# Some Basic Concepts of Chemistry

1. What is the mass of water (in g) produced from 445 g of $C_{57}H_{110}O_6$ in the following reaction?
$2C_{57}H_{110}O_6(s) + 163\ O_2(g) \rightarrow 114CO_2(g) + 110\ H_2O(l)$
2. What amount of sugar ($C_{12}H_{22}O_{11}$) (in g) is required to prepare 2 L of its 0.1 M aqueous solution?
3. 5 moles of $AB_2$ weigh $125 \times 10^{-3}$ kg and 10 moles of $A_2B_2$ weigh $300 \times 10^{-3}$ kg. What is the sum of molar mass of A ($M_A$) and molar mass of B ($M_B$) in g mol$^{-1}$ ?
4. 5.0 g of a certain element *X* forms 10.0 g of its oxide having the formula $X_4O_6$. What is the atomic mass of *X* in amu?
5. A 100% pure sample of a divalent metal carbonate weighing 2 g on complete thermal decomposition releases 448 cc of carbon dioxide at STP. What is the equivalent mass of the metal?
6. The specific heat of a metal is 0.16 cal g$^{-1}$. The equivalent mass of the metal is 20.04. What is the correct atomic mass of the metal in grams?
7. 1.500g of hydroxide of a metal gave 1.000g of its oxide on heating. What is the equivalent mass of the metal ?
8. Limestone ($CaCO_3$) decomposes into quicklime (CaO) on strong heating. How much quantity of limestone will be required to prepare 100 kg of quicklime?
9. 1 mole of mixture of CO and $CO_2$ requires exactly 28 g KOH in solution for complete conversion of all the $CO_2$ into $K_2CO_3$. How much amount more of KOH (in g) will be required for conversion into $K_2CO_3$. (If one mole of mixture is completely oxidized to $CO_2$)?
10. 1 mol of $N_2$ and 4 mol of $H_2$ are allowed to react in a sealed container and after the reaction some water is introduced in it. The aqueous solution formed required 1 L of 1 M HCl for neutralization. Calculate the mole fraction of the gaseous product in the mixture after the reaction.
11. 6.2 g of a sample containing $Na_2CO_3$, $NaHCO_3$ and non-volatile inert impurity on gentle heating loses 5% of its mass due to reaction $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$. Residue is dissolved in water and formed 100 mL solution and its 10 mL portion requires 7.5 mL of 0.2 M aqueous solution of $BaCl_2$ for complete precipitation of carbonates. Determine mass (in g) of $Na_2CO_3$ in the original sample.
12. $H_2O_2 + 2KI \xrightarrow{40\%\ \text{yield}} I_2 + 2KOH$

$$H_2O_2 + 2KMnO_4 + 3H_2SO_4 \xrightarrow{50\%\ \text{yield}} K_2SO_4 + 2MnSO_4 + 3O_2 + 4H_2O$$

150 mL of $H_2O_2$ sample was divided into two parts. First part was treated with KI and formed KOH required 200 mL of M/2 $H_2SO_4$ for neutralisation. Other part was treated with $KMnO_4$ yielding 6.74 litre of $O_2$ at 1 atm. and 273 K. Using % yield indicated find volume strength of $H_2O_2$ sample used.
13. 5 g sample contain only $Na_2CO_3$ and $Na_2SO_4$. This sample is dissolved and the volume made up to 500 mL. 25 mL of this solution neutralizes 20 mL of 0.1 M $H_2SO_4$. Calculate the percentage of $Na_2SO_4$ in the sample.
14. A mixture of FeO and $Fe_2O_3$ is completely reacted with 100 mL of 0.25 M acidified $KMnO_4$ solution. The resultant solution was then treated with Zn dust which converted $Fe^{3+}$ of the solution to $Fe^{2+}$. The $Fe^{2+}$ required 1000 mL of 0.10 M $K_2Cr_2O_7$ solution. Find out the weight percentage of $Fe_2O_3$ in the mixture.
15. An impure sample of sodium oxalate ($Na_2C_2O_4$) weighing 0.20 g is dissolved in aqueous solution of $H_2SO_4$ and solution is titrated at 70°C, requiring 45 mL of 0.02 M $KMnO_4$ solution. The end point is overrun, and back titration in carried out with 10 mL of 0.1 M oxalic acid solution. Find the percentage purity of $Na_2C_2O_4$ in sample.

# SOLUTIONS

1. **(495)** For the given reaction:
$$2C_{57}H_{110}O_6(s) + 163\,O_2(g) \longrightarrow 114\,CO_2(g) + 110\,H_2O(l)$$
$$n = \frac{445}{890} = 0.5$$
Now, moles of water $= \frac{110}{2} \times 0.5 = 27.5$
$\therefore$ Mass of water $= 27.5 \times 18 = 495$ g

2. **(68.4)** As we know,
$$\text{Molarity} = \frac{\text{No. of moles of sugar}}{\text{Volume of solution (in L)}}$$
$$0.1 = \frac{\text{No. of moles of sugar}}{2\text{ L}}$$
So, no. of moles of sugar = 0.2 mol
$\therefore$ Mass of sugar = No. of moles of sugar × Molar mass of sugar
$= 0.2 \times 342 = 68.4$ g

3. **(15)** Molar mass of A $= 5 \times 10^{-3}$
Molar mass of B $= 10 \times 10^{-3}$
5 mol $AB_2$ weighs 125 g
$\therefore AB_2 = 25$ g/mol
10 mol $A_2B_2$ weighs 300 g
$\therefore A_2B_2 = 30$ g/mol
$\therefore$ Molar mass of A$(M_A) = 5$ g
Molar mass of B $(M_B) = 10$ g
$\Rightarrow 5 + 10 = 15$ g

4. **(24)** Using the relationship
$$\frac{\text{Mol. mass of oxide}}{\text{Mass of metal in molar mass}} = \frac{\text{mass of oxide}}{\text{mass of metal}}$$
$$\frac{4x + 96}{4x} = \frac{10}{5} \Rightarrow x = 24$$

5. **(20)** Divalent metal carbonate means $MCO_3$.
$$\underset{\substack{1\text{ mol}\\2\text{g}}}{MCO_3} \xrightarrow{\Delta} MO + \underset{\substack{22400\text{cc}\\448\text{cc}}}{CO_2}$$
448 cc evolves from 2g
1cc evolves from $\frac{2}{448}$ g
22400 cc will evolve from $\frac{2}{448} \times 22400$ g $= 100$ g
i.e. 100 g is the molecular weight of the carbonate.
Then M.Wt. of metal $= 100 - (12 + 3 \times 16) = 40$ g
(wt. of carbonate, $CO_3^{2-}$)
$$\text{Equivalent weight} = \frac{\text{Molecular weight}}{\text{Valency}} = \frac{40}{2} = 20$$

6. **(40.08)** Following Dulong-Pettit law, approx. atomic mass
$$= \frac{6.4}{\text{Specific heat}} = \frac{6.4}{0.16} = 40$$
$$\text{Valency of the metal} = \frac{40}{\text{Equiv.mass}} = \frac{40}{20.04} = 2$$
Correct atomic mass = valency × eq.mass
$= 2 \times 20.04 = 40.08$ g

7. **(10)** By the law of equivalents :
$$\frac{E + \text{Eq. mass of } OH^-}{E + \text{Eq. mass of O}} = \frac{\text{mass of metal hydroxide}}{\text{mass of metal oxide}}$$
(E = Eq. mass of metal)
or $\frac{E + 17}{E + 8} = \frac{1.5}{1} \Rightarrow E = 10$

8. **(178.57)** The equation representing thermal decomposition of limestone is:
$$\underset{100\text{ g}}{CaCO_3} \longrightarrow \underset{56\text{ g}}{CaO} + \underset{44\text{ g}}{CO_2}$$
It is seen from the above equation that 56 g of quicklime is obtained from 100 g of limestone. Thefore 100 kg of CaO is obtained from
$$\frac{100}{56} \times 100 \times 10^3 = 178.57 \times 10^3 \text{ g}$$
= 178.57 kg of limestone.

9. **(84)** $CO + \frac{1}{2}O_2 \to CO_2$;
$CO_2 + 2KOH \to K_2CO_3 + H_2O$
Moles of KOH $= \frac{28}{56} = 0.50$
It corresponds to 0.25 mol of $CO_2$
Hence mol of CO $= 1 - 0.25 = 0.75$
$\equiv$ mole of $CO_2$ formed
Mol of KOH requred $= 2 \times 0.75 = 1.5 = 1.5 \times 56 = 84$ g

10. **(0.25)** $N_2 + 3H_2 \rightleftharpoons 2NH_3$,
$NH_3 + HCl \longrightarrow NH_4Cl$
Moles of $NH_3$ formed $\equiv$ 1 L of 1 M HCl = 1 mol
Moles of $N_2$ left = 1 – Moles of $N_2$ reacted
$= 1 - \frac{1}{2} = 0.5$
Moles of $H_2$ left = 4 – Moles of $H_2$ reacted
$= 4 - \frac{3}{2} = 2.5$

Hence, mole fraction of $NH_3 = \frac{\text{Moles of } NH_3}{\text{Total moles}}$

$= \frac{1}{1+0.5+2.5} = 0.25$

**11. (1.06)** Loss in mass due to heating $= 6.2 \times \frac{5}{100} = 0.31$ g

$$\underset{2 \times 84g}{2NaHCO_3} \longrightarrow Na_2CO_3 + \underset{44+18 \text{ g loss}}{CO_2 + H_2O}$$

1 mole $NaHCO_3 \longrightarrow$ 31 g loss due to heating

0.31 g loss from 0.01 mole of $NaHCO_3$

Moles of $Na_2CO_3$ produced $= \frac{0.01}{2} = 0.005$

Total moles of carbonate reacted with $BaCl_2$

$= \left(7.5 \times 0.2 \times \frac{100}{10}\right) \times 10^{-3} = 0.015$ mol

Moles of carbonates in original sample

$= 0.015 - 0.005 = 0.01$

mass of $Na_2CO_3$ in original sample

$= 0.01 \times 106 = 1.06$ g

**12. (33.6)** Moles of $H_2SO_4 = 0.1$; mole of KOH = 0.2 moles of $H_2O_2$ used in first reaction

$= \frac{0.2}{2} \times \frac{1}{0.4} = 0.25$

moles of $O_2$ produce $= \frac{6.74}{22.4} = 0.3$

$\therefore$ moles of $H_2O_2$ used in second reaction

$= \frac{0.3}{3 \times 0.5} = 0.2$

Total mole of $H_2O_2$ consumed = 0.45

Molarity of $H_2O_2 = \frac{0.45}{0.15} = 3$ M.

Volume strength $= 11.2 \times 3 = 33.6$ volumes

**13. (15.2)** Only $Na_2CO_3$ reacts with $H_2SO_4$;

$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2CO_3$

m-moles of $Na_2CO_3$ = m-moles of $H_2SO_4$

$= 20 \times 0.1 = 2$

m-moles of $Na_2CO_3$ in 500 mL solution

$= \frac{500}{25} \times 2 = 40$

wt. of $Na_2CO_3 = 40 \times 106 \times 10^{-3} = 4.24$ g

% of $Na_2CO_3 = \frac{4.24}{5} \times 100 = 84.8$

$\therefore$ % $Na_2SO_4 = 100 - 84.8 = 15.2$

**14. (80.85)** m-eq. of FeO = m-eq. of $KMnO_4$

$= 0.25 \times 5 \times 100$

m-mole of FeO ($n = 1$) $= \frac{0.25 \times 100 \times 5}{1} = 125$

Total m-eq. or m-mole. of $Fe^{2+}$

$= 1000 \times 0.1 \times 6 = 600$

(from FeO and $Fe_2O_3$ after reaction with Zn dust)

m-mole of $Fe^{2+}$ from $Fe_2O_3 = 600 - 125 = 475$

m-mole of $Fe_2O_3 = \frac{475}{2}$

Mass of FeO $= \frac{125 \times (56+16)}{1000}$ g = 9 g

Mass of $Fe_2O_3 = \frac{475}{2} \times \frac{160}{1000} = 38$ g

% $Fe_2O_3 = \frac{38}{38+9} \times 100 = 80.85\%$

**15. (83.75)** m-eq. of $Na_2C_2O_4$ = m-eq. of $KMnO_4$ reacted total m-eq. of $KMnO_4$ – excess m-eq. of $KMnO_4$ reacted with $H_2C_2O_4$

$= 45 \times 0.02 \times 5 - 10 \times 0.1 \times 2 = 2.5$

$1000 \times \frac{W}{134} \times 2 = 2.5$

$W_{Na_2C_2O_4} = 0.1675$ g

% purity of $Na_2C_2O_4$ in sample

$= \frac{0.1675}{0.2} \times 100 = 83.75$