Back Titration :

Example 3 :

A 1.2907g of a pure diprotic organic acid was dissolved in 55.50 mL of a NaOH solution, and the excess base was titrated with 3.95 mL of 0.1500 M HCl. In a second titration it was established that 40.15 mL of the base were equivalent to 32.50 mL of the HCl. Calculate the molar mass of the organic acid.

Solution :

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$
$$(0.1500\ M)$$

$$n(NaOH) = n(HCl) \Rightarrow \frac{(MV)_{NaOH}}{1000} = \frac{(MV)_{HCl}}{1000}$$

$$M_{NaOH}(40.15\ mL) = (32.50\ mL)(0.1500\ M)$$

$$\therefore M_{NaOH} = \frac{(32.50)(0.1500)}{(40.15)} = 0.1214\ M$$

$$n(NaOH_{total}) = \frac{MV}{1000} = \frac{(0.1214\ M)(55.50\ mL)}{1000}$$
$$= 6.738 \times 10^{-3}\ mol$$

$$n(NaOH_{unreacted}) = n_{HCl}$$
$$= \frac{(3.95\ mL)(0.1500\ M)}{1000}$$
$$= 5.925 \times 10^{-4}\ mol$$

$$\therefore n(NaOH_{reacted\ with\ organic\ acid}) = (6.738 \times 10^{-3}) - (5.925 \times 10^{-4})$$
$$= 6.146 \times 10^{-3}\ mol$$

Assume H_2X = organic acid (diprotic)

$$H_2X + 2NaOH \longrightarrow Na_2X + 2H_2O$$

$$n(organic\ acid) = \frac{1}{2} \times n_{NaOH}$$
$$= \left(\frac{1}{2} \times 6.146 \times 10^{-3}\right) mol$$
$$= 3.073 \times 10^{-3}\ mol$$

Back Titration : Example 3 : cont....

$$\underset{(\text{mols})}{n} = \frac{m\ (\text{mass, g})}{M_r\ (\text{molar mass, g mol}^{-1})}$$

$$\therefore M_r\ (\text{organic acid}) = \frac{m}{n} = \frac{1.2907\ \text{g}}{3.033 \times 10^{-3}\ \text{mol}}$$

$$= 420\ \text{g mol}^{-1}\ (\text{Ans})$$

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