Redox Titrations - Calculations

These are used to calculate the concentration of unknown solutions in a similar way to acid-base titrations.

First you must write the balanced equation.

1. 2.50g of iodine was dissolved in potassium iodide and made up to 250cm^3 with water. 25.0cm^3 of the iodine solution was titrated against sodium thiosulfate of which 22.0cm^3 was required. Calculate the concentration of the sodium thiosulfate solution.

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$

moles I_2 $\frac{2.5}{253.8}$ = 0.00985 in 250cm^3

$\div 10$ = 0.000985 in 25 cm^3

$I_2 : S_2O_3^{2-}$

1 : 2

$\times 2$ = 1.97×10^{-3} moles $S_2O_3^{2-}$ in 22 cm^3

Conc. $S_2O_3^{2-}$ = $\frac{1.97 \times 10^{-3}}{\frac{22}{1000}}$

= 0.09 mol dm^{-3}

2. A 1.51g sample of steel was dissolved in sulfuric acid and made up to 250cm^3 with water to produce a sample of iron (II) ions. 25.0cm^3 of the solution was titrated against 0.02moldm^{-3} $KMnO_4$. The average titre was 25.45cm^3. Calculate the percentage iron in the sample of steel.

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

moles $MnO_4^- = 0.02 \times \frac{25.45}{1000}$

$= 5.09 \times 10^{-4}$

moles Fe^{2+} $\times 5 = 2.545 \times 10^{-3}$ in 25cm^3

$\times 10 = 2.545 \times 10^{-2}$ in 250cm^3

mass Fe^{2+} in 250cm^3

$\times Mr$ $(55.8) = 1.42g$ in 250cm^3 (or in 1.51g)

$\frac{1.42}{1.51} \times 100 = 94\%$

3. Pure copper is needed for electrical purposes. The purity of a sample of copper can be found by reacting it with concentrated nitric acid, neutralising the resulting solution and treating it with excess potassium iodide. Iodine is liberated and this can be titrated with standard sodium thiosulfate solution. The reactions are

$Cu_{(s)} + 4HNO_{3(l)} \rightarrow Cu(NO_3)_{2(aq)} + 2NO_{2(g)} + 2H_2O_{(l)}$

$2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \rightarrow 2CuI_{(s)} + I_{2(aq)}$

$2S_2O_3^{2-}{}_{(aq)} + I_{2(aq)} \rightarrow S_4O_6^{2-}{}_{(aq)} + 2I^-_{(aq)}$

A copper foil electrode weighs 1.74g. It was made into a 250cm^3 solution of copper (II) ions. To 25.0cm^3 of this solution, excess potassium iodide was added and the mixture titrated with 0.1 moldm^{-3} sodium thiosulfate. The average titre was 26.8cm^3. Calculate the percentage purity of the copper foil.

moles $S_2O_3^{2-}$ = $0.1 \times \frac{26.8}{1000}$

= 2.68×10^{-3}

moles I_2 ÷2 = 1.34×10^{-3} in 25cm^3

×10 = 0.0134 in 250cm^3

moles Cu in 250cm^3 ×2 = 0.0268

mass Cu in 250cm^3 $\times \frac{Mr}{63.5}$ = 1.70g in 250cm^3

(in 1.74g sample)

$\frac{1.70}{1.74} \times 100 = 97.8\%$