Core Worksheet 2 – Chapter 1

1 Chromium can be produced by the reduction of chromium(III) oxide with aluminium:

$$Cr_2O_3 + 2Al \rightarrow Al_2O_3 + 2Cr$$

a What mass of aluminium is required for exact reaction with 20.0 kg of Cr_2O_3? [3]

b What mass of chromium is produced when 1.00 kg of chromium(III) oxide reacts with excess aluminium? [3]

2 Tin(II) chloride may be prepared by passing hydrogen chloride gas over heated tin:

$$Sn(s) + 2HCl(g) \rightarrow SnCl_2(s) + H_2(g)$$

When 5.00 g of tin is reacted with excess hydrogen chloride, 7.46 g of $SnCl_2$ is obtained. What is the percentage yield of $SnCl_2$? [3]

3 When silver nitrate is reacted with solutions containing chloride ions, insoluble silver chloride is precipitated:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

a What mass of silver chloride is precipitated when 20.0 cm^3 of 0.100 mol dm^{-3} sodium chloride solution is reacted with excess silver nitrate solution? [3]

b What mass of silver chloride is precipitated when 25.0 cm^3 of 0.0600 mol dm^{-3} silver nitrate solution is added to 20.0 cm^3 of 0.100 mol dm^{-3} sodium chloride solution? [5]

c What mass of silver chloride is precipitated when 30.0 cm^3 of 0.0800 mol dm^{-3} silver nitrate solution is added to 20.0 cm^3 of 0.0800 mol dm^{-3} $CaCl_2(aq)$? [6]

d 0.0100 mol of a metal chloride (MCl_x) is dissolved in water then reacted with excess silver nitrate solution. The mass of silver chloride precipitated was 4.30 g. Determine the value of *x*. [2]

e 1.45 g of a mixture of sodium chloride and potassium chloride is dissolved in water and made up to a total volume of 250.0 cm^3. Excess 0.100 mol dm^{-3} silver nitrate solution is added to 25.00 cm^3 of this solution. 0.325 g of AgCl is precipitated. Determine the percentage NaCl and KCl in the original mixture. [6]

4 Potassium manganate(VII) may be used to determine the concentration of iron(II) (Fe^{2+}) ions in solution. The ionic equation for the reaction is:

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

a A solution of iron(II) ammonium sulfate is made up by dissolving 9.10 g of $FeSO_4(NH_4)_2SO_4.6H_2O$ in dilute sulfuric acid and making up the total volume to 250.0 cm^3. 25.00 cm^3 of this solution is titrated against a solution of potassium manganate(VII). An average of 21.50 cm^3 of potassium manganate(VII) solution was required for complete reaction. Work out the concentration of the potassium manganate(VII) solution. [4]

b 1.21 g of iron wire is heated with sulfuric acid to convert the iron to $Fe^{2+}(aq)$. The solution is transferred to a volumetric flask and made up to a total volume of 250.0 cm^3. 25.00 cm^3 of this solution is titrated against 0.02000 mol dm^{-3} potassium manganate(VII) solution. 21.30 cm^3 of potassium manganate(VII) is required for exact reaction. Determine the percentage iron in the iron wire. [5]

c 5.00 g of hydrated iron(II) sulfate ($FeSO_4.xH_2O$) is dissolved in dilute sulfuric acid and made up to a total volume of 250.0 cm^3. 25.00 cm^3 of this solution is titrated against 0.0200 mol dm^{-3} potassium manganate(VII). 22.30 cm^3 of potassium manganate(VII) was required for complete reaction. Determine the number of moles of water of crystallisation in $FeSO_4.xH_2O$. [8]

5 Back titration is a technique in which excess of a reagent is added and the amount of reagent left over determined by titration.

2.20 g of impure calcium carbonate was reacted with 50.0 cm^3 of 2.00 mol dm^{-3} hydrochloric acid (excess). The solid impurities were filtered off and the remaining solution made up to a total volume of 250.0 cm^3 using distilled water. 25.00 cm^3 of this solution was titrated against 0.240 mol dm^{-3} sodium hydroxide solution and required 24.10 cm^3 for neutralisation.

Determine the percentage purity of the calcium carbonate. [8]