Electrochemistry

Question Paper

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Chemistry Lab Skills 2
Sub Topic	Electrochemistry
Booklet	Question Paper

Time Allowed: **27 minutes**

Score: **/22**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A student wishes to measure the E_{cell} value of an electrochemical cell in which the following reaction occurs.

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s) \quad \textbf{Equation 1}$$

The solutions and apparatus available to the student are listed below.

Solution **A**:	copper(II) sulfate	1.00 mol dm^{-3}
Solution **B**:	iron(II) sulfate	concentration unknown
Solution **C**:	potassium nitrate	saturated
Solution **D**:	barium chloride	saturated

Copper foil electrodes
Iron foil electrodes
Platinum foil electrodes

Voltmeter **W**: low resistance
Voltmeter **X**: high resistance
Ammeter **Y**: low resistance
Ammeter **Z**: high resistance

Beakers
Connecting leads
Crocodile clips
Strips of filter paper

(a) Draw a labelled diagram of the cell that the student should set up to measure E_{cell} for the reaction in **Equation 1**.

Only use items selected from the list above.

(4)

(b) (i) The student measured E_{cell} as +0.79 V. The electrode dipping into the copper(II) sulfate solution was the positive electrode.

For this half-reaction

$$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s) \qquad E^{\ominus} = +0.34\,V$$

where $E^{\ominus}$ is the **standard** electrode potential.

Use the above information to calculate the electrode potential (E) in the student's cell for the half-reaction

$$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$$

(2)

(ii) For the half-reaction

$$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s) \qquad E^{\ominus} = -0.44\,V$$

where $E^{\ominus}$ is the **standard** electrode potential.

For this half-reaction, the electrode potential (E) at a particular concentration is related to the standard electrode potential ($E^{\ominus}$) by the equation

$$E = E^{\ominus} + 0.013 \ln [Fe^{2+}] \qquad \textbf{Equation 2}$$

where ln is the natural logarithm and $[Fe^{2+}]$ is the concentration of Fe^{2+} ions in mol dm^{-3}.

Use **Equation 2**, and your answer to (b)(i), to calculate the concentration of Fe^{2+} ions in solution **B**.

(2)

(c) The concentration of another solution of iron(II) sulfate, **Q**, was found by titration. 25.0 cm^3 samples of **Q** were titrated with a solution of acidified potassium manganate(VII), concentration 0.0300 mol dm^{-3}.

The results are as follows:

Titration	Rough	1	2	3
Burette reading (final) / cm^3	25.00	24.40	24.40	25.70
Burette reading (initial) / cm^3	1.00	2.10	1.60	3.30
Titre /cm^3				
Titres used to calculate mean (✓)				

(i) Complete the table and calculate the mean titre. Indicate with a (✓) the titres that you have used in your calculation.

(2)

Mean titre .....

(ii) State the colour change at the end-point.

(1)

.....

(iii) Complete the equation for the reaction occurring during the titration. State symbols are not required.

(2)

$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow$

(iv) Calculate the concentration, in mol dm^{-3}, of the iron(II) sulfate solution, **Q**.

Give your answer to **three** significant figures.

(4)

(v) The concentration of the iron(II) sulfate solution, **Q**, was also measured on a previous day using the method described in part (a).

The concentration was found to be 0.157 mol dm^{-3}.

Calculate the percentage difference between this value and the value you calculated in (c)(iv). You should assume that the correct concentration is 0.157 mol dm^{-3}.

(1)

(vi) In the titration, the volume delivered by the pipette is accurate to ±0.06 cm^3. Each burette reading is accurate to ±0.05 cm^3.

Calculate the percentage error of the pipette for a volume of 25.00 cm^3 and of the burette for your mean titre.

(2)

Pipette .....

Burette .....

(vii) Comment on the magnitudes of the values you have calculated in (c)(v) and (c)(vi).

(1)

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(viii) Suggest why the concentration of iron(II) sulfate in solution **Q** calculated in (c)(iv) is lower than the value given in (c)(v).

(1)

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(Total for Question 1 = 22 marks)