

# Stoichiometry-1

SAP-4



## Problems based on back titration →

**Illustration - 22** 1 gm of impure  $\text{Na}_2\text{CO}_3$  is dissolved in water and the solution is made upto 250 mL. To 50 mL of this solution, 50 mL 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  $\text{Na}_2\text{CO}_3$ .

$$\text{Na}_2\text{CO}_3 : x \text{ mol in } 250 \text{ ml sol}^n$$

$$\frac{x}{5} \text{ mol in } 50 \text{ ml sol}^n$$

$$(\text{eq})_{\text{HCl}} = (\text{eq})_{\text{Na}_2\text{CO}_3} + (\text{eq})_{\text{NaOH}}$$

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

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

$$\begin{aligned} \text{mass of } \text{Na}_2\text{CO}_3 \text{ in } 250 \text{ ml sol}^n &= 8.5 \times 10^{-3} \times 106 \\ &= 0.901 \text{ gm} \end{aligned}$$

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

**Illustration - 18** 5.3g of  $\text{M}_2\text{CO}_3$  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

Sol<sup>n</sup> →

$$\begin{aligned} (\text{eq})_{\text{M}_2\text{CO}_3} + (\text{eq})_{\text{NaOH}} &= (\text{eq})_{\text{HCl}} \\ \frac{5.3}{E_{\text{M}_2\text{CO}_3}} + \frac{0.5 \times 100}{1000} &= \frac{1 \times 150}{1000} \end{aligned}$$

$$E_{M_2CO_3} = 53$$

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

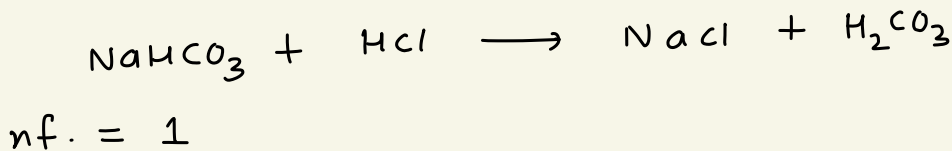
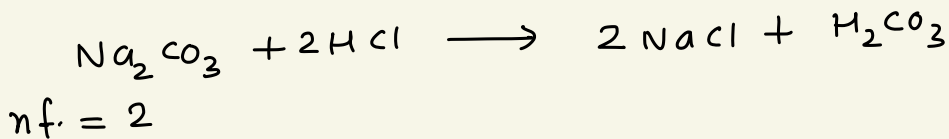
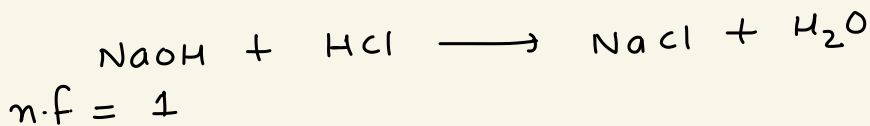
$$E_{M^+} + \frac{60}{2} = 53$$

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

### 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.

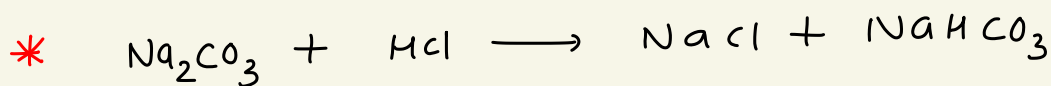
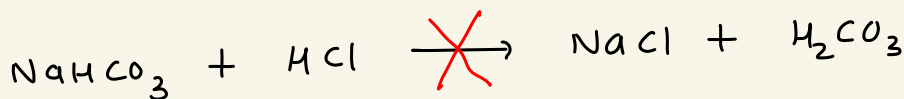
\* methyl orange indicates 100%  $RX^n$  of any type of base.



\* phenolphthalein indicates 100% Rxn of strong base (NaOH, KOH etc.), 50% Rxn of  $\text{Na}_2\text{CO}_3$ , No Rxn of  $\text{NaHCO}_3$ .



$$n.f. = 1$$



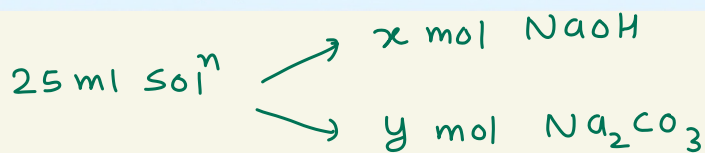
$$n.f. = 1$$

**Illustration - 24** A solution of NaOH and  $\text{Na}_2\text{CO}_3$  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  $\text{Na}_2\text{CO}_3$ .



(i) when HPh is used as indicator  $\longrightarrow$

$$(eq)_{\text{NaOH}} + (eq)_{\text{Na}_2\text{CO}_3} = (eq)_{\text{HCl}}$$

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

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

(iii) when MeOH is used as indicator

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

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

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

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

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

$$\rightarrow \frac{1}{1000} \text{ mol Na}_2\text{CO}_3 \Rightarrow 0.106 \text{ gm Na}_2\text{CO}_3$$

$$1 \text{ lit. sol}^n \rightarrow 0.06 \times 40 \text{ gm NaOH} = 2.4 \text{ gm NaOH}$$

$$\rightarrow 0.106 \times 40 \text{ gm Na}_2\text{CO}_3 = 4.24 \text{ gm Na}_2\text{CO}_3$$

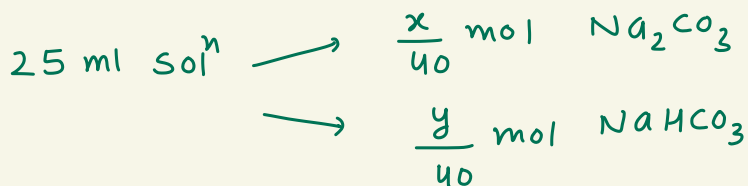
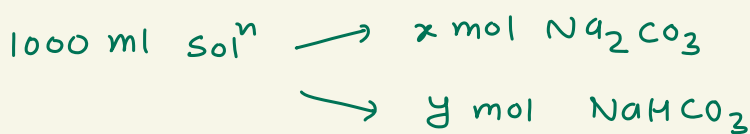
$$S_{NaOH} = 2.4 \text{ g/L}$$

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

**Illustration - 25** 8 gm of a mixture of anhydrous  $\text{Na}_2\text{CO}_3$  and  $\text{NaHCO}_3$  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  $\text{NaHCO}_3$  and  $\text{Na}_2\text{CO}_3$ .



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

$$(\text{eq})_{\text{Na}_2\text{CO}_3} + (\text{eq})_{\text{NaHCO}_3} = (\text{eq})_{\text{HCl}}$$

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

$$2x + y = 0.128 \quad \text{————— ①}$$

(b) when MPH is used as indicator  $\longrightarrow$

$$(\text{eq})_{\text{Na}_2\text{CO}_3} = (\text{eq})_{\text{HCl}}$$

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

$$x = 0.048 \quad \text{————— ②}$$

$$y = 0.032$$

$$W_{\text{Na}_2\text{CO}_3} \text{ in 1 lit sol}^n = 0.048 \times 106 \\ = 5.088 \text{ gm}$$

$$S_{\text{Na}_2\text{CO}_3} = 5.088 \text{ g/L}$$

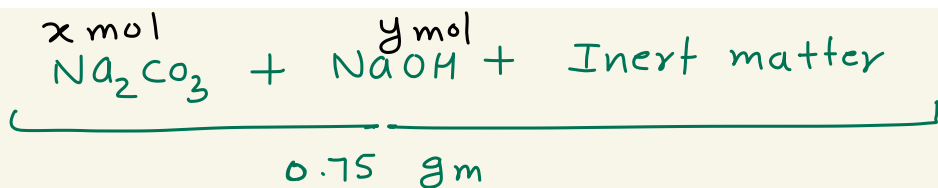
$$W_{\text{NaHCO}_3} \text{ in 1 lit. sol}^n = 0.032 \times 84$$

$$= 2.688 \text{ gm}$$

$$S_{\text{NaHCO}_3} = 2.688 \text{ g/L}$$

**21.** A mixture containing  $\text{Na}_2\text{CO}_3$ ,  $\text{NaOH}$  and inert matter weighs 0.75 g. When the aqueous solution is titrated with 0.50 N  $\text{HCl}$ , 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  $\text{Na}_2\text{CO}_3$  is :

- ☒ (A) 49.5                      (B) 24.5  
☐ (C) 37.1                      (D) None of these



$$\text{HPH} \rightarrow (eq)_{\text{Na}_2\text{CO}_3} + (eq)_{\text{NaOH}} = (eq)_{\text{HCl}}$$

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

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

$$\text{MeOH} \rightarrow (eq)_{\text{Na}_2\text{CO}_3}^{\text{left}} = (eq)_{\text{HCl}}$$

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

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

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

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

$$\begin{aligned} \% Na_2CO_3 &= \frac{0.371}{0.75} \times 100 \\ &= 49.47 \% \end{aligned}$$

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

☐ (E)

Sol<sup>n</sup> →

$$\begin{array}{rcl} M & + & O_2 \\ 0.1 \text{ gm} & & 46.6 \text{ ml} \\ & & \text{STP} \\ & & \downarrow \\ & & 46.6 \\ & & \hline & & 1000 \times 22.4 \\ & & = 2.08 \times 10^{-3} \text{ mol} \\ & & = 66.57 \times 10^{-3} \text{ gm} \end{array}$$

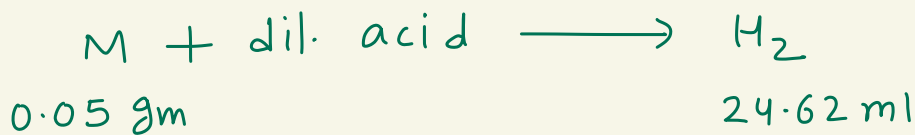
$$\begin{aligned} \frac{0.1}{66.57 \times 10^{-3}} \times 8 \text{ gm} &\leftarrow 8 \text{ gm} \\ &= 12 \text{ gm} \end{aligned}$$



48. 0.05 g of a piece of metal in dilute acid gave 24.62 mL of  $H_2$  at  $27^\circ C$  and 760 mm pressure. The

equivalent weight of metal is:

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



27°C

1 atm

14

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

$$\underline{\underline{5}} \quad 0.001 \text{ mol}$$

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

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

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

**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<sup>n</sup> →



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

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

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