SL & HL Answers to Oxidation & reduction (3) questions

1. (a) i. $Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(l)$

ii. The oxidation state of copper increases from 0 to +2 so copper has been oxidised and the oxidation state of nitrogen decreases from +5 to +4 so nitrogen has been reduced.

(b) i. In Step 2 iodide ions have been oxidised from −1 to 0 so iodide ions are acting as the reducing agent.

ii. The oxidation state of copper has changed from +2 to +1.

(c) Thiosulfate ions are acting as the reducing agent as they reduce elemental iodine (oxidation state zero) to iodide ions (oxidation state −1).

(d) Amount of $S_2O_3^{2-}(aq)$ in 21.4 cm^3 = (21.4 ÷1000) x 0.200 = 4.28 x 10^{-3} mol
Amount of I_2 in 10.0 cm^3 = 2.14 x 10^{-3} mol
Amount of I_2 in 100 cm^3 = 2.14 x 10^{-2} mol
Amount of copper reacted = 2 x 2.14 x 10^{-2} = 4.28 x 10^{-2} mol
Mass of copper reacted = 63.55 x 4.28 x 10^{-2} = 2.72 g

(e) The percentage of copper in the coin = (2.72 ÷ 3.03) x 100 = **89.8%**

2. i. When the addition of one drop of the potassium manganate(VII) solution causes a faint pink colour to remain.

ii. *Half-equations:* $MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightarrow Mn^{2+}(aq) + 4H_2O(l)$
$SO_2(aq) + 2H_2O(l) \rightarrow SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$

Overall equation: $2MnO_4^-(aq) + 5SO_2(aq) + 2H_2O(l) \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 4H^+(aq)$

iii. Amount of $MnO_4^-(aq)$ = (12.0 ÷ 1000) x 2.50 x 10^{-2} = 3.00 x 10^{-4} mol
Since $2MnO_4^-$ reacts with $5SO_2$
Amount of SO_2 = 5/2 x 3.00 x 10^{-4} = 7.50 x 10^{-4} mol
Mass of sulfur = 32.07 x 7.50 x 10^{-4} = 2.41 x 10^{--} g
Percentage by mass of S in fuel = (2.41 x 10^{-2} ÷ 10.0) x 100 = **0.24%**