Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

S24-1410U50-1E

1410U50-1E

FRIDAY, 10 MAY 2024 – MORNING

CHEMISTRY – A2 unit 5
Practical Methods and Analysis Task

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**13**	
3.	**12**	
Total	**30**	

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ADDITIONAL MATERIALS

- A calculator, pencil and ruler
- **Data Booklet** supplied by WJEC

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 30.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

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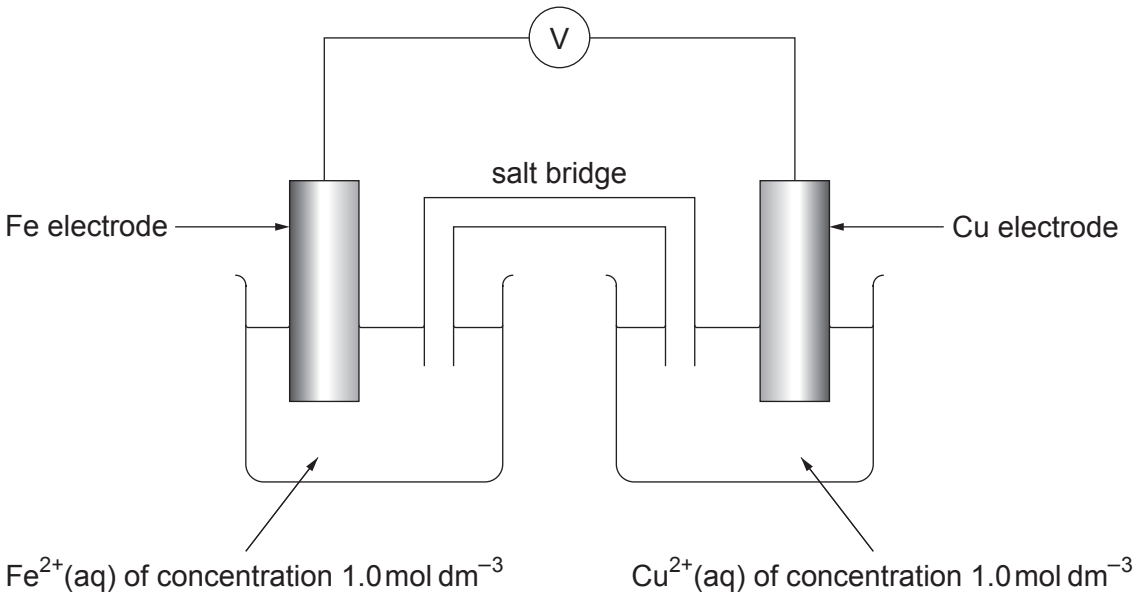
Answer **all** questions.

1. A student set up the following electrochemical cell.



(a) State how the student could have made the salt bridge. [1]

.....

.....

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(b) In this cell, the left-hand half-cell has a more negative standard electrode potential than the right-hand half-cell.

(i) Label the **positive electrode** on the diagram. [1]

(ii) The two electrodes were connected by a wire for a period of time.

I. Write an equation for the overall reaction which occurs. [1]

.....

II. Give **one** observation the student made at each half-cell. [2]

At the Fe^{2+}/Fe half-cell

.....

At the Cu^{2+}/Cu half-cell

.....

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5

2. When a solution containing Fe^{2+} ions is treated with a slight excess of a solution containing ethanedioate ions, $C_2O_4^{2-}$, a bright yellow solid is precipitated.

This compound is iron(II) ethanedioate hydrate, which may be written as $FeC_2O_4.xH_2O$.

A redox titration can be carried out to determine the relative molecular mass of iron(II) ethanedioate hydrate, and hence determine x, the number of moles of water of crystallisation.

In this titration the iron(II) ethanedioate hydrate is titrated against standard potassium manganate(VII) solution.

Titration method	
1	Accurately weigh between 3.350 g and 3.500 g of solid iron(II) ethanedioate hydrate, $FeC_2O_4.xH_2O$, in a weighing bottle.
2	Transfer the solid to a small beaker, re-weigh the weighing bottle and record the exact mass of $FeC_2O_4.xH_2O$ in the beaker.
3	Dissolve the solid in dilute sulfuric acid and make up to 500 cm^3 in a volumetric flask.
4	Use a funnel to add a small volume of the potassium manganate(VII) solution, $KMnO_4(aq)$, to rinse a burette.
5	Fill the burette with $KMnO_4(aq)$, remove the funnel and record the initial burette reading.
6	Use a volumetric pipette to transfer 25.0 cm^3 of the $FeC_2O_4.xH_2O$ solution into a conical flask and warm the contents to 70°C before titration.
7	Titrate the contents of the conical flask with $KMnO_4(aq)$ from the burette whilst swirling the flask.
8	If the temperature of the solution in the conical flask falls below 70 °C, then add boiling water.
9	Continue adding $KMnO_4(aq)$ dropwise until the first permanent colour change and record the final burette reading.
10	Repeat steps 5–9 to obtain concordant results.

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(a) Explain why the funnel is removed from the burette before the initial burette reading is taken (step 5). [1]

.....

.....

(b) Explain why the addition of boiling water to the conical flask, to maintain a temperature of 70 °C, does not have an effect on the titration results (step 8). [1]

.....

.....

(c) Give the colour at the end-point (step 9). [1]

.....

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(d) Complete both results tables below. Use the concordant volumes to calculate the mean titre. [4]

Results

Mass of $FeC_2O_4.xH_2O$

Mass of empty weighing bottle / g	6.542
Mass of weighing bottle and $FeC_2O_4.xH_2O$ / g	10.054
Mass of weighing bottle and residue / g	6.573
Mass of $FeC_2O_4.xH_2O$ / g	

Titrations

Concentration of $KMnO_4(aq)$ = 0.0215 mol dm^{-3}

	Titration 1	Titration 2	Titration 3	Titration 4
Initial burette reading / cm^3	1.60	0.30		1.20
Final burette reading / cm^3		27.45	28.00	
Titre volume / cm^3	27.85		27.20	27.10

Mean titre = ... cm^3

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At a temperature of 70 °C, both the $C_2O_4^{2-}$ and Fe^{2+} ions in the acidic solution of iron(II) ethanedioate hydrate react with potassium manganate(VII).

The water of crystallisation in the $FeC_2O_4.xH_2O$ **does not** take part in the redox process.

Redox half-equations

ethanedioate ion $C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-$ **(1)**

iron(II) ion $Fe^{2+} \longrightarrow Fe^{3+} + e^-$ **(2)**

manganate(VII) ion $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ **(3)**

(e) Use redox half-equations **(1)**, **(2)** and **(3)** given above to complete and balance the equation below for the reaction of iron(II) ethanedioate hydrate with potassium manganate(VII). [2]

$3MnO_4^- + 5FeC_2O_4 + \ldots\ldots\ldots\ldots \longrightarrow 3Mn^{2+} + 5Fe^{3+} + \ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots$

(f) Use the information given to calculate the value of x in $FeC_2O_4.xH_2O$.

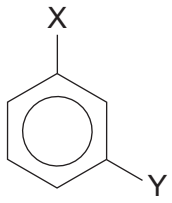
You **must** show clearly how you obtained your answer. [4]

x = ...

13

3. Compounds **A**, **B** and **C** all have the molecular formula C_8H_9NO and the structural formula shown below.

X and Y are functional groups or side chains. X and Y are **not** hydrogen atoms.



The results of tests carried out on solutions of compounds **A**, **B** and **C** are given in the table below.

	Test **1** 2,4-DNPH	Test **2** Tollens' reagent	Test **3** NaOH(aq), gentle heat	Test **4** Cold nitric(III) acid, HNO_2	Test **5** Cold HNO_2 followed by alkaline phenol
Compound **A**	yellow-orange precipitate	no reaction	no reaction	no reaction at first; bubbles of colourless gas when warmed to room temperature	red precipitate
Compound **B**	yellow-orange precipitate	silver mirror formed	no reaction	bubbles of colourless gas	bubbles of colourless gas
Compound **C**	no reaction	no reaction	pungent smelling gas formed; gas turns damp red litmus paper blue		

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(a) Draw the structures of compounds **A**, **B** and **C**. Give your reasoning. [6]

Compound **A**

Compound **B**

Compound **C**

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(b) (i) Give the structure of the red precipitate formed when compound **A** reacts in test **5**. [1]

(ii) Give the structure of the organic compound formed when compound **C** reacts in test **3**. [1]

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(c) The colourless gas formed on reaction of 200 cm^3 of a solution of compound **B** (M_r 135.09) with nitric(III) acid occupies 75.2 cm^3 at 28 °C and 1 atm.

The mole ratio of compound **B** to the gas formed is 1:1.

(i) Calculate the number of moles of gas formed. Use the ideal gas equation.

$$pV = nRT$$ [2]

Number of moles = ... mol

(ii) Calculate the concentration of compound **B** in g dm^{-3}. [2]

Concentration = ... g dm^{-3}

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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