Q8 Oxidation and reduction **[2 + 4 + 4 = 10 marks]**

a) i) Assign oxidation numbers to the atoms in the following compounds or ions:

½ mark each, must have correct sign [2 marks]

	Atom	Oxidation number	Atom	Oxidation number
MnO_4^{2-}	**Mn**	**+6**	**O**	**–2**
H_3O^+	**H**	**+1**	**O**	**–2**

b) From the half equations below, determine the balanced cell reaction and the standard electrode potential:
Hint: Determine which reaction will be oxidation and which reaction will be reduction.

$$Au^{3+}(aq) + 3\ e^- \rightleftharpoons Au(s)$$

$$I_2(s) + 2\ e^- \rightleftharpoons 2\ I^-(aq)$$

Data: $E°(\ Au^{3+}\ /\ Au\ ) = +1.42$ V and $E°(\ I_2\ /\ I^-\ ) = +0.54$ V

State the amount (measured in moles) of electrons that will be transferred in the reaction.

[4 marks]

The half cell with the more positive $E°_{cell}$ is a reduction and the other half reaction reversed is oxidation:

$Au^{3+}(aq) + 3\ e^- \rightleftharpoons Au(s)$ **reduction** **½ mark**
$2\ I^-(aq) \rightleftharpoons I_2(s) + 2\ e^-$ **oxidation** **½ mark**
Multiply reduction equation by 2 and oxidation equation by 3
$2\ Au^{3+}(aq) + 6\ e^- \rightleftharpoons 2\ Au(s)$
$6\ I^-(aq) \rightleftharpoons 3\ I_2(s) + 6\ e^-$
and add the two new equations:
Net equation is:
$2\ Au^{3+}(aq) + 6\ I^-(aq) \rightleftharpoons 2\ Au(s) + 3\ I_2(s)$ **1 mark**

$E°_{cell} = E°_{substance\ reduced} - E°_{substance\ oxidised}$

$E°_{cell} = E°_{reduction} - E°_{oxidation}$
$= +1.42\ V - (+0.54\ V)$
$= +0.88\ V$ **1 mark**

There will be 6 moles of electrons transferred in the reaction **1 mark**

Q8 (continued) Oxidation and reduction **[2 + 4 + 4 = 10 marks]**

c) Using half-reactions and showing your working, balance each half reaction separately for the following equation in acidic solution.
Hint: You do not need to write the overall balanced equation.

$$Cr^{3+}(aq) + BiO_3^-(aq) \rightarrow Cr_2O_7^{2-}(aq) + Bi^{3+}(aq)$$

[2 + 2 = 4 marks]

Oxidation reaction

$Cr^{3+}(aq) \rightarrow Cr_2O_7^{2-}aq)$

$2\ Cr^{3+}(aq) \rightarrow Cr_2O_7^{2-}aq)$

$2\ Cr^{3+}(aq) + 7\ H_2O(l) \rightarrow Cr_2O_7^{2-}aq)$

$2\ Cr^{3+}(aq) + 7\ H_2O(l) \rightarrow Cr_2O_7^{2-}aq) + 14\ H^+(aq)$

$2\ Cr^{3+}(aq) + 7\ H_2O(l) \rightarrow Cr_2O_7^{2-}aq) + 14\ H^+(aq) + 6\ e^-$

½ mark for balancing Cr, 1 mark for balancing with H_2O and H^+, ½ mark for electrons. Total 2 marks

Reduction reaction

$BiO_3^-(aq) \rightarrow Bi^{3+}(aq)$

$BiO_3^-(aq) \rightarrow Bi^{3+}(aq) + 3\ H_2O(l)$

$6\ H^+(aq) + BiO_3^-(aq) \rightarrow Bi^{3+}(aq) + 3\ H_2O(l)$

$2\ e^- + 6\ H^+(aq) + BiO_3^-(aq) \rightarrow Bi^{3+}(aq) + 3\ H_2O(l)$

1 mark for balancing with H_2O and H^+, 1 mark for electrons Total 2 marks