

Name of the Student: \_\_\_\_\_

Max. Marks : 28 Marks

Time : 28 Minutes

Q1.

The table shows some standard electrode potential data.

| Electrode half-equation                                                        | $E^\ominus / \text{V}$ |
|--------------------------------------------------------------------------------|------------------------|
| $\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$      | +1.36                  |
| $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$          | +0.80                  |
| $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$ | +0.77                  |
| $\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$      | -0.14                  |
| $\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$      | -0.44                  |

- (a) Use data from the table to deduce the species that is the best oxidising agent.

\_\_\_\_\_

(1)

- (b) Write the conventional representation for the cell used to measure the standard electrode potential for the conversion of tin(II) ions to tin.

\_\_\_\_\_

(2)

- (c) A cell was made by connecting two half-cells with a salt bridge. One half-cell consisted of silver in a solution of silver nitrate solution and the other consisted of tin in a solution of tin(II) nitrate solution.

Calculate the EMF of this cell and write a half-equation for the reaction that occurs at the negative electrode.

EMF \_\_\_\_\_

Half-equation

\_\_\_\_\_

(2)

- (d) Use data from the table above to write an equation for the reaction of silver(I) ions with iron(II) ions.



Q2.

Fuel cells are an increasingly important energy source for vehicles. Standard electrode potentials are used in understanding some familiar chemical reactions including those in fuel cells.

The following table contains some standard electrode potential data.

| Electrode half-equation                                                                          | $E^\ominus / \text{V}$ |
|--------------------------------------------------------------------------------------------------|------------------------|
| $\text{F}_2 + 2\text{e}^- \longrightarrow 2\text{F}^-$                                           | +2.87                  |
| $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$                                         | +1.36                  |
| $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \longrightarrow 2\text{H}_2\text{O}$                     | +1.23                  |
| $\text{Br}_2 + 2\text{e}^- \longrightarrow 2\text{Br}^-$                                         | +1.07                  |
| $\text{I}_2 + 2\text{e}^- \longrightarrow 2\text{I}^-$                                           | +0.54                  |
| $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \longrightarrow 4\text{OH}^-$                    | +0.40                  |
| $\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \longrightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ | +0.17                  |
| $2\text{H}^+ + 2\text{e}^- \longrightarrow \text{H}_2$                                           | 0.00                   |
| $4\text{H}_2\text{O} + 4\text{e}^- \longrightarrow 4\text{OH}^- + 2\text{H}_2$                   | -0.83                  |

- (a) A salt bridge was used in a cell to measure electrode potential.

Explain the function of the salt bridge.

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(2)

- (b) Use data from the table above to deduce the halide ion that is the weakest reducing agent.

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(1)

- (c) Use data from the table to justify why sulfate ions should **not** be capable of oxidising bromide ions.

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(1)

- (d) Use data from the table to calculate a value for the EMF of a hydrogen–oxygen fuel cell operating under alkaline conditions.

EMF = \_\_\_\_\_ V  
(1)

- (e) There are two ways to use hydrogen as a fuel for cars. One way is in a fuel cell to power an electric motor, the other is as a fuel in an internal combustion engine.

Suggest the major advantage of using the fuel cell.

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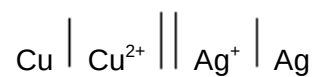
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(1)  
(Total 6 marks)

Q3.

The following cell has an EMF of +0.46 V.



Which statement is correct about the operation of the cell?

**A** Metallic copper is oxidised by  $\text{Ag}^+$  ions.

☐

**B** The silver electrode has a negative polarity.

☐

**C** The silver electrode gradually dissolves to form  $\text{Ag}^+$  ions.

☐

**D** Electrons flow from the silver electrode to the copper electrode via an external circuit.

☐

(Total 1 mark)

Q4.

The table contains some standard electrode potential data.

| Electrode half-equation                                                                      | $E^\ominus / \text{V}$ |
|----------------------------------------------------------------------------------------------|------------------------|
| $\text{F}_2 + 2\text{e}^- \longrightarrow 2\text{F}^-$                                       | +2.87                  |
| $\text{Au}^+ + \text{e}^- \longrightarrow \text{Au}$                                         | +1.68                  |
| $2\text{HOCl} + 2\text{H}^+ + 2\text{e}^- \longrightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$ | +1.64                  |
| $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$                                     | +1.36                  |
| $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \longrightarrow 2\text{H}_2\text{O}$                 | +1.23                  |
| $\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$                                         | +0.80                  |
| $\text{Fe}^{3+} + \text{e}^- \longrightarrow \text{Fe}^{2+}$                                 | +0.77                  |
| $2\text{H}^+ + 2\text{e}^- \longrightarrow \text{H}_2$                                       | 0.00                   |
| $\text{Fe}^{2+} + 2\text{e}^- \longrightarrow \text{Fe}$                                     | -0.44                  |

- (a) In terms of electrons, explain the meaning of the term **oxidising agent**.

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(1)

- (b) Identify the weakest oxidising agent in the table.  
Explain your choice.

Weakest oxidising agent \_\_\_\_\_

Explanation \_\_\_\_\_

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(2)

- (c) Write the conventional representation of the cell used to measure the standard electrode potential for the  $\text{Ag}^+ / \text{Ag}$  electrode.

State the conditions necessary when measuring this value.

Conventional representation \_\_\_\_\_

Conditions \_\_\_\_\_

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(4)

- (d) Use data from the table to explain, in terms of redox, what happens when a soluble gold(I) compound containing  $\text{Au}^+$  ions is added to water.

State what you would observe.

Write an equation for the reaction that occurs.

Explanation \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Observation \_\_\_\_\_

\_\_\_\_\_

Equation \_\_\_\_\_

(4)

The table is repeated below to help you answer these questions.

| Electrode half-equation                                                                      | $E^\ominus / \text{V}$ |
|----------------------------------------------------------------------------------------------|------------------------|
| $\text{F}_2 + 2\text{e}^- \longrightarrow 2\text{F}^-$                                       | +2.87                  |
| $\text{Au}^+ + \text{e}^- \longrightarrow \text{Au}$                                         | +1.68                  |
| $2\text{HOCl} + 2\text{H}^+ + 2\text{e}^- \longrightarrow \text{Cl}_2 + 2\text{H}_2\text{O}$ | +1.64                  |
| $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$                                     | +1.36                  |
| $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \longrightarrow 2\text{H}_2\text{O}$                 | +1.23                  |
| $\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$                                         | +0.80                  |
| $\text{Fe}^{3+} + \text{e}^- \longrightarrow \text{Fe}^{2+}$                                 | +0.77                  |
| $2\text{H}^+ + 2\text{e}^- \longrightarrow \text{H}_2$                                       | 0.00                   |
| $\text{Fe}^{2+} + 2\text{e}^- \longrightarrow \text{Fe}$                                     | -0.44                  |

- (e) A cell is made by connecting  $\text{Fe}^{2+} / \text{Fe}$  and  $\text{Ag}^+ / \text{Ag}$  electrodes with a salt bridge.

- (i) Calculate the e.m.f. of this cell.

\_\_\_\_\_

\_\_\_\_\_

Answer \_\_\_\_\_

(1)

- (ii) Suggest why potassium chloride would **not** be suitable for use in the salt bridge of this cell.

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(1)

- (f) Use data from the table to explain what happens when a solution of iron(II) chloride is exposed to the air.

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(2)

(Total 15 marks)