BACK - TITRATION

Example 5

To measure the concentration of Ca^{2+} ions, 1.50mL of human blood is treated with $Na_2C_2O_4$ solution. The precipitate, CaC_2O_4 formed is filtered and dissolved in dilute H_2SO_4 to release $C_2O_4^{2-}$ ions into solution and allow it to be oxidized. This solution required 2.55mL of 0.00044 M $KMnO_4$ to reach the end-point.

a) Calculate the mass of Ca^{2+} ions.

b) Calculate the Ca^{2+} ion concentration in units of mg Ca^{2+}/100mL blood.

Solution

Balanced equation :

$$Ca^{2+} + Na_2C_2O_4 \longrightarrow CaC_2O_4(s) + 2Na^+(aq)$$

$$CaC_2O_4(s) + H_2SO_4 \longrightarrow C_2O_4^{2-} + CaSO_4(s) + 2H^+$$

$$\left.\begin{array}{r} 2\times\left[5e^- + 8H^+ + MnO_4^- \longrightarrow Mn^{2+} + 4H_2O\right] \\ 5\left[C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-\right] \end{array}\right\} +$$

$$16H^+ + 2MnO_4^- + 5C_2O_4^{2-} \longrightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$$

$$n_{KMnO_4} = \left(\frac{2.55 \times 0.00044}{1000}\right) mols = 1.122\times10^{-6} mols.$$

$$\frac{n_{C_2O_4^{2-}}}{n_{MnO_4^-}} = \frac{5}{2} \Rightarrow n_{C_2O_4^{2-}} = \frac{5}{2} \times n_{MnO_4^-}$$

$$= \left(\frac{5 \times 1.122\times10^{-6}}{2}\right) mols$$

$$= 2.805\times10^{-6} mols$$

STOICHIOMETRY : BACK TITRATION

$$Ca^{2+} + C_2O_4^{2-} \longrightarrow CaC_2O_4$$

$M_r(Ca) = 40.08\ g\ mol^{-1}$

$$n_{Ca^{2+}} = n_{C_2O_4^{2-}} = 2.805 \times 10^{-6}\ mols$$

$$\therefore m_{Ca^{2+}} = (2.805 \times 10^{-6})(40.08\ g\ mol^{-1})$$

$$= \underline{1.12 \times 10^{-4}\ g \quad (Ans)}$$

$$1.50\ mL\ blood \equiv (1.12 \times 10^{-4})(10^3)\ mg\ Ca^{2+}$$

$$\therefore 100\ mL\ blood \equiv \left(\frac{100\,(1.12 \times 10^{-4})(10^3)}{1.50}\right) mg\ Ca^{2+}$$

$$= \underline{7.47\ mg\ Ca^{2+}\ (Ans).}$$

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