CHAPTER

1 Some Basic Concepts in Chemistry

1. The ratio of mass percent of C and H of an organic compound ($C_XH_YO_Z$) is 6 : 1. If one molecule of the above compound ($C_XH_YO_Z$) contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_XH_YO_Z$ is

(a) $C_3H_6O_3$ (b) C_2H_4O

(c) $C_3H_4O_2$ (d) $C_2H_4O_3$ *(2018)*

2. A sample of $NaClO_3$ is converted by heat to NaCl with a loss of 0.16 g of oxygen. The residue is dissolved in water and precipitated as AgCl. The mass of AgCl (in g) obtained will be

(Given : Molar mass of AgCl = 143.5 g mol^{-1})

(a) 0.54 (b) 0.35

(c) 0.48 (d) 0.41 *(Online 2018)*

3. For per gram of reactant, the maximum quantity of N_2 gas is produced in which of the following thermal decomposition reactions?

(Given : Atomic wt. Cr = 52 u, Ba = 137 u)

(a) $2NH_4NO_{3(s)} \rightarrow 2N_{2(g)} + 4H_2O_{(g)} + O_{2(g)}$

(b) $Ba(N_3)_{2(s)} \rightarrow Ba_{(s)} + 3N_{2(g)}$

(c) $(NH_4)_2Cr_2O_{7(s)} \rightarrow N_{2(g)} + 4H_2O_{(g)} + Cr_2O_3(s)$

(d) $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$ *(Online 2018)*

4. An unknown chlorohydrocarbon has 3.55% of chlorine. If each molecule of the hydrocarbon has one chlorine atom only, chlorine atoms present in 1 g of chlorohydrocarbon are

(Atomic wt. of Cl = 35.5 u; Avogadro constant = 6.023×10^{23} mol^{-1})

(a) 6.023×10^{21} (b) 6.023×10^{23}

(c) 6.023×10^{20} (d) 6.023×10^{9}

(Online 2018)

5. The most abundant elements by mass in the body of a healthy human adult are : oxygen (61.4%), carbon (22.9%), hydrogen (10.0%) and nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is

(a) 7.5 kg (b) 10 kg

(c) 15 kg (d) 37.5 kg *(2017)*

6. 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is

(a) 118.6 (b) 11.86

(c) 1186 (d) 84.3 *(2017)*

7. Excess of $NaOH_{(aq.)}$ was added to 100 mL of $FeCl_{3(aq.)}$ resulting into 2.14 g of $Fe(OH)_3$. The molarity of $FeCl_{3(aq.)}$ is

(Given : molar mass of Fe = 56 g mol^{-1} and molar mass of Cl = 35.5 g mol^{-1})

(a) 0.2 M (b) 1.8 M

(c) 0.3 M (d) 0.6 M *(Online 2017)*

8. What quantity (in mL) of a 45% acid solution of a monoprotic strong acid must be mixed with a 20% solution of the same acid to produce 800 mL of a 29.875% acid solution?

(a) 330 (b) 316

(c) 320 (d) 325 *(Online 2017)*

9. At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O_2 by volume for complete combustion. After combustion the gases occupy 330 mL. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is

(a) C_3H_6 (b) C_3H_8

(c) C_4H_8 (d) C_4H_{10} *(2016)*

10. 5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is

(a) isobutane (b) ethane

(c) butane (d) propane. *(Online 2016)*

11. An organic compound contains C, H and S. The minimum molecular weight of the compound containing 8% sulphur is (atomic weight of S = 32 amu)

(a) 600 g mol^{-1} (b) 200 g mol^{-1}

(c) 400 g mol^{-1} (d) 300 g mol^{-1} *(Online 2016)*

12. The amount of arsenic pentasulphide that can be obtained when 35.5 g arsenic acid is treated with excess H_2S in the presence of conc. HCl (assuming 100% conversion) is

(a) 0.25 mol (b) 0.50 mol

(c) 0.333 mol (d) 0.125 mol *(Online 2016)*

13. The volume of 0.1 N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of OH^- in aqueous solution is

(a) 400 mL (b) 600 mL

(c) 200 mL (d) 800 mL *(Online 2016)*

14. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06 N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is

(a) 42 mg (b) 54 mg

(c) 18 mg (d) 36 mg *(2015)*

15. A sample of a hydrate of barium chloride weighing 61 g was heated until all the water of hydration is removed. The dried sample weighed 52 g. The formula of the hydrated salt is (atomic mass Ba = 137 amu, Cl = 35.5 amu)

(a) $BaCl_2 \cdot H_2O$ (b) $BaCl_2 \cdot 2H_2O$

(c) $BaCl_2 \cdot 3H_2O$ (d) $BaCl_2 \cdot 4H_2O$ *(Online 2015)*

16. $A + 2B + 3C \rightleftharpoons AB_2C_3$

Reaction of 6.0 g of A, 6.0×10^{23} atoms of B, and 0.036 mol of C yields 4.8 g of compound AB_2C_3. If the atomic mass of A and C are 60 and 80 amu, respectively, the atomic mass of B is (Avogadro no. = 6×10^{23})

(a) 70 amu (b) 60 amu

(c) 50 amu (d) 40 amu *(Online 2015)*

17. The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecules is

(a) 3 : 16 (b) 1 : 4

(c) 7 : 32 (d) 1 : 8 *(2014)*

18. The molarity of a solution obtained by mixing 750 mL of 0.5 M HCl with 250 mL of 2 M HCl will be

(a) 0.975 M (b) 0.875 M

(c) 1.00 M (d) 1.75 M *(2013)*

19. In the reaction,

$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}{}_{(aq)} + 6Cl^{-}{}_{(aq)} + 3H_{2(g)}$

(a) 11.2 L $H_{2(g)}$ at STP is produced for every mole $HCl_{(aq)}$ consumed

(b) 6 L $HCl_{(aq)}$ is consumed for every 3 L $H_{2(g)}$ produced

(c) 33.6 L $H_{2(g)}$ is produced regardless of temperature and pressure for every mole Al that reacts

(d) 67.2 L $H_{2(g)}$ at STP is produced for every mole Al that reacts.

(2007)

20. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?

(a) 0.02 (b) 3.125×10^{-2}

(c) 1.25×10^{-2} (d) 2.5×10^{-2} *(2006)*

21. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will

(a) decrease twice

(b) increase two fold

(c) remain unchanged

(d) be a function of the molecular mass of the substance. *(2005)*

22. What volume of hydrogen gas, at 273 K and 1 atm. pressure will be consumed in obtaining 21.6 g of elemental boron (atomic mass = 10.8) from the reduction of boron trichloride by hydrogen?

(a) 89.6 L (b) 67.2 L

(c) 44.8 L (d) 22.4 L *(2003)*

23. With increase of temperature, which of these changes?

(a) Molality

(b) Weight fraction of solute

(c) Fraction of solute present in water

(d) Mole fraction *(2002)*

24. Number of atoms in 558.5 gram Fe (at. wt. of Fe = 55.85 g mol^{-1}) is

(a) twice that in 60 g carbon

(b) 6.023×10^{22}

(c) half that in 8 g He

(d) $558.5 \times 6.023 \times 10^{23}$ *(2002)*

ANSWER KEY

1. (d)	**2.** (c)	**3.** (d)	**4.** (c)	**5.** (a)	**6.** (d)	**7.** (a)	**8.** (b)	**9.** (b)	**10.** (d)	**11.** (c)	**12.** (d)
13. (a)	**14.** (c)	**15.** (b)	**16.** (c)	**17.** (c)	**18.** (b)	**19.** (a)	**20.** (b)	**21.** (a)	**22.** (b)	**23.** (c)	**24.** (a)

Explanations

1. (d) : Mass of carbon in the given compound = $12X$
Mass of hydrogen in the given compound = Y

$$\frac{12X}{Y}=\frac{6}{1} \Rightarrow 2X=Y \quad ...(i)$$

Combustion of C_XH_Y

$$C_XH_Y+\left(X+\frac{Y}{4}\right)O_2 \longrightarrow X\,CO_2+\frac{Y}{2}H_2O$$

Oxygen atoms required = $2\left(X+\frac{Y}{4}\right)$

As given, $\frac{1}{2}\times 2\left(X+\frac{Y}{4}\right)=Z$

Substituting the value of Y from eqn (i)

$$X+\frac{2X}{4}=Z \Rightarrow X+\frac{X}{2}=Z \Rightarrow \frac{3X}{2}=Z$$

Ratio of $X:Y:Z=X:2X:\frac{3X}{2}$ *i.e.*, 2 : 4 : 3

So, the formula of the compound is $C_2H_4O_3$.

2. (c) : Decomposition of $NaClO_3$ is given as :

$$2NaClO_3 \xrightarrow{\Delta} \underset{\text{(Residue) } 0.16\text{ g}}{2NaCl}+3O_2$$

No. of moles of O_2 formed = $\frac{0.16}{32}=5\times10^{-3}$

$$n_{NaCl}=\frac{2}{3}n_{O_2}=\frac{2}{3}\times5\times10^{-3}=\frac{1}{300}$$

$NaCl + Ag^+ \rightarrow AgCl + Na^+$

1 mole of AgCl is precipitated from one mole of NaCl.

$\therefore$ Mole of AgCl = $\frac{1}{300}$

$\therefore$ Mass of AgCl = Molar mass of AgCl × n_{AgCl}

$$=143.5\times\frac{1}{300}\simeq0.48\text{ g}$$

3. (d) : (a) $\underset{\text{Mol. mass}=80\text{ g mol}^{-1}}{2NH_4NO_{3(s)}} \longrightarrow \underset{\text{Mol mass}=28\text{ g mol}^{-1}}{2N_{2(g)}}+4H_2O_{(g)}+O_{2(g)}$

80 g of NH_4NO_3 gives 28 g of N_2

$\therefore$ 1 g of NH_4NO_3 will give = $\frac{28}{80}\times1=0.35$ g

(b) $\underset{\text{Mol. mass}=221\text{ g mol}^{-1}}{Ba(N_3)_{2(g)}} \longrightarrow Ba_{(s)}+3N_{2(g)}$

221 g of $Ba(N_3)_2$ gives 3 × 28 g of N_2

1 g of $Ba(N_3)_2$ will give = $\frac{3\times28}{221}\times1=0.38$ g

(c) $\underset{\text{Mol. mass}=252\text{ g mol}^{-1}}{(NH_4)_2Cr_2O_{7(s)}} \longrightarrow N_{2(g)}+4H_2O_{(g)}+Cr_2O_{3(s)}$

252 g of $(NH_4)_2Cr_2O_7$ gives 28 g of N_2

1 g of $(NH_4)_2Cr_2O_7$ will give = $\frac{28}{252}\times1=0.111$ g

(d) $\underset{\text{Mol. mass}=17\text{ g mol}^{-1}}{2NH_{3(g)}} \longrightarrow N_{2(g)}+3H_{2(g)}$

2 × 17 g of NH_3 gives 28 g of N_2

1 g of NH_3 will give = $\frac{28}{2\times17}\times1=0.823$ g

4. (c) : % of chlorine = 3.55
Thus, in 100 g of chlorohydrocarbon, mass of chlorine = 3.55 g

1 g of chlorohydrocarbon will contain = $\frac{3.55}{100}$ g of chlorine

$\therefore$ No. of moles of chlorine atoms = $\frac{\text{Mass}}{\text{Atomic mass}}=\frac{3.55}{\frac{100}{35.5}}=1\times10^{-3}$

1 mole of chlorine contains 6.023×10^{23} chlorine atoms.

$\therefore$ 1×10^{-3} mole of chlorine will contain = $1\times10^{-3}\times6.023\times10^{23}$
= 6.023×10^{20} chlorine atoms

5. (a) : Mass of elements in the body of a healthy human adult are : Oxygen (61.4%), carbon (22.9%), hydrogen (10%) and nitrogen (2.6%).

Weight of the person = 75 kg; Mass due to $^1H = 75\times\frac{10}{100}=7.5$ kg

On replacing ^1H by ^2H, 7.5 kg mass would replace with 15 kg.

$\therefore$ Net mass gained by person = (15 – 7.5) kg = 7.5 kg

6. (d) : According to the question,

$$M_2CO_3+2HCl \longrightarrow 2MCl+H_2O+CO_2$$

In this equation, number of moles of M_2CO_3 is equal to that of CO_2. *i.e.*, $n_{M_2CO_3}=n_{CO_2}$

$$\frac{\text{wt. of } M_2CO_3}{\text{molar mass of } M_2CO_3}=\ _{CO_2}$$

$$\frac{1\text{g}}{\text{Molar mass of } M_2CO_3}=0.01186\text{ mol}$$

Molar mass of $M_2CO_3=\frac{1}{0.01186}\approx84.3\text{ g mol}^{-1}$

7. (a): $\underset{\substack{100\text{ mL}\\M=?}}{3NaOH+FeCl_3} \longrightarrow \underset{2.14\text{ g}}{Fe(OH)_3}+3NaCl$

Moles of $Fe(OH)_3=\frac{2.14}{107}=2\times10^{-2}$

$\therefore$ Moles of $FeCl_3$ = moles of $Fe(OH)_3=2\times10^{-2}$

Now, $M=\frac{\text{no. of moles}\times1000}{\text{volume (mL)}}=\frac{2\times10^{-2}}{100}\times1000=0.2$ M

8. (b): $\frac{V\times45}{100}+\frac{(800-V)20}{100}=\frac{800\times29.875}{100}$

$$\frac{9V}{20}+160-\frac{V}{5}=239 \Rightarrow \frac{5V}{20}=79 \Rightarrow V=316\text{ mL}$$

9. (b) : Chemical equation for the combustion of hydrocarbon is

$$J\ \ O_{-.}+\left(\ \ +\frac{}{9}\right)W_{7-.} \rightarrow J\ W_{7-.}+\frac{}{7}O_7W_{-.}$$

Initial	15 mL	6: $\left(\ \ +\frac{}{9}\right)$y S	0
Final	0	0	15*x* mL

Now, volume of O_2 in air $= \frac{75}{655} \times 8<: = <: \text{ y S}$

$\therefore \quad <: = 6: \left(\quad + \frac{}{9} \right) \Rightarrow \quad + \frac{}{9} = :$

Out of given four options, C_3H_8 will satisfy the above equation.

10. (d) : Combustion of hydrocarbon,

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \rightarrow x\,CO_2 + \frac{y}{2}H_2O$$

5 L of alkane requires 25 L of oxygen.

1 L of alkane requires 5 L $\left(= x + \frac{y}{4}\right)$ of oxygen.

$\therefore\ x + \frac{y}{4} = 5$ which is satisfied by propane (C_3H_8).

11. (c) : % of sulphur $= \frac{\text{Aatomic wt. of sulphur}}{\text{Mol. wt. of compound}} \times 100$

$$8 = \frac{32}{\text{Mol wt. of compound}} \times 100$$

$\therefore$ Mol. wt of compound = 400 g mol^{-1}

12. (d) : Molar mass of H_3AsO_4 = 142 g mol^{-1}

$\therefore$ Number of moles of H_3AsO_4 in 35.5 g $= \frac{35.5}{142} = 0.25$ mol

$$2H_3AsO_4 + 5H_2S \xrightarrow{\text{Conc. HCl}} As_2S_5 + 8H_2O$$

2 moles of H_3AsO_4 gives 1 mole of As_2S_5

1 mole of H_3AsO_4 gives 1/2 mole of As_2S_5

$\therefore$0.25 mol of H_3AsO_4 gives $\frac{0.25}{2}$ mol of As_2S_5 = 0.125 mol of As_2S_5

13. (a) : No. of equivalents of acid = Normality × Volume = 0.1 × V_{acid}

No. of equivalents of OH^- = No. of moles = 0.04

For neutralisation,

No. of equivalents of acid = No. of equivalents of base

$0.1 \times V_{acid} = 0.04$

$$V_{acid} = \frac{0.04}{0.1} = 0.4 \text{ L} = 400 \text{ mL}$$

14. (c) : No. of milliequivalents of acetic acid initially taken = (0.06 N) × (50 mL) = 3 meq

No. of milliequivalents of acetic acid left in the filtrate = (0.042 N) × (50 mL) = 2.1 meq

No. of milliequivalents of acetic acid adsorbed by activated charcoal = (3 – 2.1) = 0.9 meq

Amount of acetic acid adsorbed by 3 g of activated charcoal = 0.9 × 60 = 54 mg

Amount of acetic acid adsorbed by 1 g of activated charcoal $\frac{: 9}{8} = 6 = \text{y s}$

15. (b) : Weight of hydrated $BaCl_2$ = 61 g

Weight of anhydrous $BaCl_2$ = 52 g; Loss in mass = 61 – 52 = 9 g

Assuming $BaCl_2 \cdot xH_2O$ as hydrate; Mass of H_2O_2 removed = 9 g

Moles of H_2O removed $= \frac{>}{6=} = 53$

Molecular mass of $BaCl_2$ = 208

% of H_2O in the hydrated $BaCl_2 = \frac{>}{; 6} \times 655 = 693 <: *$

$$\Rightarrow\ 693 <: = \frac{6=}{75=+6=} \times 655$$

On solving we get, x = 2

$\therefore$ The formula of the hydrated salt is $BaCl_2 \cdot 2H_2O$.

16. (c): $W + 7X + 8Y \rightleftharpoons WX_7Y_8$

6.0 g of A, 6.0×10^{23} atoms of B and 0.036 mol of C yields 4.8 g of compound AB_2C_3.

Atomic mass of A = 60 amu, Atomic mass of C = 80 amu

$$\text{T\{xq\{r } W = \frac{;}{;5} = 536\text{y\{x, T\{xq\{r } X = \frac{;35 \times 65^{78}}{; \times 65^{78}} = 6\text{y\{x}$$

Mole of C = 0.036 mol

Hence, C is the limiting reagent which is consumed completely.

So according to reaction, $W + 7X + 8Y \rightleftharpoons WX_7Y_8$

0.036 mol of C will form $\frac{5358;}{8} = 0.012$ mol of AB_2C_3.

$$\text{T\{xq\{r } WX_7Y_8 = \frac{\text{c qust}\mu}{\text{T\{xqo} \times \text{xm} - \text{qust}\mu}}$$

$$5356 7 = \frac{93=}{\text{T\{xqo} \times \text{xm} - \text{qust}\mu\{\text{r } WX_7Y_8}$$

So, molecular wt. of AB_2C_3 = 400

Atomic mass of A + 2 × Atomic mass of B + 3 Atomic mass of C = 400

60 + 2B + 3 × 80 = 400 $\Rightarrow$ Atomic mass of B = 50 amu

17. (c): Let the mass of $O_2 = x$ and that of $N_2 = 4x$

No. of molecules of $O_2 = \frac{x}{32}$; No. of molecules of $N_2 = \frac{4x}{28} = \frac{x}{7}$

Ratio $= \frac{x}{32} : \frac{x}{7}$ or 7 : 32

18. (b) : $M_{mix}V_{mix} = M_1V_1 + M_2V_2$

$$M_{mix} = \frac{M_1V_1 + M_2V_2}{V_{mix}} = \frac{0.5 \times 750 + 2 \times 250}{1000} = 0.875 \text{ M}$$

19. (a) : $2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_{2(g)}$

6 moles of HCl produced H_2 at STP = 3 × 22.4 L

$\therefore$ 1 mole of HCl will produce H_2 at STP $= \frac{3 \times 22.4}{6} = 11.2$ L

20. (b) : 1 mole of $Mg_3(PO_4)_2$

$\Rightarrow$ 3 moles of Mg atom + 2 moles of P atom + 8 moles of O atom

8 moles of oxygen atoms are present in = 1 mole of $Mg_3(PO_4)_2$

0.25 mole of oxygen atoms are present in $= \frac{1 \times 0.25}{8}$

$= 3.125 \times 10^{-2}$ moles of $Mg_3(PO_4)_2$

21. (a) : 1 atomic mass unit on the scale of 1/6 of C-12 = 2 amu on the scale of 1/12 of C-12.

Now, atomic mass of an element

$$= \frac{\text{Mass of one atom of the element}}{\text{1 amu (Here on the scale of } \frac{1}{6} \text{ of C–12)}}$$

$$= \frac{\text{Mass of one atom of the element}}{\text{2 amu (Here on the scale of } \frac{1}{12} \text{ of C–12)}}$$

$\therefore$ Numerically the mass of a substance will become half of the normal scale.

22. (b) : $2BCl_3 + 3H_2 \rightarrow 6HCl + 2B$ or $BCl_3 + \frac{3}{2}H_2 \rightarrow 3HCl + B$

10.8 g boron requires hydrogen = $\frac{3}{2} \times 22.4$ L

21.6 g boron will require hydrogen = $\frac{3}{2} \times \frac{22.4}{10.8} \times 21.6 = 67.2$ L

23. (c) : Volume increases with rise in temperature.

24. (a) : Fe (no. of moles) = $\frac{558.5}{55.85} = 10$ moles

C (no. of moles) = 60/12 = 5 moles.

(atomic weight of carbon = 12)