

Name of the Student: _____

Max. Marks : 17 Marks

Time : 17 Minutes

Q1.

The table shows some electrode half-equations and the associated standard electrode potentials.

Equation number	Electrode half-equation	$E^\ominus / V$
1	$\text{Cd}(\text{OH})_2(\text{s}) + 2\text{e}^- \rightarrow \text{Cd}(\text{s}) + 2\text{OH}^-(\text{aq})$	-0.88
2	$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76
3	$\text{NiO}(\text{OH})(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{e}^- \rightarrow \text{Ni}(\text{OH})_2(\text{s}) + \text{OH}^-(\text{aq})$	+0.52
4	$\text{MnO}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{e}^- \rightarrow \text{MnO}(\text{OH})(\text{s}) + \text{OH}^-(\text{aq})$	+0.74
5	$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$	+1.23

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

(1)

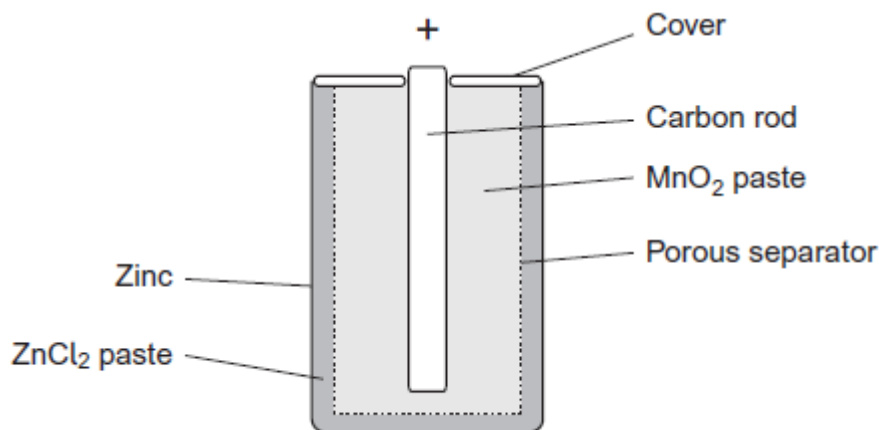
(b) Deduce the identity of the weakest oxidising agent in the table.
Explain how $E^\ominus$ values can be used to make this deduction.

Weakest oxidising agent _____

Explanation _____

(2)

(c) The diagram shows a non-rechargeable cell that can be used to power electronic devices. The relevant half-equations for this cell are equations **2** and **4** in the table above.



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

(1)

- (ii) Write an equation for the overall reaction that occurs when the cell discharges.

(1)

- (iii) Deduce **one** essential property of the non-reactive porous separator labelled in the diagram.

(1)

- (iv) Suggest the function of the carbon rod in the cell.

(1)

- (v) The zinc electrode acts as a container for the cell and is protected from external damage. Suggest why a cell often leaks after being used for a long time.

(1)

- (d) A rechargeable nickel–cadmium cell is an alternative to the cell shown in part (c). The relevant half-equations for this cell are equations **1** and **3** in the table above.

- (i) Deduce the oxidation state of the nickel in this cell after recharging is complete.

Write an equation for the overall reaction that occurs when the cell is **recharged**.

Oxidation state _____

Equation _____

(3)

- (ii) State **one** environmental advantage of this rechargeable cell compared with the non-rechargeable cell described in part (c).

(1)

- (e) An ethanol–oxygen fuel cell may be an alternative to a hydrogen–oxygen fuel cell. When the cell operates, all of the carbon atoms in the ethanol molecules are converted into carbon dioxide.

- (i) Deduce the equation for the overall reaction that occurs in the ethanol–oxygen fuel cell.

(1)

- (ii) Deduce a half-equation for the reaction at the ethanol electrode. In this half-equation, ethanol reacts with water to form carbon dioxide and hydrogen ions.

(1)

- (iii) The e.m.f. of an ethanol–oxygen fuel cell is 1.00 V. Use data from the table above to calculate a value for the electrode potential of the ethanol electrode.

(1)

- (iv) Suggest why ethanol can be considered to be a carbon-neutral fuel.

(2)

(Total 17 marks)