

Name of the Student: _____

Max. Marks : 23 Marks

Time : 23 Minutes

Q1.

This question is about a glucose–oxygen fuel cell.

When the cell operates, the glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) molecules react with water at the negative electrode to form carbon dioxide and hydrogen ions.

Oxygen gas reacts with hydrogen ions to form water at the positive electrode.

- (a) Deduce the half-equation for the reaction at the negative electrode.

(1)

- (b) Deduce the half-equation for the reaction at the positive electrode.

(1)

- (c) Give the equation for the overall reaction that occurs in the Glucose–oxygen fuel cell.

(1)

- (d) The negative electrode is made of carbon and the positive electrode is made of platinum.

Give the conventional representation for the glucose–oxygen fuel cell.

(2)

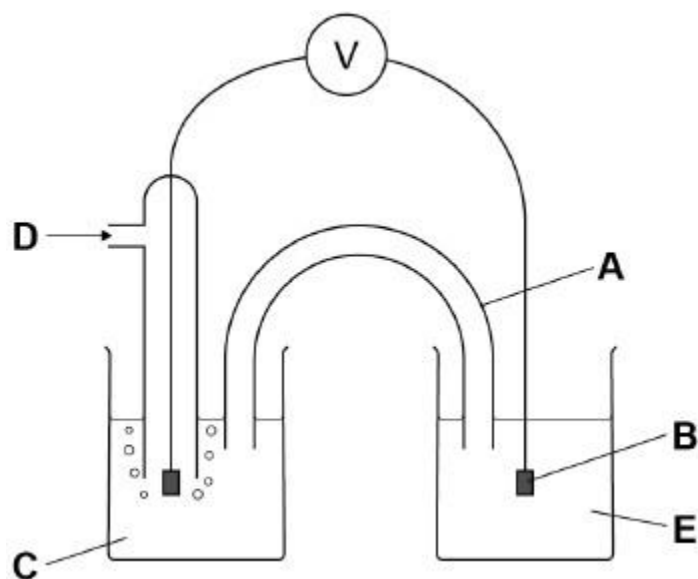
- (e) State what must be done to maintain the EMF of this fuel cell when in use.

(1)

(Total 6 marks)

Q2.

The diagram represents the cell used to measure the standard electrode potential for the $\text{Fe}^{3+}/\text{Fe}^{2+}$ electrode.



(a) Name the piece of apparatus labelled **A**.

(1)

(b) State the purpose of **A**.

(1)

(c) Name the substance used as electrode **B** in the diagram above.

(1)

(d) Complete **Table 1** to identify **C**, **D** and **E** from the diagram above. Include the essential conditions for each.

Table 1

	Identity	Conditions
C		
D		
E		

(4)

(e) The standard electrode potential, $E^\ominus$, for the $\text{Fe}^{3+}/\text{Fe}^{2+}$ electrode is +0.77 V

Give the ionic equation for the overall reaction in the cell in the diagram above.

State the change that needs to be made to the apparatus in the diagram to allow the cell reaction to go to completion.

Ionic equation _____

Change _____

(2)

- (f) A student sets up a cell as shown in the cell representation.



The student measures the cell EMF, E_{cell} , with several different concentrations of Cu^{2+} ions and Zn^{2+} ions.

The results are shown in **Table 2**.

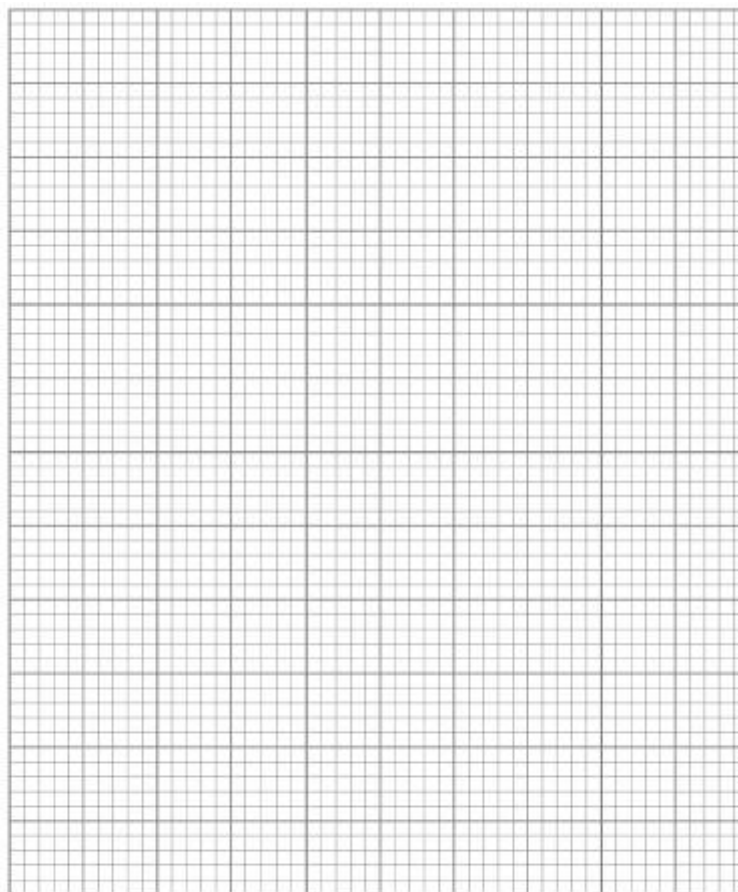
Table 2

Experiment	$[\text{Zn}^{2+}] / \text{mol dm}^{-3}$	$[\text{Cu}^{2+}] / \text{mol dm}^{-3}$	$\ln \left(\frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right)$	$E_{\text{cell}} / \text{V}$
1	0.010	1.0	-4.61	1.16
2	0.10	1.0	-2.30	1.13
3	1.0	1.0	0.00	1.10
4	1.0	0.10		1.07
5	1.0	0.010	4.61	1.04

Complete **Table 2** to show the value missing from experiment 4.

Plot a graph of E_{cell} against $\ln ([\text{Zn}^{2+}]/[\text{Cu}^{2+}])$ on the grid.

$E_{\text{cell}} / \text{V}$



$\ln \left(\frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right)$

(3)

- (g) This equation shows how E_{cell} varies with concentration for this reaction.

$$E_{\text{cell}} = (-4.3 \times 10^{-5} \times T) \ln \left(\frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right) + E^{\ominus}_{\text{cell}}$$

This equation is in the form of the equation for a straight line, $y = mx + c$

Calculate the gradient of your plotted line on the graph in part (f).

You must show your working.

Use your gradient to calculate the temperature, T , at which the measurements of E_{cell} were taken.

(If you were unable to calculate a gradient you should use the value -0.016 V

This is **not** the correct value.)

Gradient _____ V

- (h) In experiment 2 in **Table 2** the electrode potential of the Cu^{2+}/Cu electrode is +0.33 V

Use data from **Table 2** in part (f) to calculate the electrode potential for the Zn^{2+}/Zn electrode in experiment 2.

Give one reason why your calculated value is different from the standard electrode potential for Zn^{2+}/Zn electrode.

Electrode potential _____ V

Reason _____

(2)

(Total 17 marks)