al_4C_3 or $\dfrac{1}{6}\times 144$

i.e. 24 gm Al_4C_3

17. $2H_3PO_4 \longrightarrow H_4P_2O_7 + H_2O$

$n_{H_4P_2O_7} \longrightarrow \dfrac{53.4}{178} = 0.3$ mole

1 mole $H_4P_2O_7$ is obtained from 2 mole H_3PO_4

$\Rightarrow$ 0.3 mole $H_4P_2O_7$ is obtained from (2×0.3) mole H_3PO_4

= 0.6 mole H_3PO_4

i.e. $(0.6 \times 98) = 58.5$ g H_3PO_4

18. $3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$

$n_{HNO_3} = \dfrac{25.2}{63} = 0.4$

2 mole HNO_3 is produced from 3 mole NO_2

$\Rightarrow$ 0.4 mole HNO_3 is produced from $\left(\dfrac{3}{2}\times 0.4\right) = 0.6$ mole NO_2

or (0.6×46)g NO_2

i.e. 27.6g NO_2

19. $U + 3F_2 \longrightarrow UF_6$

(Excess)

$n_{UF_6} = \dfrac{2\times10^{-3}}{352}$ $\Rightarrow n_{UF_6} = 5.6 \times 10^{-6}$

1 mole UF_6 is obtained from 3 mole F_2

$\Rightarrow 5.6 \times 10^{-6}$ mole UF_6 is obtained from $\longrightarrow 5.6 \times 10^{-6} \times 3 \times 6.023 \times 10^{23}$

$= 101.1 \times 10^{17}$

$= 1 \times 10^{19}$

20. $7XeF_6 + 3I_2 \longrightarrow 6IF_7 + 7Xe$

7 mole XeF6 produces 6 mole IF_7

$\Rightarrow 3.5 \times 10^{-3}$ mole XeF_6 produces $\left(\dfrac{6}{7}\times 3.5\times10^{-3}\right)$ i.e. 3 m mol IF_7

21. $2NH_4NO_3 \longrightarrow 2N_2 + O_2 + 4H_2O.$

mole initial $\frac{1}{5}$ 0   0   0

moles final 0 $\frac{1}{5}$ $\frac{1}{10}$ $\frac{2}{5}$

$\Rightarrow n_T = \left(\frac{1}{5}+\frac{1}{10}+\frac{2}{5}\right) = \left(\frac{7}{10}\right)$

Apply = Pv = nRT $\Rightarrow v = \frac{nRT}{P} = \left(\frac{7}{10}\times 0.0821\times 873\right) = 50.14$ litre

22. $3CaCO_3 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 3H_2O + 3CO_2$

Moles $\rightarrow \frac{50}{100}$ $\frac{73.5}{98}$

$= \frac{1}{2}$ $\frac{3}{4}$

$\frac{\text{moles}}{\text{S.C}} \rightarrow \frac{1}{6}$ $\frac{3}{8}$

$\Rightarrow$ $CaCO_3$ is L. R

(i) Amount of $Ca_3(PO_4)_2$ formed = $\frac{1}{6}$ mole

(ii) Amount of unreacted reagent = $\left(\frac{3}{4}-\frac{1}{3}\right) = \frac{9-4}{12} = \left(\frac{5}{12}\right)$ moles.

23. $4A + 2B + 3C \longrightarrow A_4B_2C_3$

Moles 2   1.2   1.44

$\frac{\text{moles}}{\text{S.C}} \rightarrow \frac{2}{4}$ $\frac{1.2}{1}$ $\frac{1.44}{3}$

$\Rightarrow$ C is L.R

$\Rightarrow$ moles of product formed = $\frac{1.44}{3} = 0.48$ moles.

24. $4KO_2 + 2H_2O \longrightarrow 4\,KOH + 3O_2$

Moles $\rightarrow$ 0.158   .10

$\frac{\text{moles}}{\text{S.C}} \rightarrow \frac{0.158}{4}$ $\frac{.10}{2}$

$\Rightarrow$ KO_2 is L.R.

$\Rightarrow$ Moles of O_2 produced is $\frac{3\times 0.158}{4}$ i.e. 0.1185 mole

25. $6\,LiH + 8BF_3 \longrightarrow 6\,LiBF_4 + B_2H_6$

Moles : 2 2

$\frac{\text{moles}}{\text{S.C}} \rightarrow \quad \frac{2}{6} \quad \frac{2}{8}$

$\Rightarrow$ BF_3 is L.R.

$\Rightarrow$ Moles of B_2H_6 prepared $= \frac{1}{8} \times 2 = \frac{1}{4}$ moles i.e. 0.25 mol

26. $3TiO_2 + 4C + 6Cl_2 \longrightarrow 3TiCl_4 + 2CO_2 + 2CO$

moles $\frac{4.32}{80} \quad \frac{5.76}{12} \quad \frac{7.1}{71}$

i.e. 0.054 0.48 0.1

$\frac{\text{moles}}{\text{S.C}} \rightarrow \quad \frac{0.054}{3} \quad \frac{0.48}{4} \quad \frac{0.1}{6}$

$\Rightarrow$ Cl_2 is L.R.

$\Rightarrow$ Amount of $TiCl_4$ obtained $= \left(\frac{3}{6} \times 0.1\right) \times 190 = 9.5$ g

27. $C + 2Cl_2 \longrightarrow CCl_4$

moles$\rightarrow \frac{36}{12} \quad \frac{142}{71}$

i.e. 3 2

$\frac{\text{moles}}{\text{S.C}} \rightarrow 3 \quad 1$

$\Rightarrow$ Cl_2 is L.R.

(i) Mass of CCl_4 produced = 1 × 154 i.e. 154 gm

(ii) Remaining mass of reactants = (3 – 1) × 12 = 24 gm

28. $2SO_2 + O_2 + 2H_2O \longrightarrow 2H_2SO_4$

moles$\rightarrow$ 5.6 4.8 (excess)

$\frac{\text{moles}}{\text{S.C}} \rightarrow \quad \frac{5.6}{2} \quad \frac{4.8}{1}$

$\Rightarrow$ SO_2 is L.R.

$\Rightarrow$ maximum number of moles of H_2SO_4 that can be obtained = 5.6 mole.

29. $2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

Moles $\frac{x}{27}$ (excess)

$\Rightarrow$ moles of H_2 obtained $= \left(\frac{3}{2} \times \frac{x}{27}\right)$ .....(1)

$mg + 2HCl \longrightarrow MgCl_2 + H_2$

Moles$\rightarrow$ $\frac{(1-x)}{24}$ (excess)

$\Rightarrow$ moles of H_2 obtained = $\left(\frac{1-x}{24}\right)$ .....(2)

$\Rightarrow$ Total moles of H_2 obtained = $\left(\frac{3x}{54}+\frac{1-x}{24}\right)$ .....(3)

Now,

$\Rightarrow$ $n_{H_2} = \frac{1.12}{22.4}$ i.e. 0.05 .....(4)

Now, equation (3) & (4)

$\frac{3x}{54}+\frac{1-x}{24} = 0.05$

$\Rightarrow$ $\frac{12x+9-9x}{216} = 0.05$

m = 10.8 – 9 = $\frac{1.8}{3}$ = 60%

3x + 9 = 10.8

$\Rightarrow$ 3x = 1.8 $\Rightarrow$ x = 0.6

$\Rightarrow$ % by mass Al $\longrightarrow$ 60% & % by mass mg $\longrightarrow$ 40%

30. CaCO3 $\longrightarrow$ CaO + CO_2

moles$\rightarrow$	a	0	0
	-	a	a

$MgCO_3 \longrightarrow MgO + CO_2$

moles$\rightarrow$	b	0	0
	-	b	b

Now, According to question,

Mass of oxide produced is exactly half as much as the original sample.

$\Rightarrow$ a × 56 + b × 80 = $\frac{1}{2}$ (100 a + 84 b)

$\Rightarrow$ b = 3a

$\Rightarrow$ % weight of $CaCO_3$ = $\left(\frac{100a}{100a+84b}\right)\times 100$

= $\left(\frac{100a}{352a}\times 100\right)$ = 28.4 %

% weight of $MgCO_3$ = (100 – 28.4) i.e 71.6 %

31. $Na_2CO_3 \xrightarrow{\Delta} x$ Let mass of Na_2CO_3 be x gm 2 mass of $NaHCO_3$ be (2–x) gm

$2Na(HCO_3) \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

mole→ $\frac{2-x}{84}$ $\frac{1.89-x}{406}$

Now, $\frac{\text{moles of } NaHCO_3}{2} = \frac{\text{moles of } Na_2CO_3}{1}$

$\frac{(2-x)}{84\times 2} = \frac{1.89-x}{106}$

⇒ $212 - 106x = 84 \times 2\,(1.89 - x)$

⇒ $212 - 106x = 317.52 - 168\,x$

⇒ $168x - 106x = 317.52 - 212$

⇒ $62x = 105.52$

⇒ $x = \frac{105.52}{62} = 1.70$ g

% by mass of $Na_2CO_3 = \frac{1.70}{2}\times 100 = 85.1$ %

% by mass of $NaHCO_3$ = 14.9%

32. let $CaCO_3$ be x gm

2 $MgCo_3$ be (92 – x) gm

$CaCO_3 \longrightarrow CaO + CO_2$

Mole: $\frac{x}{100}$ 0 0

- $\frac{x}{100}$ $\frac{x}{100}$

$MgCO_3 \longrightarrow MgO + CO_2$

Mole→ $\left(\frac{92-x}{84}\right)$ - -

- $\left(\frac{92-x}{84}\right)$ $\left(\frac{92-x}{84}\right)$

Now, weight of residue = 48

⇒ $\frac{x}{100}\times 56 + \left(\frac{92-x}{84}\right)\times 40 = 48$

⇒ on solving we get x = 50

⇒ weight of $MgCO_3$ = 42 gm.

33. $NaCl \longrightarrow x$ Let NaCl be x gm & $NaHCO_3$ be (4 – x) gm

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$$

Mole$\rightarrow$ $\frac{4-x}{84}$ 0 0 0

- $\frac{(4-x)}{84\times 2}$

Now, According to question

$$44\times\frac{(4-x)}{84\times 2} = 0.66$$

$\Rightarrow$ $(4 – x) = \frac{0.66\times 84}{22\times 100}$

$\Rightarrow$ x = 1.48 gm & Weight of $NaHCO_3$ = 2.52 gm

$\Rightarrow$ % by mass of NaCl $\rightarrow \frac{1.48}{4}\times 100$ = 37 %

& % by mass of $NaHCO_3$ is 63%

34. $CaCO_3 \longrightarrow CaO + CO_2$

$n_{CO_2} = \frac{11.35}{22.70} \rightarrow \frac{1}{2}$ mole

$n_{CaCO_3} \longrightarrow$ 2 mole

$\Rightarrow$ 1 mole $CaCO_3$ produces 1 mole CO_2

$\Rightarrow$ 2 mole $CaCO_3$ produces 2 mole CO_2

But produced mole is $\frac{1}{2}$ mole

$\Rightarrow$ % of Ca in lime stone sample = $\left(\frac{20}{200}\times 100\right)$ i.e. 10%

35. Sulphur present in 1.30 gm per 100g of coal.

$$S + O_2 \longrightarrow SO_2$$

Moles$\rightarrow$ $\frac{1.30}{32}$ (excess)

- $\left(\frac{1.30}{32}\right)$

$\Rightarrow$ weight of SO_2 produced = $\left(\frac{1.30}{32}\times 64\right)$ = 2.60 gm

100 g coal sample produced 2.60 gm SO_2

$\Rightarrow$ 474 tons will produced $\frac{2.60}{100}\times 474$ i.e. (12.3 tons)

36. $2KClO_3 \longrightarrow 2KCl + 3O_2$

The loss in weight of sample is because of O_2 gas produced.

$\therefore$ 2 mole $KClO_3$ is producing 3 mole O_2

i.e. for 1 mole loss is $\left(\frac{3}{2}\times 32\right)$ i.e 48g O_2.

$\Rightarrow$ % loss in weight = $\left(\frac{48}{122.5}\right)\times 100$ = 39.18 %

37. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

1 mole $CaCO_3$ will produce 1 mole CO_2

i.e. $\left(.8\times\frac{1}{4}\right)$ mole will produce $\left(.8\times\frac{1}{4}\right)$ mole CO_2

$\Rightarrow$ Volume of CO_2 produced = .2 × 22.4 litres = 4.48 litres.

38. $C_6H_{12}O \xrightarrow{\text{cons.}H_2SO_4} C_6H_{10} + H_2O$

1	-	-
.25	.75	.75

$\Rightarrow$ 1 mole $C_6H_{12}O$ produces 0.75 mole C_6H_{10}.

$\Rightarrow$ 100 gm $C_6H_{12}O$ produces (.75 × 82)g C_6H_{10}

$\Rightarrow$ 61.5 g C_6H_{10} is produced.

39. $2CH_3COCH_3 + 6CaOCl_2 \longrightarrow Ca(CH_3COO)_2 + 2CHCl_3 + 3CaCl_2 + 2Ca(OH)_2$

x x(0.75)

$\Rightarrow$ $x \times .75 = \frac{30}{119.5}$

$\Rightarrow$ $x = \frac{30}{119.5\times 0.75}$ $\Rightarrow$ x = 0.334 mole

$\Rightarrow$ Mass of CH_3COCH_3 = 0.334 × 58 i.e. 19.4 gm

40. $Br_2 + Cl_2 \longrightarrow 2BrCl$

mole. 0.025 0.025

(0.025 × 2) × .8 = 0.04

(i) amount of BrCl formed = 0.04

(ii) Br_2 left unchanged = 0.025 – 0.02 = 0.005

41. $S_8 + 8O_2 \longrightarrow 8SO_2$

$2SO_2 + O_2 \longrightarrow 2SO_3$

1 mole S_8 = 8 mole SO_2 .....(1)

$\Rightarrow$ 2 mole SO_2 = 2 mole SO_3

i.e. 8 mole SO_2 = 8 mole SO_3 .....(2)

From (1) & (2)

SO_3 obtained from 1 mol of S_8 = (8 × 80)g SO_3 i.e. 640g SO_3

42. $2Pbs + 3O_2 \longrightarrow 2PbO + 2SO_2$

$3SO_2 + 2HNO_3 + 2H_2O \longrightarrow 3H_2SO_4 + 2NO$

$n_{Pbs} = \frac{1075.5}{239.2} = 4.49$

2 mole Pbs = 2 mole SO_2 .....(1)

3 mole SO_2 = 3 mole H_2SO_4

$\Rightarrow$ 2 mole SO_2 = 2 mole H_2SO_4 .....(3)

From (1) & (3)

1 mole Pbs = 1 mole H_2SO_4

$\Rightarrow$ 4.49 mole Pbs = 4.49 mole H_2SO_4 or 4.50 mole H_2SO_4

$\Rightarrow$ mass of H_2SO_4 = (4.50 × 98) = 441 g.m

43. $4KO_2 + 2H_2O \longrightarrow 3O_2 + 4KOH$

$KOH + CO_2 \longrightarrow KHCO_3$

(a) 3 mole O_2 is produced by 4 mole KO_2

$\Rightarrow$ 1 mole O_2 is produced by $\frac{4}{3}$ mole KO_2

$\Rightarrow$ $\left(\frac{20}{32}\right)$ mole O_2 is produced by $\left(\frac{4}{3}\times\frac{20}{22}\times 71\right)$ g KO_2 = 59.17 gm.

(b) 1 mole KO_2 = 1 mole KOH

= 1 mole CO_2

$\Rightarrow$ $\left(\frac{100}{71}\right)$ mole KO_2 = $\left(\frac{100}{71}\times 44\right)$ g CO_2 = 61.97 g CO_2

44. $NaH_2PO_4 + NH_4^+ + Mg^{+2} \longrightarrow Mg(NH_4)\,PO_4.6H_2O \xrightarrow{\Delta} Mg_2P_2O_7$

Applying P.O.A.C on 'P' atom

$1 \times n_{NaH_2PO_4} = 2 \times n_{Mg_2P_2O_7}$

$1 \times \frac{\text{weight}}{120} = 2\times\frac{1.054}{222}$

Weight of NaH_2PO_4 = $\frac{2\times1.054\times120}{222}$ = 1.14 gm

45. $H_2O + SO_3 \longrightarrow H_2SO_4$

$n_{H_2O} = \left(\frac{40\times.9}{18}\right) = 2$

$n_{SO_3} = \left(\frac{1\times50}{0.0821\times300}\right) = 2.03 = 2$

$\Rightarrow$ Weight of H_2SO_4 produced = 2 × 98 = 196 gm.

46. $A_2[H_2PtCl_6] \xrightarrow{\Delta} Pt$

$n_{Pt} = \dfrac{0.262}{195}$

$\Rightarrow$ moles of salt = $\dfrac{0.80}{2A+410}$

$\Rightarrow$ $\dfrac{0.80}{2A+410} = \dfrac{0.262}{195}$

$\Rightarrow$ $A = \left(\dfrac{.80\times 195}{0.262} - 410\right)\times\dfrac{1}{2}$

$\Rightarrow$ A = 92.70 gm/mole.

47. Atomic mass of chlorine = $\dfrac{75.77\times 34.9689 + 24.23\times 36.9659}{100}$

$= \dfrac{2649.59355 + 895.683757}{100} = 35.4527$

48. $24.31 = \dfrac{79\times 24 + (21-x)\times 25 + x\times 26}{100}$

$\Rightarrow$ 2431 = 1896 + 525 – 25x + 26x

$\Rightarrow$ x = 10

49.

%	**Atomic mass**	**Relative number of atom =** $\dfrac{\%}{\text{At mass}}$	**Simplest atomic ratio**	**Simplest whole number ratio**
$C \rightarrow 49\%$	12	$\dfrac{49}{12} = 4.08$	3	3
$H \rightarrow 2.7\%$	1	$\dfrac{2.7}{1} = 2.70$	1.98 = 2	2
$Cl \rightarrow 48.3\%$	35.5	$\dfrac{48.3}{35.5} = 1.36$	1	1

$\Rightarrow$ Emperica formula = C_3H_2Cl

$\Rightarrow$ $n = \dfrac{147}{73.5} = 2$

$\Rightarrow$ molecular formula = $(C_6H_4Cl_2)$

50. $.25 = \dfrac{x\times 56}{89600}\times 100$

$\Rightarrow$ $x = \dfrac{.25\times 89600}{56\times 100}$ $\Rightarrow x = 4$

EXERCISE # S-II

1. $\dfrac{\text{mole of HCl}}{16} = \dfrac{\text{mole of } Cl_2}{5}$

$\dfrac{\text{mole of } Cl_2}{6} = \dfrac{\text{mole of } Ca(ClO_3)_2}{1}$

$\dfrac{\text{mole of } Ca(ClO_3)_2}{1} = \dfrac{\text{mole of } NaClO_3}{2}$

Also, moles of HCl in 100 ml = 1.164

$\Rightarrow$ moles of $NaClO_3 = \left(\dfrac{5\times1.164\times2}{16\times6}\right)$

$\Rightarrow$ mass of $NaClO_3$ produced $= \left(\dfrac{5\times1.164\times2}{16\times6}\right)\times106.5 = 12.9$ g

2. (i) $P_4 + O_2 \longrightarrow P_4O_6 + P_4O_{10}$

Let $n_{P_4O_6} \longrightarrow x$ & $n_{P_4O_{10}} \longrightarrow y$

P.O.A.C on P :

$4 \times n_{P_4} = 4 \times n_{P_4O_6} + 4 \times n_{P_4O_{10}}$

$\Rightarrow$ $4 \times 1 = 4x + 4y$

$\Rightarrow$ $4 = 4x + 4y$ i.e. $x + y = 1$ .....(1)

P.O.A.C on O:

$2 \times n_{O_2} = 6x + 10y$

$2 \times 4 = 6x + 10y$

$\Rightarrow$ $3x + 5y = 4$ .....(2)

Solving equation (1) & (2)

$$\begin{array}{r} 3x+3y=3 \\ 3x+5y=4 \\ - \\ \hline y = 1/2 \end{array} \quad \& \quad x = \frac{1}{2}$$

$\Rightarrow$ moles of P_4O_6 obtained = 0.5 & moles of P_4O_{10} obtained = 0.5

(ii) $P_4 + O_2 \longrightarrow P_4O_6 + P_4O_{10}$

P.O.A.C on P :

$3 \times 4 = 4x + 4y$

$\Rightarrow$ $x + y = 3$ .....(1)

P.O.A.C on O:

$2 \times 11 = 6x + 10y$

$\Rightarrow$ $3x + 5y = 11$ .....(2)

Solving equation (1) & (2)

$$\begin{array}{r} 3x+3y=9 \\ 3x+5y=11 \\ - \quad\quad\quad \\ \hline -2y=-2 \end{array}$$

$\Rightarrow$ y = 1 & x = 2

$\Rightarrow$ moles of P_4O_6 = 2 & moles of P_4O_{10} = 1

(iii) $P_4 + O_2 \longrightarrow P_4O_6 + P_4O_{10}$

<u>P.O.A.C on P :</u>

$4 \times 3 = 4x + 4y$

$\Rightarrow$ $x + y = 3$ .....(1)

<u>P.O.A.C on O:</u>

$2 \times 13 = 6x + 10y$

$\Rightarrow$ $3x + 5y = 13$ .....(2)

Solving equation (1) & (2)

$$\begin{array}{r} 3x+3y=9 \\ 3x+5y=13 \\ - \quad\quad\quad \\ \hline -2y=-4 \end{array}$$

$\Rightarrow$ y = 2

$\Rightarrow$ moles of P_4O_6 = 1 & moles of P_4O_{10} = 1

3. $C + O_2 \longrightarrow CO_2 + CO$

Let moles of CO be x

& moles of CO_2 ben y.

<u>P.O.A.C on C :</u>

$1 = x + y$ .....(1)

<u>P.O.A.C on O:</u>

$2\times\frac{20}{22} = x + 2y$ .....(2)

Solving equation (1) & (2), we get

$x \to 0.75$ & $y = 0.25$

mass % of CO $\to \frac{.75\times28}{0.75\times28+0.25\times44}\times100 = \frac{21}{32}\times100 = 65.625\%$

mass % of CO_2 = 34.375 %

4.

	N	:	P_2O_5	:	K_2O
mole:	$\frac{30}{14}$	:	$\frac{10}{142}$	:	$\frac{10}{94}$
For	N	:	P	:	K
mole:	$\frac{30}{14}$	:	$\frac{10}{71}$	:	$\frac{10}{47}$
Simplest: ratio	10	:	0.66	:	1

5. Let $CaCl_2$ be x gm & NaCl be (10 – x) gm

$$CaCl_2 \xrightarrow{Na_2CO_3} CaCO_3 \longrightarrow CaO$$

moles: $\frac{x}{111}$ $\frac{x}{111}$ $\frac{x}{111}$

As, $\frac{x}{111} = \frac{1.12}{56}$

$\Rightarrow$ x = 2.22 gm

% NaCl = $\frac{7.78}{10} \times 100$ = 77.8 %

6. (a) $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

(b) Fe_2O_3 & Al reacts in mole ratio 1 : 2

$\Rightarrow$ ratio of mass = $\frac{100}{54}$ or 80 : 27

(c) $nFe_2O_3 \longrightarrow 100$

moles of Fe_2O_3 reacted = 50 moles

$\Rightarrow$ energy released = 50 × 200 = 10,000 units

7. $2KClO_3 \longrightarrow 2KCl + 3O_2$

mole: $\left(\frac{x}{122.5}\right)$ $\frac{x}{122.5}$ $\left(\frac{3x}{2\times122.5}\right)$

$n_{O_2} = \frac{112}{22400} = \frac{3x}{2\times122.5}$

$\Rightarrow$ x = 0.41 gm

$\Rightarrow$ mass of KCl obtained from 0.41 gm $KClO_3$

$= \left(\frac{2\times74.5}{2\times122.5}\times0.41\right)$ = 0.25 gm KCl

$$\underset{\left(0.59/122.5\right)}{4KClO3} \longrightarrow 3KClO_4 + KCl$$

& mass of KCl obtained from 0.59g $KClO_3$

$= \frac{74.5\times0.59}{4\times122.5}$ = 0.089g KCl

& mass of $KClO_4$ obtained from 0.59g $KClO_3$

$= \frac{3\times138.5}{4\times122.5}\times0.59$ = 0.500 gm

$\Rightarrow$ % by weight of $KClO_4$ in residue

$= \left(\frac{0.500}{.84}\right)\times100$ = 59.72 %

8. $\left[Cr(H_2O)_5\,Cl\right].Cl_2.H_2O + \underset{\text{(excess)}}{AgNO_3} \longrightarrow 2AgCl + \left[cr(H_2O)_5\,Cl\right].(NO_3)_2$

moles of $\left[Cr(H_2O)_5\,Cl\right]\cdot Cl_2\cdot H_2O$ is $\dfrac{5.33}{266.5}$ i.e. 0.02 moles

$\Rightarrow$ moles of AgCl obtained = 2 × 0.02 = 0.04 mole
mass of AgCl obtained = 0.04 × 143.5 = 5.74 gm

9. Let the metal carbonate be M_2CO_3

As, mass % of O = 48 = $\dfrac{48}{2x+60}\times 100$

$\Rightarrow$ x = 20
i.e. molar mass of metal = 20gm/mole

$\Rightarrow$ moles of M_2CO_3 = $\dfrac{5\times 10^{-3}}{(20\times 2+60)}$ = 5×10^{-5} mole.

$\Rightarrow$ moles of metal is 10^{-4} mole

$\Rightarrow$ Number of atoms of metal present = $10^{-4} \times 6 \times 10^{23}$
i.e. 6×10^{19} atoms

10. $A_x\,B_y + O_2 \longrightarrow AO$ + oxide of B.
Apply P. O. A. C on A,

$x \times \dfrac{2.5}{24x+14y} = 1 \times \dfrac{3}{40}$

$\Rightarrow$ x : y = 3 : 2

$\Rightarrow$ Emperical formula of compound is 3 : 2

11. $Ca + Cl_2 \longrightarrow CaCl_2$

moles$\rightarrow \left(\dfrac{2.4\times 10^{24}}{6\times 10^{23}}\right)\left(\dfrac{380\times 96}{760\times 0.08\times 300}\right)$

$\simeq 4$ $\simeq 2$

$\Rightarrow$ Cl_2 is L.R.

$\Rightarrow$ mass of $CaCl_2$ = 2 × 111 = 222 gm

12. $P_4\,S_3 + 8O_2 \longrightarrow P_2O_{10} + 3SO_2$

mole: $\left(\dfrac{1}{64}\times\dfrac{1}{3}\right)$ $\dfrac{1}{284}$ $\dfrac{1}{64}$

$\Rightarrow$ mass of P_4S_3 required = $\dfrac{1}{64\times 3}\times 220$ = 1.1458 gm

13. $H_4P_2O_7 + 2NaOH \longrightarrow Na_2H_2P_2O_7 + 2H_2O$
moles: 3 5

$\Rightarrow$ NaOH is L.R.

$\Rightarrow$ number of molecules $Na_2H_2P_2O_7$ formed = (2.5) N_A
& number of molecules H_2O formed = (5) N_A

$\Rightarrow$ Total number of molecules formed in product is $(7.5)N_A$.

EXERCISE # O-I

1. (A) 1 of - atom of c = 12 g

(B) $\frac{1}{2}$ mole CH_4 = 8 g

(C) 10 ml of H_2O = 10 g

(D) 3.011×10^{23} atoms of oxygen = 8g

$\Rightarrow$ option (A) is

2. $n_{CO_2} = \frac{44}{44} = 1$ mole

$\Rightarrow$ the molecules of $CO_2 = N_A$ i.e. 6×10^{23}.

$\Rightarrow$ correct option is (A)

3. $n_{NH_3} = \frac{4.25}{17}$ i.e. mole

$\Rightarrow$ option (B) is correct.

4. Charge on 1 gram ions of Al^{+3} is $3N_Ae$ Coulomb

$\Rightarrow$ option (D) is correct.

5. Atomic weight of A = 40 u

& Atomic weight of B = 80 u

$\frac{x}{40} \times N_A = y$ ....(1)

$\frac{2x}{80} N_A \rightarrow ?$ ....(2)

Comparing (1) and (2), we get 2xg of B = y

$\Rightarrow$ option (C) is correct

6. $n_{Al} \longrightarrow \frac{54}{27} = 2$ mole.

$\Rightarrow$ mass of same number of magnesium atoms = 48 gm

$\Rightarrow$ Correct option is (C).

7. Weight of molecule of compounds $C_{60}H_{22}$

$= (60 \times 12 + 22 \times 1)$ amu $= (720 + 22)$ amo

$= 742 \times 1.66 \times 10^{-24}$ g $= 1.24 \times 10^{-21}$ gm

$\Rightarrow$ Option (B) is correct.

8. $n_{NO_3^-} = \frac{3.1 \times 10^{-3}}{62 \times 10}$

$= 0.5 \times 10^{-4}$

$= 5 \times 10^{-5}$

Number of electron in 3.1 mg $NO_3^{\ominus} = 5 \times 10^{-5} \times 32 \times 6.022 \times 10^{23} = 9.6 \times 10^{20}$.

$\Rightarrow$ Correct option is (C)

9. Ratio of number of molecules of CO_2 & N_2O

$$= \frac{2x}{44} \times N_A \times \frac{44}{5x \times N_A} = 2 : 5$$

$\Rightarrow$ correct option is (B)

10. (A) $n_{C_2H_6} = \frac{15}{30} = \frac{1}{2}$ mole

$\Rightarrow$ number of carbon atoms = $\frac{N_A}{2} \times 2$ i.e. N_A

(B) $n_{Na_2C_2O_4} = \frac{40.2}{134} = 0.3$ mole

$\Rightarrow$ number of carbon atoms = $0.3 \times 2N_A = 0.6\ N_A$

(C) $n_{glucose} = \frac{72}{180} = 0.4$

$\Rightarrow$ number of carbon atoms = $0.4 \times 6N_A = 2.4\ N_A$

(D) $n_{C_5H_{10}} = \frac{35}{70} = 0.5$

$\Rightarrow$ number of carbon atoms = $0.5 \times 5N_A = 2.5\ N_A$

$\Rightarrow$ Correct option is (D)

11. number of H-atom in 0.9 gm glucose = $\frac{0.9}{180} \times 12N_A = 0.06\ N_A$

(A) $nN_2H_4 = \frac{0.048}{32}$

$\Rightarrow$ number of H-atoms = $\frac{0.048}{32} \times 4\,N_A = 0.006\ N_A$

(B) $n_{NH_3} = \frac{0.17}{17}$

$\Rightarrow$ number of H-atom = $0.01 \times 3N_A = 0.03\ N_A$

(C) $n_{C_2H_6} = \frac{0.30}{30} = 0.01$

$\Rightarrow$ number of H-atoms = $0.06\ N_A$.

(D) $n_{H_2} \longrightarrow \frac{0.03}{2} = \frac{0.03}{2}$ mole

$\Rightarrow$ number of H-atoms = $\frac{0.03}{2} \times 2\ N_A = 0.03\ N_A$

$\Rightarrow$ Correct option is (C)

12. $n_{CuSO_4.5H_2O} = \left(\frac{1 \times 10^{22}}{6.022 \times 10^{23}}\right) = 1.66 \times 10^{-2}$ mole

$\Rightarrow$ weight = $1.66 \times 10^{-2} \times 249.5 = 4.159$ gm

$\Rightarrow$ Correct option is (C)

13. $n_C \longrightarrow \dfrac{1.2\times10^{-3}}{12}$ mole

$\Rightarrow$ number of carbon atoms = $\dfrac{1.2\times10^{-3}}{12}\times N_A$

= 6.02×10^{19} atoms

$\Rightarrow$ Correct option is (B).

14. mass of 1.2 mole ethanol = (1.2 × 46) g

$\Rightarrow$ Volume = $\dfrac{\text{mass}}{\text{density}} = \dfrac{1.2\times46}{0.8}$ = 69 ml

$\Rightarrow$ Correct option is (C).

15. $n_{NO_2} = \dfrac{112}{22.4\times10^3}$

$\Rightarrow$ number of molecules = $\dfrac{112}{22.4\times10^3}\times6.02\times10^{23} = 3.1 \times 10^{21}$

Now, volume = $\dfrac{\text{mass}}{\text{density}} = \dfrac{5\times10^{-3}\times46}{1.15}$

= 200×10^{-3} = 0.20 ml

$\Rightarrow$ Correct option is (B).

16. Let the molecule be A_xB_y

Molecular weight of compounds formed = $\left(\dfrac{XN_A + MY}{5}\right)$

$\Rightarrow$ Correct option is (A).

17. By Avogadro's Hypothesis,
for gas A, $P.v_A = n_A \cdot RT$
for gas B, $P.v_B = n_B \cdot RT$
If $n_A = n_B$
$\Rightarrow v_A = v_B$
$\Rightarrow$ Correction option is (B).

18. $NaI \longrightarrow Na^+ + I^-$
As, 100 g salt contains 0.5 g NaI

$\Rightarrow$ 3g salt contains $\left(\dfrac{.5}{100}\times3\right)$ g NaI.

= 0.015 g NaI.

$n_{NaI} \longrightarrow \dfrac{0.015}{150}$ mole

$\Rightarrow$ number of I^- ions = $\dfrac{0.015}{150}\times6.02\times10^{23}$

= 6.02×10^{19}.

$\Rightarrow$ Correct option is (C).

19. By Avogadro's hypothesis

n_{O_2} = $n_{\text{unknown gas}}$

$\Rightarrow \quad \frac{1}{32} = \frac{2.375}{M}$ (M $\rightarrow$ molar mass of unknown gas)

$\Rightarrow \quad M = 2.375 \times 32 \quad \Rightarrow \quad M = 76$

$\Rightarrow$ correct option is (C)

20. Ratio of number of atoms = 2 : 1 : 2 : 3

$\Rightarrow$ Correct option is (C).

21. $2P + Q \longrightarrow R$

mole : 8 (Excess) 0

0 4

$\Rightarrow$ Correct option is (C).

22. $4\,Al + 3O_2 \longrightarrow 2Al_2O_3$

(Excess) 1.5 0

0 1

$\Rightarrow$ weight of Al 54 gm.

23. $C_XH_YO_Z + \left(X + \frac{Y}{4} - \frac{Z}{2}\right) O_2 \longrightarrow X\,CO_2 + \frac{Y}{2} H_2O$

$n_{CO_2} = \frac{132}{44} = 3$

$\Rightarrow \quad X = 3$

$n_{H_2O} \longrightarrow \frac{54}{18} = 3$

$\Rightarrow \quad Y = 6.$

$\Rightarrow$ Correct option is (C).

24. $C_2H_4O_2 + 2O_2 \longrightarrow 2CO_2 + 2H_2O$.

1 mole $C_2H_4O_2$ & 2 mole O_2 produces 2 mole CO_2

i.e. 124 g mixture produces 88 gm CO_2

$\Rightarrow$ 620g mixture will produces $\frac{88}{124} \times 620 = 440$ gm

$\Rightarrow$ Correct option is (C)

25. $5A_2 + 2B_4 \longrightarrow 2AB_2 + 4A_2B$.

5 mole A_2 produce 2 mole AB_2

$\Rightarrow$ (2 × 250)g AB_2 is produced from 100g A_2

$\Rightarrow$ 1000g AB_2 is produced from $\left(\frac{100}{2 \times 250}\right) \times 1000$g of A_2

= 200 g of A_2

Also, 2 mole AB_2 is produced from 2 mole B_4

$\Rightarrow$ (2×250)g AB_2 is produced from $(2 \times 120 \times 4)$ g of B_4

$\Rightarrow$ 1000 g AB_2 is produced from $\left(\frac{2\times120\times4}{2\times250}\right)\times1000 = 1920$ gm.

$\Rightarrow$ Minimum mass of mixture of A_2 & B_2 is (1920 + 200)

i.e. 2120 gm

$\Rightarrow$ Correct option is (A)

26. $3Mg + 2NH_3 \longrightarrow Mg_3N_2 + 3H_2$

Mole : $\frac{48}{24}$ $\frac{34}{17}$

= 2 = 2

$\Rightarrow$ Mg is L. R.

$\Rightarrow$ mass of Mg_3N_2 produced is $\frac{2}{3}\times(100)$ g $= \frac{200}{3}$ g

$\Rightarrow$ Correct option is (A)

27. $P_4S_3 + 8O_2 \longrightarrow P_4O_{10} + 3SO_2$

Mole : $\frac{440}{220}$ $\frac{384}{32}$

= 2 = 12

$\Rightarrow$ O_2 is L.R

$\Rightarrow$ mass of P_4O_{10} produced $= \frac{(12\times284)}{8}$ g = 426 gm.

$\Rightarrow$ Correct option is (B).

28. $12C + 11\,H_2 + \frac{11}{2}O_2 \longrightarrow C_{12}\,H_{22}\,O_{11}$

Mole : $\frac{84}{12}$ $\frac{12}{2}$ $\frac{56}{22.4}$

= 7 6 2.5

$\Rightarrow$ O_2 is L.R.

$\Rightarrow$ Mass of sucrose produced = $\left(\frac{2}{11}\times2.5\right)\times342$ g = 155.5 g

$\Rightarrow$ Correct option is (B).

29. $H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + 2H_2O$.

Mole .5 0.2

$Ca(OH)_2$ is L.R.

$\Rightarrow$ number of moles of $CaSO_4$ formed = 0.2

$\Rightarrow$ Correct option is (A)

30. $I_2 + 2Cl_2 \longrightarrow ICl + ICl_3$

Mole: $\frac{25.4}{254}$ $\frac{14.2}{71}$

= 0.1 0.2

No. L. R

$\Rightarrow$ moles of ICl produced = 0.1

& moles of ICl_3 produced = 0.1

$\Rightarrow$ Correct option is (A)

31. $2P_4 + 8O_2 \longrightarrow P_4O_6 + P_4O_{10}$

Mole : $\frac{31}{124}$ $\frac{32}{32}$

= $\frac{1}{4}$ 1

No. L. R

$\Rightarrow$ Weights of P_4O_6 produced $= \frac{1}{2}\times\frac{1}{4}\times 220 = 27.5$ g

& weight of P_4O_{10} produced $= \frac{1}{8}\times 284 = 35.5$ g

$\Rightarrow$ Correct option is (B)

32. $CaCO_3 \longrightarrow CaO + CO_2$

$Na_2CO_3 + CO_2 + H_2O \longrightarrow 2\ NaHCO_3$

$n_{Na_2CO_3} = \frac{21.2\times 10^3}{106} = 2 \times 10^2$ moles.

Moles of $CaCO_3$ = mole of CO_2 .....(1)

Moles of CO_2 = mole of Na_2CO_3 .....(2)

From (1) & (2)

Mole of $CaCO_3 = 2 \times 10^2$

$\Rightarrow$ Mass o f $CaCO_3 = 2 \times 10^2 \times 100 = 20$ kg

$\Rightarrow$ Correct option is (B).

33. $NaI + AgNO_3 \longrightarrow AgI + NaNO_3$.

$2AgI + Fe \longrightarrow FeI_2 + 2Ag$

$2FeI_2 + 3Cl_2 \longrightarrow 2FeCl_3 + 2I_2$.

$n_{I_2} = (1 \times 10^3)$

$\frac{\text{mole of } AgNO_3}{1} = \frac{\text{mole of } AgI}{1}$ .....(1)

$\frac{\text{mole of } AgI}{2} = \frac{\text{mole of } FeI_2}{1}$ .....(2)

$\frac{\text{mole of } FeI_2}{2} = \frac{\text{mole of } I_2}{2}$ .....(3)

From (1), (2) & (3)

$\therefore$ Mole of I_2 = mole of FeI_2 = $\dfrac{\text{mole of AgI}}{2}$

$= \dfrac{\text{mole of } AgNO_3}{2}$

$\Rightarrow$ $10^3 = \dfrac{\text{wt of } AgNO_3}{170\times 2}$

$\Rightarrow$ wt. of $AgNO_3$ = 340 kg

$\Rightarrow$ Correct option is (A)

34. Let $CaCl_2$ be x g & NaCl be (10 – x) g

$CaCl_2 \longrightarrow CaCO_3 \longrightarrow CaO$

Moles $\dfrac{x}{111}$ $\quad$ $\dfrac{x}{111}$ $\quad$ $\dfrac{x}{111}$

moles of CaO $\longrightarrow \dfrac{1.62}{56}$

$\Rightarrow$ moles of $CaCl_2 = \dfrac{1.62}{56}$

$\Rightarrow \dfrac{1.62}{56} = \dfrac{x}{111}$

$\Rightarrow x = \dfrac{111\times 1.62}{56}$

$\Rightarrow x = 3.21$

$\Rightarrow$ % by mass of $CaCl_2 = \dfrac{3.21}{10}\times 100 = 32.1$ %

$\Rightarrow$ Correct option is (A)

35. for Alkali metal carbonate

$M_2CO_3 + HCl \longrightarrow MCl + CO_2 + H_2O$
(Excess)

$$\frac{\text{For Alkaline Earth metal carbonate}}{MCO_3 + HCl \longrightarrow MCl_2 + CO_2 + H_2O}$$

$n_{CO_2} = \dfrac{1\times 12.315}{0.0821\times 300} = 0.5$ mole

$Li_2CO_3 + 2HCl \longrightarrow 2LiCl + CO_2 + H_2O$

1 mole CO_2 is produced from 1 mole Li_2CO_3

$\Rightarrow$ 0.5 mole CO_2 is produced from .5 mole Li_2CO_3 OR = .5 × (74)

= 37 gm. of Li_2CO_3 & mass of impurity = 3 gm

$\Rightarrow$ Correct option is (B)

36. $M = \dfrac{99 \times 20 + \frac{1}{2} \times (21+22)}{100} = 20.002$

20.015 आ रहा है।

$\Rightarrow$ Correct option is (A)

37. $PCl_5 \longrightarrow PCl_3 + Cl_2$

$M_{Avg.} = \dfrac{M_{Theo.}}{1+(n-1)\alpha} = \dfrac{208.5}{1+0.5} = 139$

$\Rightarrow$ % change in $M_{Avg.}$ of the mixture = $\left(\dfrac{208.5-139}{208.5}\right) \times 100 = 33.33\ \%$

$\Rightarrow$ Correct option is (C)

38. $8 = \dfrac{1 \times 32}{M} \times 100$

$\Rightarrow$ M = 400

$\Rightarrow$ Correct option is (B).

39. $n = \dfrac{\text{molecular formula mass}}{\text{Emperical formula mass}}$

$\Rightarrow n = \dfrac{120}{30} = 4$

$\Rightarrow$ molecular formula = $(CH_2O) \times 4$ i.e. $(C_4H_8O_4)$

$\Rightarrow$ Correct option is (B)

40.

Element	%	Relative number of atoms	Simplest atomic Ratio	Simplest whole Number ratio
Ca	20	$\frac{20}{40} = \frac{1}{2}$	1	1
Br	80	$\frac{80}{80} = 1$	2	2

$\Rightarrow$ Empirical formula is $CaBr_2$

As, $n = \dfrac{200}{200} = 1$

$\Rightarrow$ Molecular formula is $CaBr_2$

$\Rightarrow$ correct option is (B).

41. $69.98 = \frac{21\times12}{M}\times100$

$\Rightarrow M = \frac{21\times12}{69.98}\times100$ $\Rightarrow M = 360.1$

$\Rightarrow$ Correct option is (D)

42. **Method-1**

Let the compound be $C_xH_yO_z$

Now, weight % of C = 8 × (weight % of H)

$\Rightarrow \quad \frac{x}{y} = \frac{2}{3}$

Also, weight % of C = $\frac{1}{2}$ × (weight % of O)

$\Rightarrow \quad \frac{x}{z} = \frac{2}{3}$

$\Rightarrow$ The correct option is (B)

Method-2

$Ag_2A \longrightarrow Ag$

P.O. A.C. on Ag

$$2\times\frac{1}{216+M_A} = \frac{0.5934}{108}\times1$$

$\Rightarrow M_A \to 148$

$\Rightarrow$ molar mass of Acid = 150

	C	H	O
weight %	8	1	16
mole %	2	3	3

$\Rightarrow$ Empirical formula = $C_2H_3O_3$

$\Rightarrow n = 2$ $\Rightarrow$ molecular formula is $C_4H_6O_6$

$\Rightarrow$ Correct option is (B)

43. Let % of NO_2 be x

NO % of number be (100 – x)

$\Rightarrow 34 = \frac{x\times46+(100-x)\times30}{100}$ $\Rightarrow$ x = 25 %

$\Rightarrow$ Correct option is (A)

EXERCISE # O-II

1. For $(NH_4)_3PO_4$:

Ratio of number of O atoms to number of H atoms = $\frac{4}{12}$ i.e. (1 : 3)

Ratio of number of cations to number of anions = 3 : 1

Number of gm-atoms of nitrogen to atoms of oxygen = $\frac{3}{4}$

Total number of atoms in 1 mole of $(NH_4)_3\,PO_4 = 20N_A$

$\Rightarrow$ Correct options are (A), (B)

2. $2\,Mg + O_2 \longrightarrow 2\,MgO$

moles: $\frac{12}{24}$ $\frac{32}{32}$

$\Rightarrow$ Mg is L.R, So is 100% consumed
i.e. number MgO is left unburnt
Amount of O_2 left unreacted = 0.75 gm molecule
Amount of MgO formed = 0.5 × 40 i.e. 20 gm
The mixture at the end will weight 44 gm. $\Rightarrow$ Correct option (A)

3. $3\,CaCO_3 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 3H_2O + 3CO_2$

moles : $\frac{50}{100} = 0.5$ $\frac{68.6}{98} = 0.7$ $\Rightarrow$ $CaCO_3$ is L.R.

Amount of salt formed = $\left(\frac{1}{3}\times 0.5\times 310\right)$ = 35.93 gm

$n_{CO_2} = 0.5$

$\Rightarrow$ Correct option are (A), (B), (C)

4. $C_7H_8 + 3HNO_3 \longrightarrow C_7H_5N_3O_6 + 3H_2O$

As, C_7H_8 & HNO_3 reacts in 1 : 3 ratio

$\Rightarrow$ x × 92 + 3x × 62 = 140.5 $\Rightarrow$ x = 0.5

$\Rightarrow$ Maximum weight of $C_7H_5N_3O_6$ which can be produced is 0.5 × 227 i.e 113.5 gm
Correct option is (B).

5. $A + N \xrightarrow{I} B + L$

4 4

$A + N \xrightarrow{II} \frac{1}{2}B + \frac{1}{2}(C) + L$

4 2 2

$\Rightarrow$ B will always be greater than C & If 2 moles of C are formed the total 6 mole of B are also formed

$\Rightarrow$ Correct option are (A), (D)

6. $4Ag + 8KCN + O_2 + 2H_2O \longrightarrow 4K[Ag(CN)_2] + 4KOH$

$\Rightarrow$ $4 \times 108g$ of Ag reacts with $8 \times 65g$ of KCN 100g of Ag reacts with $\frac{8\times65}{4\times108}\times100$

Hence statement A is correct

$\Rightarrow$ $4 \times 108g$ of Ag require 32 gm of O_2

$\Rightarrow$ 100g of Ag require = $\frac{32}{4\times108}\times100$ = 7.40 gm

Hence option (C) is correct.

Volume of O_2 required = $\frac{7.4}{32}\times22.4$ = 5.20 liters

7. $CaO + 3C \longrightarrow CaC_2 + CO$

(A) Find product contains 85% CaC_2 & 15% CaO.

Let mass of product = 100 gm

$\therefore$ mass of CaC_2 = 85 gm

mass of CaO = 15 gm

used mole of CaO = mole of CaC_2 produced = $\left(\frac{85}{64}\right)$

$\therefore$ mass of CaO producing 85 gm CaI_2 = $\frac{85}{64}\times56$ =74.375 gm

$\therefore$ Initial mass of CaO = (74.375 + 15) = 89.375

85 gm CaC_2 obtained from 89.38 gm CaO

1000 kg CaC_2 obtained from $\frac{89.38}{85}\times10^3$ kg CaO. = 1051.47 kg CaO.

(B) 100 gm produced requires CaO = 89.38g

$\Rightarrow$ 10^3 kg product requires CaO = $\frac{89.38}{100}\times10^3$ = 893.8 kg CaO.

8. $2NH_3 + \frac{5}{2}O_2 \longrightarrow 2NO + 3H_2O.$

$2NO + O_2 \longrightarrow 2NO_2$

$2NO_2 + H_2O \longrightarrow HNO_3 + HNO_2$

$3HNO_2 \longrightarrow HNO_3 + NO + H_2O$

(A) Moles of HNO_3 produced is help of moles of Ammonia used if HNO_2 is not used to produce HNO_3 by reaction (IV) .

(B) Incorrect

(C) $\frac{1}{4}$th of total HNO_3 is produced by reaction (IV) if HNO_2 is used to produce HNO_3.

(D) Moles of number produced in reaction (IV) is 50% of moles of total HNO_3 produced.

9. mass of substance = 0.42 gm.

Volume of $N_2 = \frac{100}{11}$ ml

Temperature = 250 K

Pressure = 860 – 24 = 836 mm Hg

Step (1)

Volume of N_2 at S.T.P. i.e. $V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2}$

$\Rightarrow \quad V_2 = \frac{836 \times 100 \times 273}{760 \times 11 \times 250} \qquad \Rightarrow \quad V_2 = 10.92$ ml

Step (2)

% of N_2 in organic compound $= \frac{28 \times 10.92}{22700 \times 0.42} \times 100 = \frac{10}{3}\%$

$\Rightarrow$ Correct option is (A)

10. $2A + 3B \longrightarrow C$

moles: 3 4

$\Rightarrow$ B is L.R. & C formed is $\frac{4}{3}$ moles only if the yeild is 100%.

$\Rightarrow$ Correct option (C).

11. $Y_3Al_5O_{12}$

weight % of Y $\longrightarrow \frac{89 \times 3}{594} \times 100 = 44.95$ %

weight % of Al $\longrightarrow \frac{27 \times 5}{594} \times 100 = 22.73$ %

weight % of O $\longrightarrow \frac{12 \times 6}{594} \times 100 = 32.32$ %

12. $n_{C_6H_8O_6} = \frac{17.6 \times 10^{-3}}{176} = 10^{-4}$ moles

O - atoms present = $6 \times 6 \times 10^{23} \times 10^{-4} = 3.6 \times 10^{20}$

moles of vitamin C in 1 gm of vitamin C = 5.68×10^{-3}.

moles of vitamin C that should be consumed daily = 10^{-4}

13. $2H_2 + O_2 \longrightarrow 2H_2O$

moles: $\frac{1}{2}$ $\frac{1}{32}$ $\Rightarrow$ O_2 is L.R.

$\Rightarrow$ mass of H_2O produced = $\frac{1}{32} \times 2 \times 18 = 1.125$ g

$3H_2 + N_2 \longrightarrow 2NH_3$

moles: $\frac{1}{2}$ $\frac{1}{28}$ $\Rightarrow$ H_2 is L.R.

$\Rightarrow$ mass of NH_3 produced = $\frac{1}{28}\times 2\times 17$ = 1.214 g

H2 + $Cl_2 \longrightarrow 2HCl$

moles: $\frac{1}{2}$ $\frac{1}{71}$ $\Rightarrow$ Cl_2 is L.R

$\Rightarrow$ mass of HCl produced = $2 \times 36.5 \times \frac{1}{71}$ = 10028 g

$2H_2 + C \longrightarrow CH_4$

moles: $\frac{1}{2}$ $\frac{1}{12}$ $\Rightarrow$ C is L. R.

$\Rightarrow$ Mass of CH_4 produced = $\frac{1}{12}\times 16$ = 1.333g Correct option is (A)

14. $Fe + Br_2 \longrightarrow FeBr_2$

$Br_2 + 3FeBr_2 \longrightarrow Fe_3Br_8$

$Fe_3Br_8 + 4Na_2CO_3 \longrightarrow 8NaBr + 4CO_2 + Fe_3O_4$.

(a) $n_{NaBr} = \frac{2.06\times 10^3\times 10^3}{103} = 2 \times 10^4$

$$\frac{\text{moles of Fe}}{1} = \frac{\text{moles of FeBr}_2}{1}$$

$$\frac{\text{moles of FeBr}_2}{3} = \frac{\text{moles of Fe}_3\text{Br}_8}{1}$$

& $$\frac{\text{moles of Fe}_3\text{Br}_8}{1} = \frac{\text{mole of NaBr}}{8}$$

$\Rightarrow$ moles of Fe = $\frac{\text{moles of NaBr}}{8}\times 3 = \frac{2\times 10^4}{8}\times 3$

$\Rightarrow$ mass of Fe required = $\frac{6\times 10^4\times 56}{8}$ = 420 kg $\Rightarrow$ Correct option is (B)

(b) $3FeBr_2 + Br_2 \longrightarrow Fe_3Br_8$

mole : $\frac{3}{8}\times 2\times 10^4\times\frac{100}{70}\times\frac{100}{60}$ $\frac{1}{8}\times 2\times 10^4\times\frac{100}{70}$

$Fe_3Br_8 + 4Na_3CO_3 \longrightarrow 8\,NaBr + 4CO_2 + Fe_3O_4$

mole : $\frac{1}{8}\times 2\times 10^4\times\frac{100}{70}$ 2×10^4

$\Rightarrow$ $\frac{10^6}{8\times 7} = 0.01786 \times 10^6$

$= 1.786 \times 10^4$ moles

$\Rightarrow$ mass of Fe required = $\frac{1.786\times 10^4\times 56}{10^2} = 17.86 \times 56$

= 1000 kg or 10^3 kg

$\Rightarrow$ Correct option is (C)

(c) moles of CO_2 formed = $\frac{1}{2} \times 2 \times 10$ = 10 moles

$\Rightarrow$ Correct option is (B).

15. (a) $Ca_2B_6O_{11} + 2Na_2CO_3 \longrightarrow 2CaCO_3 + Na_2B_4O7 + 2NaBO_2$

$\left(\frac{3}{200} \times \frac{10^2}{32.2} \times \frac{100}{60}\right) \times 100 \times 100 \qquad \left(\frac{3}{200} \times \frac{10^2}{32.2} \times 100\right) \times 100$

$Na_2B_4O_7 \longrightarrow 2NaBO_2 + B_2O_3$

$\left(100 \times \frac{3}{200} \times \frac{10^2}{32.2} \times 100\right) \qquad \left(\frac{10^2}{32.2}\right) \times 100$

$COO + B_2O_3 \longrightarrow CO(BO_2)_2$

$\left(\frac{10^2}{32.2}\right) \times 100 \qquad 10^2$

$n_{CO(BO_2)_2} = \frac{14.5 \times 10^3}{1450} = 10^2$ moles

$\Rightarrow$ mass of $Ca_2B_6O_{11}$ required = $10^2 \times (80 + 66 + 176) = 322 \times 10^2$g = 32.2 kg

$\Rightarrow$ correct option is (A)

(b) mass of $Ca_2B_6O_{11}$ obtained = $\frac{3 \times 10^8}{200 \times 32.2 \times 60} \times 3220 = \frac{10^8}{400}$ g

$= \frac{10^6}{4 \times 10^3}$ kg $= \frac{1000}{4}$ kg = 250 kg

$\Rightarrow$ correct option is (A)

16. $UF_6 + H_2O \longrightarrow U_x\, O_y\, F_z + \left(H_{\frac{5}{5}}\; F_{\frac{95}{19}}\right)$ or (HF)

(a) The empirical formula of gas is HF

$\Rightarrow$ Correct option is (C)

(b) Mass of H_2O = 3.88 –3.52 = 0.36 gm

$\Rightarrow$ moles of H_2O = 0.2

$\Rightarrow$ $UF_6 + 2H_2O \longrightarrow U_1O_2F_2 + 4HF$

$\Rightarrow$ Empirical formula of solid is UF_2O_2

$\Rightarrow$ Correct option is (A)

(c) 1 mole UF_6 gives 4 more HF

$\Rightarrow$ % of fluorine converted in gaseous product

$= 100 - \left(\frac{114 - 76}{114}\right) \times 100 = 66.66$ %

$\Rightarrow$ Correct option is (C)

EXERCISE # JEE-MAINS

1. Moles pg CO $= \dfrac{2.01\times10^{23}}{6.02\times10^{23}} = 0.33$

Mass of CO $= 0.33 \times 28$

$= 9.3$ gm

2.

	C	H	N
WT	9	1	3.5
Moles	$\frac{9}{12}$	$\frac{1}{1}$	$\frac{3.5}{14}$
	$\frac{3}{4}$	1	$\frac{1}{4}$
	3	4	1

EF = $C_3H_4N_1$ $\Rightarrow$ Mass (54)

MF = n (EF)

108 = n (54)

n = 2

MF = $C_6H_8N_2$

3. Remain unchanged

The mass of 1 mole of the substance will remain unchanged.

$\Rightarrow$ Correct option is (2)

4. 8 mole oxygen atom is present in 1 mole $Mg_3(PO_4)_2$

$\Rightarrow$ 0.25 mole oxygen atom is present in $\left(\frac{1}{8}\times.25\right) = 3.125 \times 10^{-2}$ mole.

$\Rightarrow$ Correct option is (1)

5. V.D = 94.8 $\Rightarrow$ molar mass $= 2 \times 94.8 = 189.6$ gm

$\Rightarrow$ mass of chlorine = 74.75% of 189.6 = 141.726 gm

$\Rightarrow$ mole of Cl $= \dfrac{141.726}{35.5} = 4$

$\Rightarrow$ Formed of metal chloride will be MCl_4.

$\Rightarrow$ Correct option is (2)

6. $n_{O_3} \longrightarrow \dfrac{16}{48} = \dfrac{1}{3}$ mole

$n_{CO} \longrightarrow \dfrac{28}{28} \sim 1$ mole

$n_{O_2} \longrightarrow \dfrac{16}{32} = \dfrac{1}{2}$ mole

$\Rightarrow$ Ratio of oxygen atoms = 1 : 1 : 1

$\Rightarrow$ Correct option is (D)

7. $C_xH_y + \left(x+\frac{y}{4}\right) O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$

$n_{CO_2} \rightarrow \frac{3.08}{44} = 0.07$

$n_{H_2O} \rightarrow \frac{.72}{18} = 0.04$

$\therefore$ C : H = 0.07 : 0.04 = 7 : 8

$\Rightarrow$ The empirical formula of compounds is (C_7H_8)

$\Rightarrow$ Correct option is (4)

8.

	0		N
ratio of masses $\longrightarrow$	1	:	4
ratio of mole $\longrightarrow$	$\frac{1}{16}$	:	$\frac{4}{14}$
ratio of molecules $\longrightarrow$	$\frac{N_A}{16}$	:	$\frac{4N_A}{14}$

$\Rightarrow$ Ratio of number of molecules = 7 : 32

$\Rightarrow$ Correct option is (D)

9. $2C_8H_7SO_3Na + Ca^{+2} \longrightarrow Ca(C_8H_7SO_3)_2 + 2Na^+$

mole : $\frac{1}{206}$

$\Rightarrow$ maximum uptake of Ca^{+2} ions = $\frac{1}{412}$

$\Rightarrow$ Correct option is (4).

10. By carius method,

$$\% \text{ Br} = \frac{80 \times \text{weight of AgBr}}{188 \times \text{Weight of organic Halide}} \times 100$$

$$= \frac{80}{188} = \frac{141 \times 10^{-3}}{250 \times 10^{-3}} \times 100 = 24$$

$\Rightarrow$ Correct option is (1)

11. $100\text{ kg} \longrightarrow (10\text{kg}\ ^1H)$

$\downarrow$

$(20\text{kg}\ ^2H)$

$\Delta W = 10$ kg

$\Rightarrow$ weight gain is 10% of 75 kg i.e. 7.5 kg

$\Rightarrow$ Correct option is (3)

12. $M_2CO_3 + \underset{(excess)}{2HCl} \longrightarrow 2MCl + CO_2 + H_2$

$n_{CO_2} \longrightarrow 0.01186$

1 mole CO_2 is produced by 1 mole M_2CO_3

$\Rightarrow$ 0.01186 mole CO_2 is produced by $\left(\frac{1 \times 0.01186}{1}\right)$ mole M_2CO_3

$\Rightarrow$ $\frac{1}{M_{(M_2CO_3)}} = 0.01186$

$\Rightarrow$ $M_{M_2CO_3} = \frac{1}{0.01186} = 84.3$ gm $\Rightarrow$ Correct option is (2)

13.

Element	C	:	H
Mass ratio	6	:	1
Mole ratio	1	:	2

So, empirical formula : CH_2

For buring CH_2 unit ; oxygen required is $\frac{3}{2}$ mole

$\Rightarrow$ Empirical formula is $(CH_2O_{3/2})$ i.e. $C_2H_4O_3$

$\Rightarrow$ Correct option is (1)

14. Moles of $C_{57}H_{110}O_6$ $= \frac{445}{890} = 0.5$ moles

From 2 moles of $C_{57}H_{110}O_6 \longrightarrow 110$ moles of H_2O is produced

0.5 moles of $C_{57}H_{110}O_6 \longrightarrow 110 \times \frac{0.5}{2}$ moles H_2O

$\Rightarrow 27.5$ moles

Mass of H_2O $= 27.5 \times 18$ gram

$= 495$ gram

15. $2\ NaHCO_3 + H_2C_2O_4 \longrightarrow Na_2C_2O_4 + 2CO_2 + 2H_2O$

Moles of CO_2 $= \frac{0.25 \times 10^{-3}}{25}$

$= 10^{-5}$ moles

Moles of $NaHCO_3$ $= \frac{2}{2} \times 10^{-5} = 10^{-5}$

wt. of $NaHCO_3$ $= 10^{-5} \times 84$

% Mass $= \frac{84 \times 10^{-5}}{10 \times 10^{-3}} \times 100 = 8.4\%$

16. $C_x H_y N_z \xrightarrow[\text{Method}]{\text{Duma}} 6CO_2 + 4H_2O + N_2$

Clearly,

$x = 6$

$y = 8$

$z = 2$

Hence $C_6H_8N_2$

17. Methane $\underset{1 \text{ mole}}{CH_4}$ → 1 mole C; 4 mole H

% mole of C $= \frac{1}{1+4} \times 100$

18. $N_2 + 3H_2 \longrightarrow 2NH_3$

Option B

56 gm N_2 = 2 moles

10 gm H_2 = 5 moles

Clearly H_2 is limiting

19. (1) $4\,Fe + 3O_2 \longrightarrow 2\,Fe_2O_3$

4×56 gm $\quad 3\times32$ gm

1 gm $\quad \frac{3\times32}{4\times56} = \frac{3}{7}$ gram

(2) $C_3H_8 + SO_2 \longrightarrow 3CO_2 + 4H_2O$

44 g $\quad$ 80 gm

1 gram $\quad \frac{80}{44} = \frac{20}{11}$ gram

(3) $2Mg + O_2 \longrightarrow 2MgO_2$

$2\times24 \quad 32$

1 gram $\quad \frac{32}{2\times24} = \frac{2}{3}$ gram

(4) $P_4 + SO_2 \longrightarrow P_4O_{10}$

$4\times31 \quad 5\times16$

1 gram $\quad \frac{80}{124} = \frac{20}{31}$ gram

Ans. (1)

20. Mass of 1 mol of $AB_2 = M_A + 2M_B = 25 \times 10^{-3}$ kg

Mass of 1 mol of $A_2B_2 = 2M_A + 2M_B = 30 \times 10^{-3}$ kg

$M_A = 5 \times 10^{-3}$ kg / mol

$M_B = 10 \times 10^{-3}$ kg / mol

21. $C_xH_4 \quad + \quad \left(x + \frac{4}{4}\right)O_2 \longrightarrow x / O_2 \quad + \quad \frac{y}{2}H_2O$

$\frac{25}{M} \qquad \frac{88}{44} = 2 \qquad \frac{9}{18} = \frac{1}{2}$ moles

Moles of $CO_2 = \frac{25}{M} \times x = 2$

Moles of $H_2O = \frac{25}{M} \times \frac{y}{2} = \frac{1}{2}$

$\frac{x}{y} = 2 \Rightarrow x = 2y$

E.F. $= C_{z_y} H_y$

Also $\underset{\text{gm Carbon}}{2y \times 12} + \underset{\text{gram H}}{y} \Rightarrow 24 : 1$

22. $C_xH_y \quad + \quad \left(x + \frac{y}{4}\right)O_2 \longrightarrow x\,CO_2 \quad + \quad \frac{y}{2}H_2O$

10 ml 55 ml

40 ml

For gases, volume is proportional to moles

$\frac{10}{55} = \frac{1}{x + \frac{4}{4}}$ .... (1)

$\frac{1}{x} = \frac{10}{40}$ .... (2)

$x = 4$

$y = 6$

C_4H_6

EXERCISE # JEE-ADVANCED

1. Mass of 1 e^- = 9.1×10^{-31} kg

$\Rightarrow$ moles of e^- weighing 1 kg = $\dfrac{1}{9.108\times10^{-31}}\times\dfrac{1}{N_A} = \dfrac{1}{9.108\times6.023}\times10^{8}$

$\Rightarrow$ Correct option is (D)

2. $6CaO + P_4O_{10} \longrightarrow 2Ca_3(PO_4)_2$

$nP_4O_{10} \longrightarrow \dfrac{852}{284} = 3$ mole

1 mole P_4O_{10} reacts with 6 mole CaO

$\Rightarrow$ 3 mole P_4O_{10} reacts with 18 mole CaO or 18×56 CaO

i.e. 1008g CaO.

3. Atomic mass of Fe = $\dfrac{54\times5+56\times90+57\times5}{100} = 55.95$

$\Rightarrow$ Correct option is (B)