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 Cu_2O 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
$\therefore$ Equivalent weight of metal $= \frac{47.22}{52.78} \times 35.5 = 31.76$

5. **(d)** Molecular weight of $ZnSO_4.7H_2O$
$= 65 + 32 + (4 \times 16) + 7(2 \times 1 + 16) = 287$ g
$\therefore$ 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 M_3 be the molarity of final mixture,
$$M_3 = \frac{M_1V_1 + M_2V_2}{V_3} \quad \text{where } V_3 = V_1 + V_2$$
$$M_3 = \frac{480 \times 1.5 + 520 \times 1.2}{480 + 520} = 1.344 \text{ M}$$

7. **(b)** Given $N_1 = 10N, V_1 = 10$ mL, $N_2 = 0.1N, V_2 = ?$
$N_1V_1 = N_2V_2$
or $10 \times 10 = 0.1 \times V_2$
or $V_2 = \frac{10 \times 10}{0.1}$, $V_2 = 1000$ mL
Volume of water to be added
$= V_2 - V_1 = 1000 - 10 = 990$ mL.

8. **(b)** $M_1V_1 = M_2V_2$
$0.5 \times 100 = 0.1 \times V_2$
$V_2 = 500\ cm^3$
Volume of water to be added to 100 cm^3 of solution
$= 500 - 100 = 400\ cm^3$

9. **(b)** Molarity of a mixture of solution of same substance is given by
$M_1V_1 + M_2V_2 + M_3V_3 + ... = M(V_1 + V_2 + V_3)$
(1st soln) (2nd soln) (3rd soln) (mixture)

10. **(a)** Choice (a) is P_4S_3
124 g of P is present in 220 g of P_4S_3 (31 × 4)
$\therefore$ 1.24 g of P is present in $= \frac{220}{124} \times 1.24 = 2.2$ g

11. **(a)** Fe (no. of moles) $= \frac{558.5}{55.85} = 10$ moles $= 10N_A$ 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 6.023×10^{23} molecules
$\therefore$ 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
$= 2 \times 7.5 \times 10^{22}$
$= 15 \times 10^{22}$ atoms

14. **(c)** $\because$ 100 g $CaCO_3 = 6.023 \times 10^{23}$ molecules
$\therefore$ 10 g $CaCO_3 = \frac{6.023 \times 10^{23}}{100} \times 10$
$= 6.023 \times 10^{22}$ molecule
1 molecule of $CaCO_3$ = 50 protons
6.023×10^{22} molecule of $CaCO_3 = 50 \times 6.023 \times 10^{22}$
$= 3.0115 \times 10^{24}$

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 X_2Y

16. **(b)** $2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3$
According to equation, $\frac{3}{2}$ mole of O_2 combines with 2 mole Al.
2 mole Al = 54 g

17. **(a)** $A_3(BC_4)_2 = 3 \times 2 + 2[5 + (-2 \times 4)] = 0.$

18. **(a)** $N^{3-} = 10e^-$
4.2 g of N^{3-} ions have $= \frac{10\ N_A}{14} \times 4.2 = 3\ N_A$

19. (d) $2CO + O_2 \rightarrow 2CO_2$
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) $Cr_2O_7^{2-} + 14H^+ + 6e \rightarrow 2Cr^{3+} + 7H_2O$
Equivalent weight of $K_2Cr_2O_7$

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

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

Mass of one atom of nitrogen $= \frac{14}{6.023 \times 10^{23}}$
$= 2.32 \times 10^{-23}$ g

Mass of 1×10^{-10} mole of oxygen $= 16 \times 10^{-10}$ g
Mass of 1×10^{-10} mole of copper $= 63 \times 1 \times 10^{-10}$
$= 63 \times 10^{-10}$ g

22. (b) Equivalent weight $= \frac{\text{Mass of metal} \times 11200}{\text{Volume in mL of hydrogen}}$
Given, mass of metal = 0.32 g
Volume of hydrogen at NTP = 112 mL
Equivalent weight $= \frac{0.32 \times 11200}{112} = 32$ g

23. (c) Number of moles of A $= \frac{x}{40}$
Number of atoms of A $= \frac{x}{40} \times$ Avogadro no. = y (say)
Or $x = \frac{40y}{\text{Avogadro no.}}$
Number of moles of B $= \frac{2x}{80}$
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) ∵ 22.4 litre at STP contains
6.023×10^{23} molecules of H_2
∴ 15 litre at STP contains $= \frac{15}{22.4} \times 6.023 \times 10^{23}$
$= 4.03 \times 10^{23}$ molecules of H_2
(b) ∵ 22.4 litre at STP contains
6.023×10^{23} molecules of N_2
∵ 5 litre at STP contains $= \frac{5}{22.4} \times 6.023 \times 10^{23}$
$= 1.344 \times 10^{23}$ molecules of N_2
(c) ∵ 2 g of $H_2 = 6.023 \times 10^{23}$ molecules of H_2
∵ 0.5 g of $H_2 = \frac{0.5}{2} \times 6.023 \times 10^{23}$
$= 1.505 \times 10^{23}$ molecules of H_2
(d) Similarly 10 g of O_2 gas
$= \frac{10}{32} \times 6.023 \times 10^{23}$ molecules of O_2
$= 1.88 \times 10^{23}$ molecules of O_2
Thus (a) will have maximum number of molecules

25. (a) One molecule of sugar $(C_{12}H_{22}O_{11})$ = 45 atoms
Number of moles of sugar $= \frac{1000}{342} = 2.92$
Number of molecules $= 2.92 \times 6.023 \times 10^{23}$
$= 17.60 \times 10^{23}$ molecules
Number of atoms $= 45 \times 17.60 \times 10^{23}$
$= 7.92 \times 10^{25}$ atoms

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

27. (c) 22400 mL of water contains = 6.023×10^{23} molecules
1 mL of water contains $= \frac{6.023 \times 10^{23}}{22400}$ molecules
= 20 drops (given)
∴ 1 drop of water will contain $= \frac{6.023 \times 10^{23}}{22400 \times 20}$
$= 1.344 \times 10^{18}$ molecules.

28. (c) (a) Moles = given wt./molecular wt.
Weight of H_2 = mole × molecular wt.
$= 0.2 \times 2 = 0.4$ g
(b) 6.023×10^{23} represents 1 mole
Thus 6.023×10^{22} will represent in 0.1 mole
Weight of $N_2 = 0.1 \times 28 = 2.8$ g
(c) Weight of silver = 0.1 g
(d) Weight of oxygen $= 32 \times 0.1 = 3.2$ 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 contain 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) $\underset{2(78)}{2C_6H_6} + \underset{15(32)}{15O_2(g)} \rightarrow 12CO_2(g) + 6H_2O(g)$
∵ 156 g of benzene required oxygen $= 15 \times 22.4$ L
∴ 1 g of benzene required oxygen $= \frac{15 \times 22.4}{156}$ L
∴ 39 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

$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

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 $= C_3H_5O_2$

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

$= (C_3H_5O_2) \times 2 = C_6H_{10}O_4$

33. (a)

	Fe_2O_3	+	3CO	$\rightarrow$	2Fe	+	$3CO_2$
	1 vol.		3 vol.		2 vol.		3 vol.
	1 mol.		3 mol.		2 mol.		3 mol.

($\because$ 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)

$$\underset{2\text{ g}}{H_2} + \underset{71\text{ g}}{Cl_2} \rightarrow \underset{73\text{ g}}{2HCl}$$

2 g of H_2 reacts with 71 g of Cl_2

100 g of H_2 will react with $\frac{71}{2} \times 100 = 3550$ g of Cl_2

Hence, Cl_2 is the limiting reagent.

71 g of Cl_2 produces 73 g of HCl

100 g of Cl_2 will produce $\frac{73}{71} \times 100 = 102.8$ g of HCl

35. (b)

	$NH_3(g)$	+	HCl (g)	$\rightarrow$	NH_4Cl (s)
t = 0	20 mL		40 mL		
t = t	0		20 mL		solid

Final volume = 20 mL.

36. (d) $2NaHCO_3 \xrightarrow{150°C} Na_2CO_3 + CO_2 + H_2O$

$$\frac{n_{NaHCO_3}}{n_{CO_2}} = \frac{2}{1}$$

$n_{NaHCO_3} = 2n_{CO_2}$

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

$W_{NaHCO_3} = 0.01 \times 84 = 0.84$ g

$W_{Na_2CO_3} = 1.00 - 0.84 = 0.16$ g

% $Na_2CO_3 = 16$.

37. (c) 5 L water $= 5 \times 10^3$ g $= 5 \times 10^6$ mg

5×10^6 mg water contains 25 mg $CaCO_3$

$\therefore$ 10^6 mg water contains 5 mg $CaCO_3$

$\therefore$ Concentration is 5 ppm.

38. (b) Number of moles of $O_2 = \frac{w}{32}$

Number of moles of $N_2 = \frac{4w}{28} = \frac{w}{7}$

$\therefore$ Ratio $= \frac{w}{32} : \frac{w}{7} = 7 : 32$

39. (c)

N_2	+	$3H_2$	$\rightarrow$	$2NH_3$
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

N_2 used = 5 L, left = 30 – 5 = 25 L

H_2 used = 15 L, left = 30 – 15 = 15 L

40. (c) 1 mole of $(NH_4)_2HPO_4$ would give $\frac{1}{2}$ mole of P_2O_5

$2(NH_4)_2HPO_4 \equiv P_2O_5$

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

$$\% \text{ of } P_2O_5 = \frac{\text{wt. of } P_2O_5}{\text{wt. of salt}} \times 100$$

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

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

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

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

or Volume occupied by $\frac{6.023 \times 10^{23}}{18}$ molecules of water = 1 cm^3

[$\therefore$ 1g water $= \frac{1}{18}$ 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) $2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^-(aq) + 3H_2(g)$

$\because$ 6 moles of HCl produces 3 moles of H_2

3 moles of $H_2 = 3 \times 22.4$ L of H_2 at S.T.P

$\therefore$ 1 mole of HCl produces $\frac{3 \times 22.4}{6}$ L of H_2 at S.T.P

= 11.2 L of H_2 at STP

43. (d) Molecular weight of $(CHCOO)_2Fe = 170$

Fe present in 100 mg of $(CHCOO)_2Fe$

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

This is present in 400 mg of capsule

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

44. (a) $2Ag_2CO_3 \xrightarrow{\Delta} 4Ag + 2CO_2 + O_2$
2×276 g $\quad 4 \times 108$ g

$\because 2 \times 276$ g of Ag_2CO_3 gives 4×108 g of silver

$\therefore$ 1 g of Ag_2CO_3 gives $= \frac{4 \times 108}{2 \times 276}$

$\therefore$ 2.76 g of Ag_2CO_3 gives

$\frac{4 \times 108 \times 2.76}{2 \times 276} = 2.16$ g

45. (a) $Mg^{2+} + Na_2CO_3 \longrightarrow MgCO_3 + 2Na^+$
1 g eq. $\quad$ 1g eq.

1 g eq. of Mg^{2+} = 12 g of Mg^{2+} = 12000 mg

= 1000 milli eq. of Na_2CO_3

$\therefore$ 12 mg Mg^{2+} = 1 milli eq. Na_2CO_3

46. (b) For one mole of the oxide;

Moles of M = 0.98

Moles of O^{2-} = 1

Let moles of $M^{3+} = x$

$\therefore$ Moles of $M^{2+} = 0.98 - x$

On balancing charge

$(0.98 - x) \times 2 + 3x - 2 = 0$

$x = 0.04$

$\therefore$ % of $M^{3+} = \frac{0.04}{0.98} \times 100 = 4.08\%$

47. (c) Percentage (by mass) of elements given in the body of a healthy human adult is :-

Oxygen = 61.4%, Carbon = 22.9%,

Hydrogen = 10.0% and Nitrogen = 2.6%

$\because$ Total weight of person = 75 kg

$\therefore$ Mass due to ^1H is $= 75 \times \frac{10}{100} = 7.5$ kg

If ^1H atoms are replaced by ^2H atoms.

Mass gain by person would be = 7.5 kg

48. (d) The reaction may given as

$Z_2O_3 + 3H_2 \longrightarrow 2Z + 3H_2O$

0.1596 g of Z_2O_3 react with 6 mg of H_2

6 mg = 0.006 g

$\therefore$ 1 g of H_2 react with $= \frac{0.1596}{0.006} = 26.6$ g of Z_2O_3

$\therefore$ Eq. wt. of $Z_2O_3 = 26.6$

(from the definition of eq. wt.)

Eq. wt. of Z + Eq. wt. of O = E + 8 = 26.6

$\Rightarrow$ Eq. wt. of Z = 26.6 – 8 = 18.6 g

Valency of metal in $Z_2O_3 = 3$

$\text{Eq. wt. of metal} = \frac{\text{Atomic wt.}}{\text{valency}}$

$\therefore$ At. wt. of Z = 18.6 × 3 = 55.8 g

49. (c) Mass of iron in 100 g haemoglobin = 0.334 g

$\therefore$ In 67200 g haemoglobin, mass of iron

$= \frac{67200 \times 0.334}{100} = 672 \times 0.334$ g

$\therefore$ Number of Fe atoms in one molecule of haemoglobin

$= \frac{672 \times 0.334}{56} = 4$

50. (d) Specific volume (volume of 1 g) of cylindrical virus particle = 6.02×10^{-2} cc/g

Radius of virus (r) = 7 Å = 7×10^{-8} cm

Length of virus = 10×10^{-8} cm

Volume of virus

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

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

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

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

51. (d) Since molarity of solution is 3.60 M. It means 3.6 moles of H_2SO_4 is present in its 1 litre solution.

Mass of 3.6 moles of H_2SO_4

= Moles × Molecular mass

= 3.6 × 98 g = 352.8 g

$\therefore$ 1000 mL solution has 352.8 g of H_2SO_4

29% H_2SO_4 by mass means 29 g of H_2SO_4 is present in 100 g of solution

$\therefore$ 352.8 g of H_2SO_4 is present in

$= \frac{100}{29} \times 352.8$ g of solution

= 1216 g of solution

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

52. (c) For element Fe, mole of atoms $= \frac{69.9}{56} = 1.25$

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

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

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 Fe_2O_3 = 160 g

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

Molecular formula = Fe_2O_3

53. (a) $2Mg + O_2 \rightarrow 2MgO$
$2 \times 24 \quad 2 \times 16 \quad 2(24 + 16)$

48 g of Mg requires, 32 g of O_2

1 g of Mg requires, $\frac{32}{48} = 0.66$ 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 g of O_2 will react with $\frac{48}{32} \times 0.5 = 0.75$ g of Mg

Excess of Mg = (1.0 – 0.75) = 0.25 g

54. **(c)** $M_2O_x \xrightarrow{\text{Reduction}} M$

Eq. of M_2O_x = eq. of Metal

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

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

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 × valency

$= 9 \times 2.66 = 23.9$ g