

4 (a) Define standard cell potential,  $E_{\text{cell}}^{\ominus}$ . Include a description of standard conditions.

.....  
.....  
..... [2]

(b) The Daniell cell is an electrochemical cell consisting of a  $\text{Cu}^{2+}(\text{aq})/\text{Cu}(\text{s})$  electrode and a  $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$  electrode.

(i) Draw a labelled diagram of this electrochemical cell.

Include all necessary substances and relevant pieces of apparatus needed to measure the  $E_{\text{cell}}^{\ominus}$ .

It is **not** necessary to state the conditions used.

[3]

(ii) State the charge carriers that transfer current through the solutions and through the wire.

the solutions ..... the wire ..... [1]

(iii) The standard electrode potential,  $E^{\ominus}$ , for the  $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$  electrode is  $-0.76\text{V}$ .

Water is added to a standard  $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$  electrode.

The new concentration of  $\text{Zn}^{2+}(\text{aq})$  is  $0.25\text{mol dm}^{-3}$ .

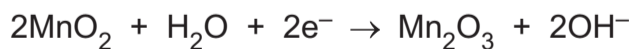
Use the Nernst equation to calculate the electrode potential,  $E$ , for this new  $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$  electrode.

$E(\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})) = \dots\dots\dots \text{V}$  [2]

(c) An electrochemical cell consists of a  $\text{ZnO}/\text{Zn}$  electrode and a  $\text{MnO}_2/\text{Mn}_2\text{O}_3$  electrode in an alkaline electrolyte.

The standard cell potential,  $E_{\text{cell}}^{\ominus}$ , for this cell is  $+1.47\text{V}$ .

The half-equation at each electrode when this cell is discharging is shown.



(i) Use this information to determine the change in oxidation state of manganese when this cell is discharging.

from ..... to ..... [1]

(ii) Write the equation for the overall reaction that occurs when this cell is discharging.

..... [1]

(iii) The  $E^{\ominus}$  for the  $\text{ZnO}/\text{Zn}$  electrode is  $-1.28\text{V}$ .

Calculate the standard electrode potential,  $E^{\ominus}$ , for the  $\text{MnO}_2/\text{Mn}_2\text{O}_3$  electrode.

$E^{\ominus}(\text{MnO}_2/\text{Mn}_2\text{O}_3) = \dots\dots\dots \text{V}$  [1]

[Total: 11]