Marking scheme for Core Worksheet 2 – Chapter 1

1 **a** moles of $Cr_2O_3 = \frac{20000}{152} = 131.6$ mol [1]

moles of Al = 131.6 × 2 = 263.2 mol [1]

mass of Al = 263.2 × 26.98 = 7100 g [1]

b moles of $Cr_2O_3 = \frac{1000}{152} = 6.58$ mol [1]

moles of Cr = 6.58 × 2 = 13.16 mol [1]

mass of Cr = 13.16 × 52 = 684 g [1]

2 moles of Sn = $\frac{5.00}{118.69} = 0.0421$ mol [1]

theoretical yield of $SnCl_2$ = 0.0421 × 189.59 = 7.99 g [1]

percentage yield of $SnCl_2 = \frac{7.46}{7.99} \times 100 = 93.4\%$ [1]

3 **a** moles of NaCl = $\frac{20.0}{1000} \times 0.100 = 2.00 \times 10^{-3}$ mol [1]

moles of AgCl = 2.00×10^{-3} mol [1]

mass of AgCl = $2.00 \times 10^{-3} \times 143.32 = 0.287$ g [1]

b moles of $AgNO_3 = \frac{25.0}{1000} \times 0.0600 = 1.50 \times 10^{-3}$ mol [1]

moles of NaCl = $\frac{20.0}{1000} \times 0.100 = 2.00 \times 10^{-3}$ mol [1]

$AgNO_3$ is the limiting reactant [1]

moles of AgCl = 1.50×10^{-3} mol [1]

mass of AgCl = $1.50 \times 10^{-3} \times 143.32 = 0.215$ g [1]

c moles of $AgNO_3 = \frac{30.0}{1000} \times 0.0800 = 2.40 \times 10^{-3}$ mol [1]

moles of $CaCl_2 = \frac{20.0}{1000} \times 0.0800 = 1.60 \times 10^{-3}$ mol [1]

moles of $Cl^- = 2 \times 1.60 \times 10^{-3} = 3.20 \times 10^{-3}$ mol [1]

$AgNO_3$ is the limiting reactant [1]

moles of AgCl = 2.40×10^{-3} mol [1]

mass of AgCl = $2.40 \times 10^{-3} \times 143.32 = 0.344$ g [1]

d moles of AgCl = $\frac{4.30}{143.32}$ = 0.0300 mol [1]

$x = 3$ [1]

e **Note**: this question is difficult and is beyond what is required for the IB examinations.

moles of AgCl = $\frac{0.325}{143.32}$ = 2.27×10^{-3} mol [1]

moles of Cl^- in 25.00 cm^3 of solution = 2.27×10^{-3} mol

moles of Cl^- in 1.45 g of mixture = $2.27 \times 10^{-3} \times 10 = 2.27 \times 10^{-2}$ mol [1]

let mass of NaCl in mixture be x, then mass of KCl is $1.45 - x$

$$\frac{x}{58.44} + \frac{1.45 - x}{74.55} = 2.27 \times 10^{-2}$$ [1]

$x = 0.879$ g [1]

mass of NaCl = 0.879 g; mass of KCl = 0.571 g [1]

% NaCl = $\frac{0.879}{1.45} \times 100$ = 60.6 %; % KCl = 39.4% [1]

4 **a** moles of $FeSO_4(NH_4)_2SO_4.6H_2O$ = $\frac{9.10}{392.19}$ = 0.0232 mol [1]

moles $FeSO_4(NH_4)_2SO_4.6H_2O$ in 25.00 cm^3 solution = $\frac{0.0232}{10}$ = 0.00232 mol [1]

moles of MnO_4^- = $\frac{0.00232}{5}$ = 4.64×10^{-4} mol [1]

concentration of MnO_4^- = $\frac{4.64 \times 10^{-4}}{21.50 \times 10^{-3}}$ = 0.0216 mol dm^{-3} [1]

b moles of MnO_4^- = $\frac{21.30}{1000} \times 0.0200 = 4.26 \times 10^{-4}$ mol [1]

moles of Fe^{2+} in 25.00 cm^3 of solution = $4.26 \times 10^{-4} \times 5 = 2.13 \times 10^{-3}$ mol [1]

moles of Fe^{2+} in 250.0 cm^3 of solution = $2.13 \times 10^{-3} \times 10 = 2.13 \times 10^{-2}$ mol

moles of Fe in the iron wire = 2.13×10^{-2} mol [1]

mass of Fe = $2.13 \times 10^{-2} \times 55.85$ = 1.19 g [1]

% Fe in the wire = $\frac{1.19}{1.21} \times 100$ = 98.3% [1]

c moles of MnO_4^- = $\frac{22.30}{1000} \times 0.0200 = 4.46 \times 10^{-4}$ mol [1]

moles of Fe^{2+} in 25.00 cm^3 of solution = $4.46 \times 10^{-4} \times 5 = 2.23 \times 10^{-3}$ mol [1]

moles of Fe^{2+} in 250.0 cm^3 of solution = $2.23 \times 10^{-3} \times 10 = 2.23 \times 10^{-2}$ mol [1]

mass of $FeSO_4$ = $2.23 \times 10^{-2} \times 151.91 = 3.39$ g [1]

mass of H_2O = 5.00 – 3.39 = 1.61 g [1]

moles of H_2O = $\frac{1.61}{18.02} = 0.0893$ mol [1]

ratio $H_2O : FeSO_4 = 0.0893 : 2.23 \times 10^{-2} = 4.01 : 1$ [1]

therefore $x = 4$ [1]

5 moles of NaOH = $\frac{24.10}{1000} \times 0.240 = 5.784 \times 10^{-3}$ mol [1]

moles of HCl in 25.00 cm^3 = 5.78×10^{-3} mol [1]

moles of HCl in 250.0 cm^3 = $5.78 \times 10^{-3} \times 10 = 5.78 \times 10^{-2}$ mol [1]

moles of HCl in original solution = $\frac{50.0}{1000} \times 2.00 = 0.100$ mol [1]

moles of HCl that reacted with $CaCO_3$ = $0.100 - 5.78 \times 10^{-2} = 0.0422$ mol [1]

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

moles of $CaCO_3$ = $\frac{0.0422}{2} = 0.0211$ mol [1]

mass of $CaCO_3$ = $0.0211 \times 100.09 = 2.11$ g [1]

% purity = $\frac{2.11}{2.20} \times 100 = 96.0$ % [1]