Standard electrode potentials	$E^{\ominus}$/V
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.77
$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$	+1.36
$2BrO_3^-(aq) + 12H^+(aq) + 10e^- \longrightarrow Br_2(aq) + 6H_2O(l)$	+1.52
$O_3(g) + 2H^+(aq) + 2e^- \longrightarrow O_2(g) + H_2O(l)$	+2.08
$F_2O(g) + 2H^+(aq) + 4e^- \longrightarrow 2F^-(aq) + H_2O(l)$	+2.15

Each of the above can be reversed under suitable conditions.

(a) (i) Identify the most powerful reducing agent in the table.

.....

(ii) Identify the most powerful oxidising agent in the table.

.....

(iii) Identify **all** the species in the table which can be oxidised in acidic solution by $BrO_3^-(aq)$.

.....

(4 marks)

(b) The cell represented below was set up.

$$Pt|Fe^{2+}(aq),Fe^{3+}(aq)||BrO_3^-(aq),Br_2(aq)|Pt$$

(i) Deduce the e.m.f. of this cell.

.....

(ii) Write a half-equation for the reaction occurring at the negative electrode when current is taken from this cell.

.....

(iii) Deduce what change in the concentration of $Fe^{3+}(aq)$ would cause an increase in the e.m.f. of the cell. Explain your answer.

Change in concentration .....

Explanation .....

.....

.....

(6 marks)

2.

The table below shows some standard electrode potentials.

	$E^{\ominus}$/V
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.77
$Cr^{3+}(aq) + e^- \longrightarrow Cr^{2+}(aq)$	−0.41
$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$	−0.44
$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$	−0.76
$Cr^{2+}(aq) + 2e^- \longrightarrow Cr(s)$	−0.91

(a) Predict the products, if any, when the following substances are mixed. In each case use $E^{\ominus}$ values from the table to explain your answer.

(i) iron metal with aqueous zinc(II) ions

Products, if any .....

Explanation .....

.....

(ii) aqueous iron(III) ions with aqueous chromium(II) ions

Products, if any .....

Explanation .....

.....

(5 marks)

(b) Calculate the e.m.f. of the following standard cell and deduce an equation for the overall cell reaction.

$$Zn(s)|Zn^{2+}(aq)||Cr^{3+}(aq),Cr^{2+}(aq)|Pt$$

e.m.f. .....

Equation .....

(2 marks)

(c) Chromium(III) ions are weakly acidic in aqueous solution as shown by the following equation.

$$[Cr(H_2O)_6]^{3+}(aq) \rightleftharpoons [Cr(H_2O)_5(OH)]^{2+}(aq) + H^+(aq)$$

The value of K_a for this reaction is 1.15×10^{-4} mol dm^{-3}.

Calculate the pH of a 0.500 mol dm^{-3} solution of $[Cr(H_2O)_6]^{3+}(aq)$.

.....

.....

.....

.....

.....

.....

(5 marks)

3.

(a) In terms of electrons, state what happens to the oxidising agent in a redox reaction.

.....

(1 mark)

(b) State the value of the standard electrode potential for the following half-equation. Give a reason why it has this value.

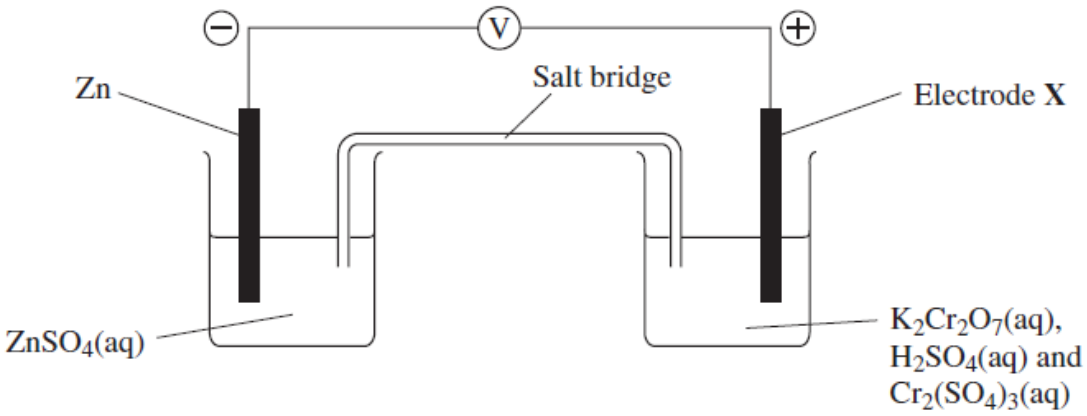
$$H^+(aq) + e^- \longrightarrow \tfrac{1}{2}H_2(g)$$

Value of $E^{\ominus}$ .....

Reason .....

(2 marks)

(c) Consider the electrochemical cell shown below. The aqueous mixture in the right-hand part of the cell contains the oxidising agent and the reducing agent for that part of the cell.



State the purpose of the salt bridge and of the electrode **X**. Identify the substance or substances from which each of these is made.

Purpose of salt bridge.....

.....

Salt bridge is made from.....

Purpose of electrode **X** .....

.....

Electrode **X** *is made from* .....

(4 marks)

(d) Give the oxidation state of chromium in $K_2Cr_2O_7$

.....

(1 mark)

(e) Write half-equations for the reactions at each electrode and an overall equation for the cell reaction.

Positive electrode half-equation

.....

Negative electrode half-equation

.....

Overall equation for cell reaction

.....

(3 marks)