VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Stoichiometry-1

SAP-4

Problems based on back titration →

Illustration - 22 *1 gm of impure Na_2CO_3 is dissolved in water and the solution is made upto 250 mL. To 50 mL of this solution, 50mL of 0.1N HCl is added and the mixture after shaking well, required 10 mL of 0.16N NaOH solution for complete neutralization. Calculate % purity of the sample of Na_2CO_3.*

Na_2CO_3 : x mol in 250 ml solⁿ

$\frac{x}{5}$ mol in 50 ml solⁿ

$$(eq)_{HCl} = (eq)_{Na_2CO_3} + (eq)_{NaOH}$$

$$\frac{0.1 \times 50}{1000} = \left(\frac{x}{5} \times 2\right) + \left(\frac{0.16 \times 10}{1000}\right)$$

$$x = \frac{5}{2} \times \frac{3.4}{1000} = 8.5 \times 10^{-3} \text{ mol}$$

mass of Na_2CO_3 in 250 ml solⁿ

$$= 8.5 \times 10^{-3} \times 106$$

$$= 0.901 \text{ gm}$$

$$\% \text{ purity} = \frac{0.901}{1} \times 100 = 90.1\%$$

Illustration - 18 *5.3g of M_2CO_3 is dissolved in 150 ml of 1 N HCl. Unused acid required 100 ml of 0.5 N NaOH. Hence equivalent weight of M is :*

(A) 53 (B) 46 (C) 2 (D) 23

Solⁿ →

$$(eq)_{M_2CO_3} + (eq)_{NaOH} = (eq)_{HCl}$$

$$\frac{5.3}{E_{M_2CO_3}} + \frac{0.5 \times 100}{1000} = \frac{1 \times 150}{1000}$$

$$E_{M_2CO_3} = 53$$

$$E_{M^+} + E_{CO_3^{2-}} = 53$$

$$E_{M^+} + \frac{60}{2} = 53$$

$$E_{M^+} = 53 - 30 = 23$$

Double indicator titration →

* In a mix. of $NaOH + Na_2CO_3$ or $Na_2CO_3 + NaHCO_3$, two indicators (phenolphthalein and methyl orange) are required.

* Methyl orange indicates 100% Rx^n of any type of base.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

$n.f = 1$

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2CO_3$$

$nf. = 2$

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2CO_3$$

$nf. = 1$

* Phenolphthalein indicates 100% Rx^n of strong base (NaOH, KOH etc.), 50% Rx^n of Na_2CO_3, No Rx^n of $NaHCO_3$.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

$nf. = 1$

$$NaHCO_3 + HCl \not\longrightarrow NaCl + H_2CO_3$$

* $Na_2CO_3 + HCl \longrightarrow NaCl + NaHCO_3$

$nf. = 1$

Illustration - 24 *A solution of NaOH and Na_2CO_3 is prepared. 25 mL of this solution required for neutralisation:*

(a) *25.0 mL of 0.10 N HCl when phenolphthalein is used as indicator.*

(b) *35.0 mL of 0.10 N HCl when methyl orange is used as indicator.*

Find the strength of NaOH and Na_2CO_3.

25 ml sol^n → x mol NaOH ; → y mol Na_2CO_3

(i) when HPh is used as indicator →

$$(eq)_{NaOH} + (eq)_{Na_2CO_3} = (eq)_{HCl}$$

$$(x \times 1) + (y \times 1) = \frac{0.1 \times 25}{1000}$$

$$x + y = \frac{2.5}{1000} \quad \text{———} \quad ①$$

(iii) when MeOH is used as indicator

$$(eq)_{NaOH} + (eq)_{Na_2CO_3} = (eq)_{HCl}$$

$$(x \times 1) + (y \times 2) = \frac{0.1 \times 35}{1000}$$

$$x + 2y = \frac{3.5}{1000} \quad \text{—— } (2)$$

$$y = \frac{1}{1000}, \quad x = \frac{1.5}{1000}$$

25 ml sol^n $\rightarrow$ $\frac{1.5}{1000}$ mol NaOH $\Rightarrow$ 0.06 gm NaOH

$\rightarrow$ $\frac{1}{1000}$ mol Na_2CO_3 $\Rightarrow$ 0.106 gm Na_2CO_3

1 lit. sol^n $\rightarrow$ 0.06×40 gm NaOH $= 2.4$ gm NaOH

$\rightarrow$ 0.106×40 gm Na_2CO_3 $= 4.24$ gm Na_2CO_3

$$S_{NaOH} = 2.4 \ g/L$$

$$S_{Na_2CO_3} = 4.24 \ g/L$$

Illustration - 25 *8 gm of a mixture of anhydrous Na_2CO_3 and $NaHCO_3$ was dissolved in water and made upto 1000 mL. 25 mL of this solution required for neutralisation:*

(a) 32.0 mL of N/10 HCl using methyl orange and *(b) 12.0 mL of N/10 HCl using phenolphthalein.*

Find the strength of $NaHCO_3$ and Na_2CO_3.

$$1000\ ml\ sol^n \rightarrow x\ mol\ Na_2CO_3$$
$$\rightarrow y\ mol\ NaHCO_3$$

$$25\ ml\ sol^n \rightarrow \frac{x}{40}\ mol\ Na_2CO_3$$
$$\rightarrow \frac{y}{40}\ mol\ NaHCO_3$$

(a) when MeOH is used as indicator $\rightarrow$

$$(eq)_{Na_2CO_3} + (eq)_{NaHCO_3} = (eq)_{HCl}$$

$$\left(\frac{x}{40} \times 2\right) + \left(\frac{y}{40} \times 1\right) = \frac{1}{10} \times \frac{32}{1000}$$

$$2x + y = 0.128 \text{ ——— } (1)$$

(b) when HPH is used as indicator $\rightarrow$

$$(eq)_{Na_2CO_3} = (eq)_{HCl}$$

$$\left(\frac{x}{40} \times 1\right) = \frac{1}{10} \times \frac{12}{1000}$$

$$x = 0.048 \text{ ——— } (2)$$

$$y = 0.032$$

$$W_{Na_2CO_3} \text{ in 1 lit. } sol^n = 0.048 \times 106$$
$$= 5.088\ gm$$

$$S_{Na_2CO_3} = 5.088\ g/L$$

W_{NaHCO_3} in 1 lit. sol^n $= 0.032 \times 84$

$= 2.688$ gm

$S_{NaHCO_3} = 2.688\ g/L$

21. A mixture containing Na_2CO_3, NaOH and inert matter weighs 0.75 g. When the aqueous solution is titrated with 0.50 N HCl, the colour of the phenolphthalein disappears when 21.00 mL of the acid has been added. Methyl orange is then added and 7.00 mL more of the acid is required to give a red colour to the solution. The % of Na_2CO_3 is :

(A) 49.5 (B) 24.5

(C) 37.1 (D) None of these

$$\underbrace{\overset{x\ mol}{Na_2CO_3} + \overset{y\ mol}{NaOH} + \text{Inert matter}}_{0.75\ gm}$$

HPH $\rightarrow$

$$(eq)_{Na_2CO_3} + (eq)_{NaOH} = (eq)_{HCl}$$

$$(x \times 1) + (y \times 1) = \frac{0.5 \times 21}{1000}$$

$$x + y = \frac{10.5}{1000} \quad \text{——— (1)}$$

MeOH $\rightarrow$

$$(eq)_{Na_2CO_3}^{left} = (eq)_{HCl}$$

$$(2x - x) = \frac{0.5 \times 7}{1000}$$

$$x = \frac{3.5}{1000} \quad \text{——} \quad (2)$$

$$y = \frac{7}{1000}$$

$$W_{Na_2CO_3} = \frac{3.5}{1000} \times 106 = 0.371 \text{ gm}$$

$$\% \, Na_2CO_3 = \frac{0.371}{0.75} \times 100$$

$$= 49.47\%$$

22. 0.1g of metal combines with 46.6 mL of oxygen to form oxide at STP. The equivalent weight of metal is :

(A) 12 (B) 24 (C) 6 (D) 36

$\underline{\text{Sol}^n \rightarrow}$

$$M + O_2$$

0.1 gm 46.6 ml STP

$$\Downarrow$$

$$\frac{46.6}{1000 \times 22.4}$$

$$= 2.08 \times 10^{-3} \text{ mol}$$

$$= 66.57 \times 10^{-3} \text{ gm}$$

$$\frac{0.1}{66.57 \times 10^{-3}} \times 8 \text{ gm} \longleftarrow 8 \text{ gm}$$

$$\simeq 12 \text{ gm}$$

48. 0.05 g of a piece of metal in dilute acid gave 24.62 mL of H_2 at 27°C and 760 mm pressure. The equivalent weight of metal is:

(A) 25 (B) 12.5 (C) 50 (D) 37.5

$$M + \text{dil. acid} \longrightarrow H_2$$

0.05 gm

24.62 ml

27°C

1 atm

$\Downarrow$

$$n = \frac{1 \times \frac{24.62}{1000}}{24.63}$$

$\simeq$ 0.001 mol

$$(eq)_M = (eq)_{H_2}$$

$$\frac{0.05}{E} = (0.001 \times 2)$$

$$E = \frac{0.05}{0.002} = 25$$

75. What weight of a metal of equivalent weight 12 will give 0.475 g of its chloride?

(A) 0.12 g (B) 0.24 g (C) 0.36 g (D) 0.48 g

Sol^n →

$$M + Cl_2 \longrightarrow MCl_x$$

gm = ? $\qquad\qquad\qquad$ 0.475 gm

$$(eq)_M = (eq)_{MCl_x}$$

$$\frac{x}{12} = \frac{0.475}{12 + \left(\frac{35.5}{1}\right)}$$

$$x = 0.12 \text{ gm}$$