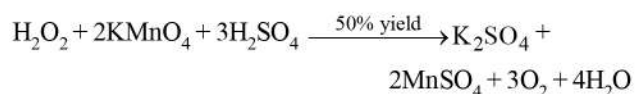


Some Basic Concepts of Chemistry

- What is the mass of water (in g) produced from 445 g of $C_{57}H_{110}O_6$ in the following reaction?
 $2C_{57}H_{110}O_6(s) + 163 O_2(g) \rightarrow 114CO_2(g) + 110 H_2O(l)$
- 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?
- 5 moles of AB_2 weigh 125×10^{-3} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. What is the sum of molar mass of A (M_A) and molar mass of B (M_B) in $g \text{ mol}^{-1}$?
- 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?
- 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?
- 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?
- 1.500g of hydroxide of a metal gave 1.000g of its oxide on heating. What is the equivalent mass of the metal?
- Limestone ($CaCO_3$) decomposes into quicklime (CaO) on strong heating. How much quantity of limestone will be required to prepare 100 kg of quicklime?
- 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)?
- 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.
- 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 $2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$. 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.

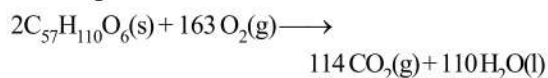


150 mL of H_2O_2 sample was divided into two parts. First part was treated with KI and formed KOH required 200 mL of

- 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.
- 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.
 - 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.
 - 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 $70^\circ C$, requiring 45 mL of 0.02 M $KMnO_4$ solution. The end point is overrun, and back titration is 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:



$$n = \frac{445}{890} = 0.5$$

$$\text{Now, moles of water} = \frac{110}{2} \times 0.5 = 27.5$$

$$\therefore \text{Mass of water} = 27.5 \times 18 = 495 \text{ g}$$

2. (68.4) As we know,

$$\text{Molarity} = \frac{\text{No. of moles of sugar}}{\text{Volume of solution (in L)}}$$

$$0.1 = \frac{\text{No. of moles of sugar}}{2L}$$

$$\text{So, no. of moles of sugar} = 0.2 \text{ mol}$$

$$\therefore \text{Mass of sugar} = \text{No. of moles of sugar} \times \text{Molar mass of sugar}$$

$$= 0.2 \times 342 = 68.4 \text{ g}$$

3. (15) Molar mass of A = 5×10^{-3}

$$\text{Molar mass of B} = 10 \times 10^{-3}$$

$$5 \text{ mol } AB_2 \text{ weighs } 125 \text{ g}$$

$$\therefore AB_2 = 25 \text{ g/mol}$$

$$10 \text{ mol } A_2B_2 \text{ weighs } 300 \text{ g}$$

$$\therefore A_2B_2 = 30 \text{ g/mol}$$

$$\therefore \text{Molar mass of A } (M_A) = 5 \text{ g}$$

$$\text{Molar mass of B } (M_B) = 10 \text{ g}$$

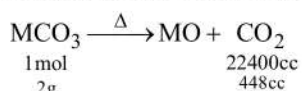
$$\Rightarrow 5 + 10 = 15 \text{ g}$$

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 .



$$448 \text{ cc evolves from } 2 \text{ g}$$

$$1 \text{ cc evolves from } \frac{2}{448} \text{ g}$$

$$22400 \text{ cc will evolve from } \frac{2}{448} \times 22400 \text{ g} = 100 \text{ g}$$

i.e. 100 g is the molecular weight of the carbonate.

$$\text{Then M. Wt. of metal} = 100 - (12 + 3 \times 16) = 40 \text{ g}$$

(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

$$= \frac{6.4}{\text{Specific heat}} = \frac{6.4}{0.16} = 40$$

$$\text{Valency of the metal} = \frac{40}{\text{Equiv. mass}} = \frac{40}{20.04} = 2$$

$$\text{Correct atomic mass} = \text{valency} \times \text{eq. mass}$$

$$= 2 \times 20.04 = 40.08 \text{ g}$$

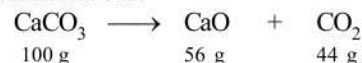
7. (10) By the law of equivalents :

$$\frac{E + \text{Eq. mass of } OH^-}{E + \text{Eq. mass of O}} = \frac{\text{mass of metal hydroxide}}{\text{mass of metal oxide}}$$

(E = Eq. mass of metal)

$$\text{or } \frac{E + 17}{E + 8} = \frac{1.5}{1} \Rightarrow E = 10$$

8. (178.57) The equation representing thermal decomposition of limestone is:

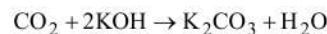


It is seen from the above equation that 56 g of quicklime is obtained from 100 g of limestone. Therefore 100 kg of CaO is obtained from

$$\frac{100}{56} \times 100 \times 10^3 = 178.57 \times 10^3 \text{ g}$$

$$= 178.57 \text{ kg of limestone.}$$

9. (84) $CO + \frac{1}{2}O_2 \rightarrow CO_2$;



$$\text{Moles of KOH} = \frac{28}{56} = 0.50$$

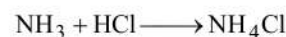
It corresponds to 0.25 mol of CO_2

$$\text{Hence mol of CO} = 1 - 0.25 = 0.75$$

$$\equiv \text{mole of } CO_2 \text{ formed}$$

$$\text{Mol of KOH required} = 2 \times 0.75 = 1.5 = 1.5 \times 56 = 84 \text{ g}$$

10. (0.25) $N_2 + 3H_2 \rightleftharpoons 2NH_3$,



$$\text{Moles of } NH_3 \text{ formed} \equiv 1 \text{ L of } 1 \text{ M HCl} = 1 \text{ mol}$$

$$\text{Moles of } N_2 \text{ left} = 1 - \text{Moles of } N_2 \text{ reacted}$$

$$= 1 - \frac{1}{2} = 0.5$$

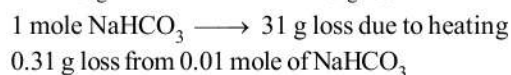
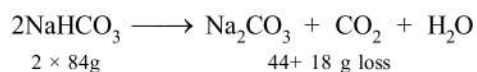
$$\text{Moles of } H_2 \text{ left} = 4 - \text{Moles of } H_2 \text{ reacted}$$

$$= 4 - \frac{3}{2} = 2.5$$

$$\text{Hence, mole fraction of NH}_3 = \frac{\text{Moles of NH}_3}{\text{Total moles}}$$

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

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



$$\text{Moles of Na}_2\text{CO}_3 \text{ produced} = \frac{0.01}{2} = 0.005$$

Total moles of carbonate reacted with BaCl₂

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

Moles of carbonates in original sample

$$= 0.015 - 0.005 = 0.01$$

mass of Na₂CO₃ in original sample

$$= 0.01 \times 106 = 1.06 \text{ g}$$

12. (33.6) Moles of H₂SO₄ = 0.1; mole of KOH = 0.2 moles of H₂O₂ used in first reaction

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

$$\text{moles of O}_2 \text{ produce} = \frac{6.74}{22.4} = 0.3$$

∴ moles of H₂O₂ used in second reaction

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

Total mole of H₂O₂ consumed = 0.45

$$\text{Molarity of H}_2\text{O}_2 = \frac{0.45}{0.15} = 3 \text{ M.}$$

Volume strength = 11.2 × 3 = 33.6 volumes

13. (15.2) Only Na₂CO₃ reacts with H₂SO₄;



m-moles of Na₂CO₃ = m-moles of H₂SO₄

$$= 20 \times 0.1 = 2$$

m-moles of Na₂CO₃ in 500 mL solution

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

$$\text{wt. of Na}_2\text{CO}_3 = 40 \times 106 \times 10^{-3} = 4.24 \text{ g}$$

$$\% \text{ of Na}_2\text{CO}_3 = \frac{4.24}{5} \times 100 = 84.8$$

$$\therefore \% \text{ Na}_2\text{SO}_4 = 100 - 84.8 = 15.2$$

14. (80.85) m-eq. of FeO = m-eq. of KMnO₄
 = 0.25 × 5 × 100

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

$$\text{Total m-eq. or m-mole. of Fe}^{2+} = 1000 \times 0.1 \times 6 = 600$$

(from FeO and Fe₂O₃ after reaction with Zn dust)

$$\text{m-mole of Fe}^{2+} \text{ from Fe}_2\text{O}_3 = 600 - 125 = 475$$

$$\text{m-mole of Fe}_2\text{O}_3 = \frac{475}{2}$$

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

$$\text{Mass of Fe}_2\text{O}_3 = \frac{475}{2} \times \frac{160}{1000} = 38 \text{ g}$$

$$\% \text{ Fe}_2\text{O}_3 = \frac{38}{38 + 9} \times 100 = 80.85\%$$

15. (83.75) m-eq. of Na₂C₂O₄ = m-eq. of KMnO₄ reacted
 total m-eq. of KMnO₄ - excess m-eq. of KMnO₄
 reacted with H₂C₂O₄
 = 45 × 0.02 × 5 - 10 × 0.1 × 2 = 2.5

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

$$W_{\text{Na}_2\text{C}_2\text{O}_4} = 0.1675 \text{ g}$$

% purity of Na₂C₂O₄ in sample

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