MOLE CONCEPT AND STOICHIOMETRY

Assignment Sheet

STEP UP ANSWERSHEET

35. (i) $2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$

2 vol. 13 vol.

2 vol.of butane require 13 vol.of oxygen (according to Gay Lussac's Law)

$\therefore$ 90 dm^3 of butane require = $\frac{13 \times 90}{2}$ = 585 dm^3

Ans. 585 dm^3 of oxygen is required.

(ii) Given (Vapour Density) VD = 8

$\therefore$ Mol.wt = 2 × VD = 2 × 8 = 16

No. of moles in 24.0 g of gas = $\frac{\text{wt}}{\text{mol. wt}} = \frac{24}{16}$

= 1. 5 moles

At STP 1 mole of a gas occupies 22.4 *l*.

$\therefore$ 1.5 moles of the gas will occupy = $\frac{22.4 \times 1.5}{1}$ = 33.6 *l*

(iii) 'X' number of molecules. **[2013]**

36. (i) 3rd period, 16th group.
(ii) Z is a non-metal
(iii) H_2Z **[2014]**

37. Vapour density

[2014]

38. Given : $2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$

2 vol. 4 vol.

$\therefore$ 1 vol. 2 vol.

According to Gay Lussac's law :

2 volume of CO_2 is produced from 1 vol. of C_2H_2

$\therefore$ 8.4dm^3 of CO_2 at S.T.P. is produced from

$$= \frac{1 \times 8.4}{2}$$

= 4.2 dm^3 of C_2H_2

Ans. At S.T.P. 4.2 dm^3 of ethyne is required. **[2014]**

39. (i) Avogadro's Law : "Under the same conditions of temperature and pressure equal volumes of all gases contain the same number of molecules".

(ii) 1. Molecular weight of NH_3 = (14 + 3 × 1) = 17g
17g of NH_3 at s.t.p. occupies a volume of 22.4dm^3

So 68g of NH_3 at s.t.p. occupies a volume of $\frac{22.4 \times 68}{17}$

= 89.6 dm^3

2. Number of moles of NH_3 in 68 g = $\frac{\text{wt.}}{\text{mol. wt.}}$

$= \frac{68}{17} = 4$ moles

3. No. of molecules present = 4 × 6.023 × 10^{23}

[2014]

40. (D) 6.02 × 10^{23} atoms of carbon **[2015]**

41. (i) 32 gm of sulphur contain = 6.023 × 10^{23} atoms

y 3.2 gm of sulphur contain = $\frac{6.023 \times 10^{23}}{32}$ × 3.2 = 6.023 × 10^{22} atoms

Now, 6.023 × 10^{23} atoms of calcium have mass = 40 g

y 6.023 × 10^{22} atoms of calcium have mass = $\frac{40}{6.023 \times 10^{23}}$ × 6.023 × 10^{22}

= 4 g

Hence, the mass of calcium is 4 g.

(ii) $H_2 + Cl_2 \longrightarrow 2HCl$

1 vol 1 vol 2 vols

Since, 1 volume of chlorine reacts with 1 volume of hydrogen,
y 4 litres of chlorine will react with only 4 volumes of hydrogen
y (6 – 4) i.e., 2 litres of hydrogen will remain unreacted.
HCl formed will get dissolved in water.
y Volume of residual gas hydrogen is 2 litres.

(iii) Given,
Empirical formula = CH
Now, Empirical formula mass = 12 × 1 + 1 × 1 = 13
Molecular mass = 2 × vapour density = 2 × 13 = 26
Molecular mass = n × Empirical formula mass

$$n = \frac{\text{Molecular formula mass}}{\text{Empirical formula mass}} = \frac{26}{13} = 2$$

Molecular formula = n × Empirical formula = 2 (CH) = C_2H_2
Hence, the molecular formula of the compound is C_2H_2. **[2015]**

42. $(NH_4)_2Cr_2O_7 \xrightarrow{\text{heat}} N_2(g) + 4H_2O(g) + Cr_2O_3$

$2 \times (14 + 4) + (52 \times 2) + 16 \times 7 = 252$ $(2 \times 52) + (16 \times 3) = 104 + 48 = 152$

(i) 252 gm of $(NH_4)_2\ Cr_2O_7$ = 1 mole

y 63 gm $(NH_4)_2Cr_2O_7 = \frac{63}{252} = 0.25$ mole

Hence, 0.25 mole of $(NH_4)_2Cr_2O_7$ is heated

(ii) From the chemical equation
1 mole of $(NH_4)_2Cr_2O_7$ liberates 1 mole of N_2
y 0.25 mole of $(NH_4)_2Cr_2O_7$ liberates is 0.25 moles of N_2

(iii) Volume of 1 mole of N_2 at S.T.P. is 22.4 *l*.
y 0.25 volume of 1 mole of N_2 at S.T.P. is $22.4 \times 0.25 = 5.6$ *l*.

(iv) 252 g of $(NH_4)_2Cr_2O_3$ forms is 38 g of Cr_2O_3.
$(NH_4)_2Cr_2O_7 \xrightarrow{\text{heat}} N_2(g) + 4H_2O(g) + Cr_2O_3$ **[2015]**

43. (i) Given,
20 *l* of a gas at STP = 32g

∴ 1 *l* of gas at STP would be = $\frac{32}{20}$ g

a we know that

A gas at STP has volume = 22.4 *l*

∴ Gram molecular weight of the gas = $\frac{32}{20} \times 22.4 = 35.84$ g

(ii) $2Ca(NO_3)_2 \longrightarrow 2CaO + 4NO_2 + O_2$

$2 \times (164)g \longrightarrow 2(56)g$

From the above given chemical reaction

328 g of $Ca(NO_3)_2$ decomposes to form 112 g of CaO

∴ 82 g of Ca $(NO_3)_2$ will decompose = $\frac{112}{328} \times 82 = 28$ g of CaO

329 g of $Ca(NO_3)_2$ gives 4×22.4 vol. of NO_2

∴ 82 g of $Ca(NO_3)_2$ gives = $\frac{4 \times 22.4 \times 82}{328} = 22.4l$

82 g of Ca $(NO_3)_2$ evolves = 22.4*l* of NO_2. **[2016]**

44. (i) The mass of 6×10^{23} molecules of O_2 is 32 g

y The mass of 12×10^{24} molecules = $\frac{12 \times 10^{24} \times 32}{6 \times 10^{23}} = 640$ g

(ii) Volume of 6×10^{23} molecules of $O_2 = 22.4\ l$

y Volume of 12×10^{24} molecules of $O_2 = \dfrac{22.4 \times 12 \times 10^{24}}{6 \times 10^{23}} = 448\ l$

[2016]

45.

Element	% composition	At. Wt.	Relative No. of atoms	Simplest ratio
C	82.76	12	$\frac{82.76}{12} = 6.89$	$\frac{6.89}{6.89} = 1 \times 2 = 2$
H	17.24	1	$\frac{17.24}{1} = 17.24$	$\frac{17.24}{6.89} = 2.5 \times 2 = 5$

y Empirical formula = C_2H_5

Empirical formula mass = $(12 \times 2) + (1 \times 5)$

= $24 + 5 = 29$

Vapour density $\longrightarrow$ 29

Molecular mass = V.D × 2 = 29×2

= 58 gm

Molecular formula mass = n × Empirical formula mass

$$n = \frac{\text{Molecular Formula mass}}{\text{Empirical Formula mass}}$$

$$= \frac{58}{29}$$

n × Empirical formula = Molecular formula

Molecular formula = $2 \times C_2H_5$

= C_4H_{10}

[2016]

46. $\cdot\cdot\cdot_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

Given : Ammonia used = 100 cm^3

in the reaction,

From the equation 4 vols. of NH_3 requires 5 vols. of O_2 for its oxidation.

y 1 vol. will require = $\frac{5}{4}$

Thus 100 cm^3 of ammonia will require = $\frac{5}{4} \times 100 = 125$ cm^3 of oxygen

[2016]

47. (i) For every 5 moles of O_2, 1 mole of propane is burnt.
20% of air contains oxygen.
20% of 1000 = 20 × 1000/100 = 200 cm^3 of O_2.
$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
$\therefore$ 1vol. : 5vol. $\rightarrow$ 3vol. : 4vol. According to Lussac's Law
Thus, Volume of propane = 40 cm^3

(ii) Mass of gas = 24 g
Volume of gas= 11.6 litres
22.4 L of gas at STP = 1 mole
11.2 L of gas at STP = 11.2 / 22.4 = 0.5 moles
Mass of 0.5 moles of gas = 24 g
Mass of 1 mole of gas or molar mass = 24/0.5 = 48 g

[2017]

48. (i) 1 kg = 1000 grams
2g of hydrogen molecules = 1 mole
1g of hydrogen molecules = 1/2 mole
$\therefore$ 1000 g of hydrogen molecules = 1/2 × 1000 = 500 moles

(ii) Molecular weight of Carbon dioxide = 44 g
Vapour density = 44/2 = 22

$$\text{Vapour density} = \frac{\text{Wt. of a certain volume of gas i.e } CO_2}{\text{Wt. of the same volume of } H_2 \text{ [same condition]}}$$

(iii) If the number of molecules of hydrogen is X, then number of molecules of carbon dioxide will also be X.

(iv) This is according to the Avogadro's Law which states that " under similar conditions of temperature and pressure equal volumes of all gases contain the same number of molecules."

49. (i) Mass of sodium = 4.6g.
Relative atomic mass of sodium = 23g.

$$\text{Gram atoms} = \frac{\text{Mass in grams}}{\text{Relative atomic mass [At.wt.]}}$$

$$= \frac{4.6}{23}$$

$$= 0.2 \text{ g atoms}$$

4.6 grams of sodium has 0.2 gram atoms

[2017]

(ii) Percentage composition

$$= \frac{\text{w.t. of the element in one molecule of the compound}}{\text{Gram molecular weight of the compound}} \times 100$$

Molecular weight of $CuSO_4.5H_2O$ = 250 g

Weight of $5H_2O$ = 90g

i.e 250 g of $CuSO_4.5H_2O$ contains 90 g of water of crystallization

y % composition of water of crystallization $= \frac{90 \times 100}{250}$

$= 36\%$

36 % of water of crystallization.

(iii) Molecular weight = 2 × vapour density

= 2 × empirical formula weight

(Vapour density = empirical formula weight)

Also, Molecular Weight = Empirical formula weight × *n*

y 2 × empirical formula weight = Empirical formula weight × *n*

y n = 2

Therefore,

Molecular Formula = (Empirical Formula) × *n*

$= (XY_2)_2$

$= X_2Y_4$ **[2017]**