

Chapter-1 : Some Basic Concepts of Chemistry

1. (c) According to Avogadro's law "equal volumes of all gases contain equal number of molecules under similar conditions of temperature and pressure". Thus if 1 L of a gas contains N molecules, 2 L of any other gas under the same conditions of temperature and pressure will contain 2N molecules.
2. (d) In CuO and Cu₂O the O : Cu is 1 : 1 and 1 : 2 respectively. This is law of multiple proportion.
3. (d) Round off the digit at 2nd position of decimal 3.929 = 3.93.
4. (b) Suppose weight of metallic chloride = 100 g
Then weight of metal = 47.22 g
Weight of chlorine = 100 - 47.22 = 52.78 g
$$\therefore \text{Equivalent weight of metal} = \frac{47.22}{52.78} \times 35.5 = 31.76$$
5. (d) Molecular weight of ZnSO₄·7H₂O
= 65 + 32 + (4 × 16) + 7(2 × 1 + 16) = 287 g
$$\therefore \text{percentage mass of zinc (Zn)} = \frac{65}{287} \times 100 = 22.65\%$$
6. (b) From the molarity equation.
 $M_1V_1 + M_2V_2 = M_3V_3$
Let M₃ be the molarity of final mixture,
$$M_3 = \frac{M_1V_1 + M_2V_2}{V_3} \text{ where } V_3 = V_1 + V_2$$

$$M_3 = \frac{480 \times 1.5 + 520 \times 1.2}{480 + 520} = 1.344 \text{ M}$$
7. (b) Given N₁ = 10N, V₁ = 10 mL, N₂ = 0.1N, V₂ = ?
N₁V₁ = N₂V₂
or 10 × 10 = 0.1 × V₂
or $V_2 = \frac{10 \times 10}{0.1}, V_2 = 1000 \text{ mL}$
Volume of water to be added
= V₂ - V₁ = 1000 - 10 = 990 mL.
8. (b) M₁V₁ = M₂V₂
0.5 × 100 = 0.1 × V₂
V₂ = 500 cm³
Volume of water to be added to 100 cm³ of solution
= 500 - 100 = 400 cm³
9. (b) Molarity of a mixture of solution of same substance is given by
$$M_1V_1 + M_2V_2 + M_3V_3 + \dots = M(V_1 + V_2 + V_3)$$

(1st soln) (2nd soln) (3rd soln) (mixture)
10. (a) Choice (a) is P₄S₃
124 g of P is present in 220 g of P₄S₃ (31 × 4)
$$\therefore 1.24 \text{ g of P is present in} = \frac{220}{124} \times 1.24 = 2.2 \text{ g}$$
11. (a) Fe (no. of moles) = $\frac{558.5}{55.85} = 10 \text{ moles} = 10N_A \text{ atoms.}$
No. of moles in 60 g of C = 60/12 = 5 moles = 5N_A atoms.
12. (d) At S.T.P. 22.4 litre of gas contains 6.023 × 10²³ molecules
$$\therefore \text{molecules in 8.96 litre of gas} = \frac{6.023 \times 10^{23} \times 8.96}{22.4} \approx 24.1 \times 10^{22}$$
13. (c) Number of molecules of gas at STP
$$= \frac{6.023 \times 10^{23} \times 2.8}{22.4} = 7.5 \times 10^{22} \text{ molecules}$$

Number of atoms in diatomic molecule
= 2 × 7.5 × 10²²
= 15 × 10²² atoms
14. (c) $\therefore 100 \text{ g CaCO}_3 = 6.023 \times 10^{23} \text{ molecules}$
$$\therefore 10 \text{ g CaCO}_3 = \frac{6.023 \times 10^{23}}{100} \times 10 = 6.023 \times 10^{22} \text{ molecule}$$

1 molecule of CaCO₃ = 50 protons
6.023 × 10²² molecule of CaCO₃ = 50 × 6.023 × 10²²
= 3.0115 × 10²⁴
15. (c) 50% of X (Atomic mass 10), 50% of Y (Atomic mass 20).
Relative number of atoms of X = $\frac{50}{10} = 5$ and
Y = $\frac{50}{20} = 2.5$
Simple Ratio 2 : 1
Formula X₂Y
16. (b) $2\text{Al} + \frac{3}{2}\text{O}_2 \rightarrow \text{Al}_2\text{O}_3$
According to equation, $\frac{3}{2}$ mole of O₂ combines with 2 mole Al.
2 mole Al = 54 g
17. (a) A₃(BC₄)₂ = 3 × 2 + 2 [5 + (-2 × 4)] = 0.
18. (a) N³⁻ = 10e⁻
4.2 g of N³⁻ ions have = $\frac{10 N_A}{14} \times 4.2 = 3 N_A$

19. (d) $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$
 2 vol 1 vol 2 vol
 1 vol of O_2 reacts with 2 vol of CO
 1 L of O_2 reacts with 2 L of CO
 CO left after reaction = $3 - 2 = 1$ L
 1 L of O_2 produces 2 L of CO_2 .
 Hence, after the reaction, CO = 1 L, CO_2 = 2 L

20. (c) $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
 Equivalent weight of $\text{K}_2\text{Cr}_2\text{O}_7$

$$= \frac{\text{Molecular Mass}}{6} = \frac{294.2}{6} = \frac{M}{6}$$

21. (a) Mass of one atom of oxygen = $\frac{16}{6.023 \times 10^{23}}$
 $= 2.66 \times 10^{-23} \text{ g}$

$$\text{Mass of one atom of nitrogen} = \frac{14}{6.023 \times 10^{23}}$$

$$= 2.32 \times 10^{-23} \text{ g}$$

$$\text{Mass of } 1 \times 10^{-10} \text{ mole of oxygen} = 16 \times 10^{-10} \text{ g}$$

$$\text{Mass of } 1 \times 10^{-10} \text{ mole of copper} = 63 \times 1 \times 10^{-10}$$

$$= 63 \times 10^{-10} \text{ g}$$

22. (b) Equivalent weight = $\frac{\text{Mass of metal} \times 11200}{\text{Volume in mL of hydrogen}}$

$$\text{Given, mass of metal} = 0.32 \text{ g}$$

$$\text{Volume of hydrogen at NTP} = 112 \text{ mL}$$

$$\text{Equivalent weight} = \frac{0.32 \times 11200}{112} = 32 \text{ g}$$

23. (c) Number of moles of A = $\frac{x}{40}$
 Number of atoms of A = $\frac{x}{40} \times \text{Avogadro no.} = y$ (say)
 Or $x = \frac{40y}{\text{Avogadro no.}}$

$$\text{Number of moles of B} = \frac{2x}{80}$$

$$\text{Number of atoms of B}$$

$$= \frac{2x}{80} \times \text{Av. no.} = \frac{2}{80} \times \frac{40y}{\text{Av. no.}} \times \text{Av. no.} = y$$

24. (a) No. of molecules in different cases

- (a) \therefore 22.4 litre at STP contains

$$6.023 \times 10^{23} \text{ molecules of } \text{H}_2$$

$$\therefore 15 \text{ litre at STP contains} = \frac{15}{22.4} \times 6.023 \times 10^{23}$$

$$= 4.03 \times 10^{23} \text{ molecules of } \text{H}_2$$

- (b) \therefore 22.4 litre at STP contains

$$6.023 \times 10^{23} \text{ molecules of } \text{N}_2$$

$$\therefore 5 \text{ litre at STP contains} = \frac{5}{22.4} \times 6.023 \times 10^{23}$$

$$= 1.344 \times 10^{23} \text{ molecules of } \text{N}_2$$

- (c) $\therefore 2 \text{ g of } \text{H}_2 = 6.023 \times 10^{23} \text{ molecules of } \text{H}_2$

$$\therefore 0.5 \text{ g of } \text{H}_2 = \frac{0.5}{2} \times 6.023 \times 10^{23}$$

$$= 1.505 \times 10^{23} \text{ molecules of } \text{H}_2$$

- (d) Similarly 10 g of O_2 gas

$$= \frac{10}{32} \times 6.023 \times 10^{23} \text{ molecules of } \text{O}_2$$

$$= 1.88 \times 10^{23} \text{ molecules of } \text{O}_2$$

Thus (a) will have maximum number of molecules

25. (a) One molecule of sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) = 45 atoms

$$\text{Number of moles of sugar} = \frac{1000}{342} = 2.92$$

$$\text{Number of molecules} = 2.92 \times 6.023 \times 10^{23}$$

$$= 17.60 \times 10^{23} \text{ molecules}$$

$$\text{Number of atoms} = 45 \times 17.60 \times 10^{23}$$

$$= 7.92 \times 10^{25} \text{ atoms}$$

26. (b) 1 mol = 6.023×10^{23} atoms/molecules
 1 mol = Molar volume = 22.4 L at NTP

$$1 \text{ mol} = \text{Gram atomic mass or gram molecular mass}$$

27. (c) 22400 mL of water contains = 6.023×10^{23} molecules

$$1 \text{ mL of water contains} = \frac{6.023 \times 10^{23}}{22400} \text{ molecules}$$

$$= 20 \text{ drops (given)}$$

$$\therefore 1 \text{ drop of water will contain} = \frac{6.023 \times 10^{23}}{22400 \times 20}$$

$$= 1.344 \times 10^{18} \text{ molecules.}$$

28. (c) (a) Moles = given wt./molecular wt.
 Weight of H_2 = mole \times molecular wt.
 $= 0.2 \times 2 = 0.4 \text{ g}$

- (b) 6.023×10^{23} represents 1 mole
 Thus 6.023×10^{22} will represent in 0.1 mole
 Weight of $\text{N}_2 = 0.1 \times 28 = 2.8 \text{ g}$

- (c) Weight of silver = 0.1 g

- (d) Weight of oxygen = $32 \times 0.1 = 3.2 \text{ g}$
 Thus, 0.1 g silver is the lightest.

29. (c) 58.5 g of NaCl contains 6.023×10^{23} molecules.
 10 g will contain 1.03×10^{23} molecules of NaCl.
 Since it contains 95% NaCl, so, total number of molecules

$$= \frac{95}{100} \times 1.03 \times 10^{23} = 0.98 \times 10^{23} \text{ or } 10^{23}.$$

30. (d) $2\text{C}_6\text{H}_6 + 15\text{O}_2(\text{g}) \rightarrow 12\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
 2(78) 15(32)

$$\therefore 156 \text{ g of benzene required oxygen} = 15 \times 22.4 \text{ L}$$

$$\therefore 1 \text{ g of benzene required oxygen} = \frac{15 \times 22.4}{156} \text{ L}$$

$$\therefore 39 \text{ g of benzene required oxygen}$$

$$= \frac{15 \times 22.4 \times 39}{156} = 84.0 \text{ L}$$

31. (c) According to stoichiometry they should react as follow
 $4\text{NH}_3 + 5\text{O}_2 \longrightarrow 4\text{NO} + 6\text{H}_2\text{O}$
 4 mole of NH_3 requires 5 mole of O_2 .
 1 mole of NH_3 requires $= \frac{5}{4} = 1.25$ mole of O_2 .
 Hence O_2 is consumed completely.

32. (c)

Element	%	Relative no. of atoms	Simplest ratio of atoms
C	49.3	$49.3/12 = 4.1$	$4.1/2.74 = 1.5$ $1.5 \times 2 = 3$
H	6.84	$6.84/1 = 6.84$	$6.84/2.74 = 2.5$ $= 2.5 \times 2 = 5$
O	43.86	$43.86/16 = 2.74$	$2.74/2.74 = 1$ $1 \times 2 = 2$

\therefore Empirical formula = $\text{C}_3\text{H}_5\text{O}_2$

Empirical formula mass

$$= (3 \times 12) + (5 \times 1) + (2 \times 16) = 36 + 5 + 32 = 73$$

Molecular mass = $2 \times$ Vapour density

$$= 2 \times 73 = 146$$

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = 146/73 = 2$$

Molecular formula = Empirical formula $\times 2$

$$= (\text{C}_3\text{H}_5\text{O}_2) \times 2 = \text{C}_6\text{H}_{10}\text{O}_4$$

33. (a) $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
 1 vol. 3 vol. 2 vol. 3 vol.
 1 mol. 3 mol. 2 mol. 3 mol.
 (\therefore vol% = mol%)

One gram mol of any gas occupies 22.4 litre at NTP.

1 mol of Fe_2O_3 requires 3 mol of CO for its reduction
 i.e., 1 mol of Fe_2O_3 requires 3×22.4 litre or 67.2 dm^3 CO to get itself reduced.

34. (b) $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
 2 g 71 g 73 g

2 g of H_2 reacts with 71 g of Cl_2

$$100 \text{ g of } \text{H}_2 \text{ will react with } \frac{71}{2} \times 100 = 3550 \text{ g of } \text{Cl}_2$$

Hence, Cl_2 is the limiting reagent.

71 g of Cl_2 produces 73 g of HCl

$$100 \text{ g of } \text{Cl}_2 \text{ will produce } \frac{73}{71} \times 100 = 102.8 \text{ g of HCl}$$

35. (b) $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
 t = 0 20 mL 40 mL
 t = t 0 20 mL solid

Final volume = 20 mL.

36. (d) $2\text{NaHCO}_3 \xrightarrow{150^\circ\text{C}} \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$

$$\frac{n_{\text{NaHCO}_3}}{n_{\text{CO}_2}} = \frac{2}{1}$$

$$n_{\text{NaHCO}_3} = 2n_{\text{CO}_2}$$

$$= 2 \times \frac{112}{22400} = 0.01 \text{ mol}$$

$$W_{\text{NaHCO}_3} = 0.01 \times 84 = 0.84 \text{ g}$$

$$W_{\text{Na}_2\text{CO}_3} = 1.00 - 0.84 = 0.16 \text{ g}$$

$$\% \text{Na}_2\text{CO}_3 = 16.$$

37. (c) 5 L water = $5 \times 10^3 \text{ g} = 5 \times 10^6 \text{ mg}$
 $5 \times 10^6 \text{ mg}$ water contains 25 mg CaCO_3
 \therefore 10⁶ mg water contains 5 mg CaCO_3
 \therefore Concentration is 5 ppm.

38. (b) Number of moles of $\text{O}_2 = \frac{w}{32}$
 Number of moles of $\text{N}_2 = \frac{4w}{28} = \frac{w}{7}$
 \therefore Ratio = $\frac{w}{32} : \frac{w}{7} = 7 : 32$

39. (c) $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
 1 vol. 3 vol. 2 vol.
 10 L 30 L 20 L

It is given that only 50% of the expected product is formed hence only 10 litre of NH_3 is formed

$$\text{N}_2 \text{ used} = 5 \text{ L, left} = 30 - 5 = 25 \text{ L}$$

$$\text{H}_2 \text{ used} = 15 \text{ L, left} = 30 - 15 = 15 \text{ L}$$

40. (c) 1 mole of $(\text{NH}_4)_2\text{HPO}_4$ would give $\frac{1}{2}$ mole of P_2O_5



$$2(36+1+31+64)=264 \quad 62+80=142$$

$$\% \text{ of } \text{P}_2\text{O}_5 = \frac{\text{wt. of } \text{P}_2\text{O}_5}{\text{wt. of salt}} \times 100$$

$$= \frac{142}{264} \times 100 = 53.78\%$$

41. (c) Density = $\frac{\text{Mass}}{\text{Volume}}$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{1 \text{ gram}}{1 \text{ gram cm}^{-3}} = 1 \text{ cm}^3$$

$$\therefore \text{Volume occupied by 1 gram water} = 1 \text{ cm}^3$$

$$\text{or Volume occupied by } \frac{6.023 \times 10^{23}}{18} \text{ molecules of}$$

$$\text{water} = 1 \text{ cm}^3$$

$$[\therefore 1 \text{ g water} = \frac{1}{18} \text{ moles of water}]$$

Thus volume occupied by 1 molecule of water

$$= \frac{1 \times 18}{6.023 \times 10^{23}} \text{ cm}^3 = 3.0 \times 10^{-23} \text{ cm}^3.$$

i.e. the correct answer is option (c).

42. (a) $2\text{Al}(\text{s}) + 6\text{HCl}(\text{aq}) \rightarrow 2\text{Al}^{3+}(\text{aq}) + 6\text{Cl}^{-}(\text{aq}) + 3\text{H}_2(\text{g})$

\therefore 6 moles of HCl produces 3 moles of H_2

3 moles of $\text{H}_2 = 3 \times 22.4 \text{ L of } \text{H}_2 \text{ at S.T.P}$

$$\therefore 1 \text{ mole of HCl produces } \frac{3 \times 22.4}{6} \text{ L of } \text{H}_2 \text{ at S.T.P}$$

$$= 11.2 \text{ L of } \text{H}_2 \text{ at STP}$$

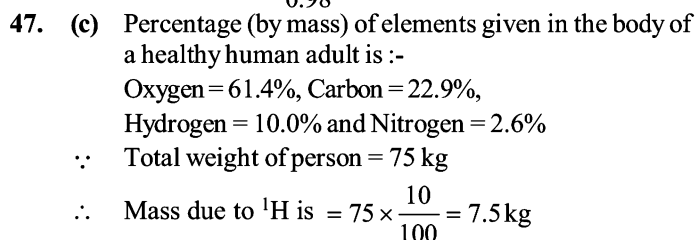
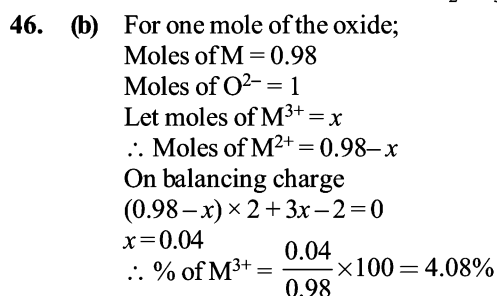
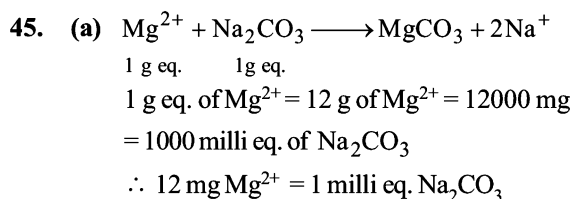
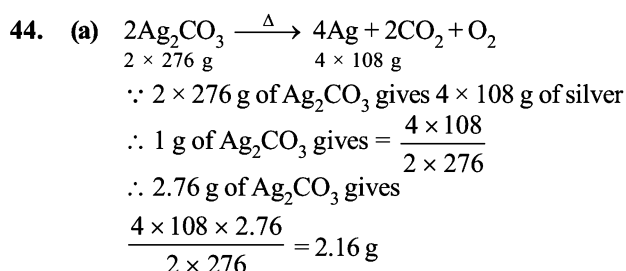
43. (d) Molecular weight of $(\text{CHCOO})_2\text{Fe} = 170$

Fe present in 100 mg of $(\text{CHCOO})_2\text{Fe}$

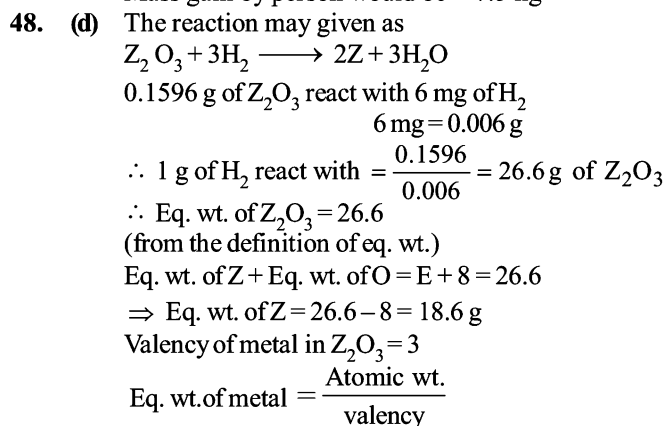
$$= \frac{56}{170} \times 100 \text{ mg} = 32.9 \text{ mg}$$

This is present in 400 mg of capsule

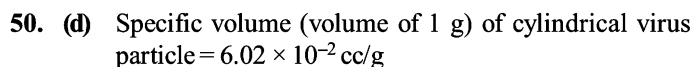
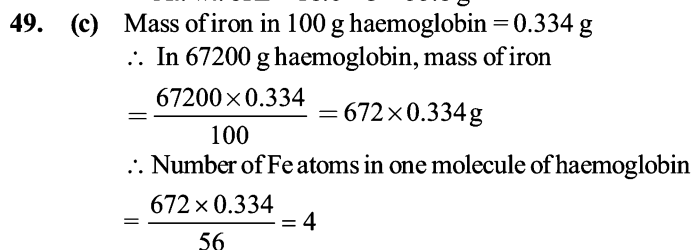
$$\% \text{ of Fe in capsule} = \frac{32.9}{400} \times 100 = 8.2 \approx 8$$



If ^1H atoms are replaced by ^2H atoms.
 Mass gain by person would be = 7.5 kg



$$\therefore \text{At. wt. of Z} = 18.6 \times 3 = 55.8 \text{ g}$$



$$\text{Radius of virus (r)} = 7 \text{ \AA} = 7 \times 10^{-8} \text{ cm}$$

$$\text{Length of virus} = 10 \times 10^{-8} \text{ cm}$$

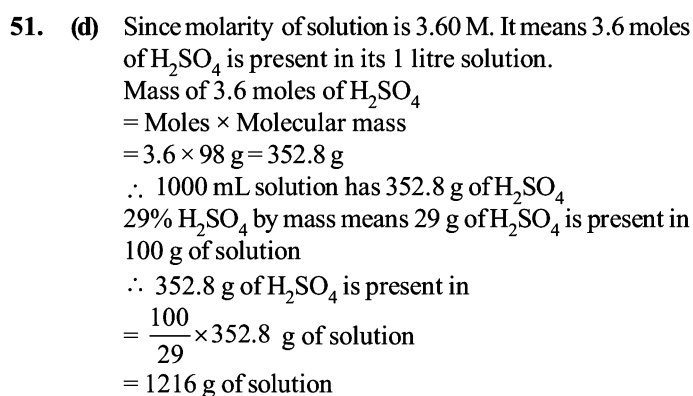
Volume of virus

$$\pi r^2 l = \frac{22}{7} \times (7 \times 10^{-8})^2 \times 10 \times 10^{-8} = 154 \times 10^{-23} \text{ cc}$$

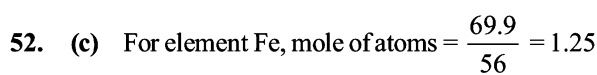
$$\text{Wt. of one virus particle} = \frac{\text{volume}}{\text{specific volume}}$$

$$\therefore \text{Mol. wt. of virus} = \text{Wt. of } N_A \text{ particle}$$

$$= \frac{154 \times 10^{-23}}{6.02 \times 10^{-2}} \times 6.02 \times 10^{23} = 15400 \text{ g/mol} = 15.4 \text{ kg/mol}$$



$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{1216}{1000} = 1.216 \text{ g/mL} = 1.22 \text{ g/mL}$$



$$\text{For element O, mole of atoms} = \frac{30.1}{16} = 1.88$$

$$\text{Mole ratio of Fe} = \frac{1.25}{1.25} = 1,$$

$$\text{Mole ratio of O} = \frac{1.88}{1.25} = 1.5$$

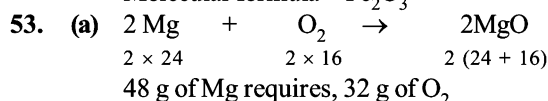
Simplest whole number ratio of Fe and O = 2, 3

Empirical formula of compound = Fe_2O_3

Molecular mass of $\text{Fe}_2\text{O}_3 = 160 \text{ g}$

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{160}{160} = 1$$

Molecular formula = Fe_2O_3



$$1 \text{ g of Mg requires, } \frac{32}{48} = 0.66 \text{ g of O}_2$$

Oxygen available = 0.5 g

Hence, O_2 is limiting reagent.

32 g of O_2 reacts with 48 g of Mg

$$0.5 \text{ g of O}_2 \text{ will react with } \frac{48}{32} \times 0.5 = 0.75 \text{ g of Mg}$$

$$\text{Excess of Mg} = (1.0 - 0.75) = 0.25 \text{ g}$$

54. (c) $M_2O_x \xrightarrow{\text{Reduction}} M$
 Eq. of M_2O_x = eq. of Metal

$$\frac{\text{Wt. of } M_2O_x}{\text{Eq. wt. of } M_2O_x} = \frac{\text{Wt. of Metal}}{\text{Eq. wt. of Metal}}$$

$$\frac{4}{2 \times 56 + x \times 16} = \frac{2.8}{56}$$

$$\frac{4}{2x} = \frac{2.8}{x}$$

On solving we get,

$$\Rightarrow \frac{4}{56 + 8x} = \frac{2.8}{56} \Rightarrow \frac{1}{14 + 2x} = \frac{1}{20} \Rightarrow 2x = 6 \Rightarrow x = 3$$

Hence, the oxide is M_2O_3 .

55. (a) Given equivalent weight of metal = 9 g
 Vapour density of metal chloride = 59.25
 \therefore molecular weight of metal chloride
 $= 2 \times V.D = 2 \times 59.25 = 118.5 \text{ g}$

\therefore valency of metal

$$= \frac{\text{molecular weight of metal chloride}}{\text{equivalent weight of metal } 35.5}$$

$$\text{Valency of metal} = \frac{118.5}{9 + 35.5} = \frac{118.5}{44.5} = 2.66$$

Therefore atomic weight of the metal

= equivalent weight \times valency

$$= 9 \times 2.66 = 23.9 \text{ g}$$