



GCE A LEVEL

1410U50–1E

FRIDAY, 10 MAY 2024 – MORNING

CHEMISTRY – A2 UNIT 5

PRACTICAL METHODS AND ANALYSIS TASK

**1 hour plus your additional time
allowance**

Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

FOR EXAMINER'S USE ONLY		
Question	Maximum Mark	Mark Awarded
1.	5	
2.	13	
3.	12	
Total	30	

(Turn over)

ADDITIONAL MATERIALS

- A calculator and ruler
- DATA BOOKLET supplied by WJEC.

ITEMS INCLUDED WITH QUESTION PAPER

A separate Diagram Booklet.

The Diagram Booklet MUST be handed in to the invigilators and sent for marking.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball – point pen, black felt tip or your usual method.

Write your name, centre number and candidate number in the spaces on the front cover.

Answer ALL questions.

Write your answers in the spaces provided.

(Turn over)

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.

(Turn over)

Answer ALL questions.

1. A student set up the electrochemical cell shown in the diagram for Question 1 in the separate Diagram Booklet.

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

[1 mark]

(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 in the separate Diagram Booklet.

[1 mark]

continued on the next page . . .

(Turn over)

Question 1 (b) continued

1. (b) (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 mark]

II. Give ONE observation the student made at each half-cell.

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

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

[2 marks]

Total for Question 1 = 5 marks

(Turn over)

2. When a solution containing Fe^{2+} ions is treated with a slight excess of a solution containing ethanedioate ions, $\text{C}_2\text{O}_4^{2-}$, a bright yellow solid is precipitated.

This compound is iron(II) ethanedioate hydrate, which may be written as $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$

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.

Refer to the titration method given in the table provided in the separate Diagram Booklet.

continued on the next page . . .

Question 2 continued

- 2. (a) Explain why the funnel is removed from the burette before the initial burette reading is taken (step 5).**

[1 mark]

- (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 mark]

continued on the next page . . .

(Turn over)

Question 2 continued

2. (c) Give the colour at the end–point (step 9).

[1 mark]

(d) Complete both results tables for Question 2 (d), provided in the separate Diagram Booklet. Use the concordant volumes to calculate the mean titre.

Mean titre = _____ cm^3
[4 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

2. (e) Refer to the redox half–equations provided for Question 2 (e) in the separate Diagram Booklet.

At a temperature of 70 °C, both the $\text{C}_2\text{O}_4^{2-}$ and Fe^{2+} ions in the acidic solution of iron(II) ethanedioate hydrate react with potassium manganate(VII).

The water of crystallisation in the $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ DOES NOT take part in the redox process.

Use redox half–equations (1), (2) and (3) to complete and balance the equation for the reaction of iron(II) ethanedioate hydrate with potassium manganate(VII).

[2 marks]

continued on the next page . . .

(Turn over)

Question 2 continued

2. (f) Use the information given to calculate the value of x in $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$

You **MUST** show clearly how you obtained your answer.

Space for working:

$x =$ _____

[4 marks]

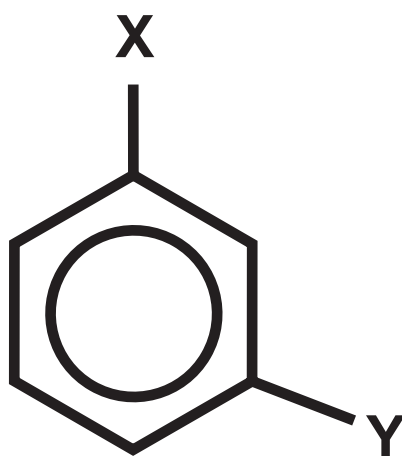
Total for Question 2 = 13 marks

(Turn over)

3. Compounds **A**, **B** and **C** all have the molecular formula $\text{C}_8\text{H}_9\text{NO}$ 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 provided for Question 3 in the separate Diagram Booklet.

continued on the next page . . .

Question 3 continued

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

Compound A

continued on the next page . . .

(Turn over)

Question 3 (a) continued

Compound B

continued on the next page . . .

(Turn over)

Question 3 (a) continued

Compound C

[6 marks]

continued on the next page . . .

(Turn over)

Question 3 continued

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

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 (b) continued

- 3. (b) (ii) Give the structure of the organic compound formed when compound C reacts in test 3**

[1 mark]

continued on the next page . . .

(Turn over)

Question 3 continued

3. (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.

$$pV = nRT$$

Space for working continues on the next page:

Question 3 (c) continued**Extra space for working:****Number of moles = _____ mol****[2 marks]****continued on the next page . . .****(Turn over)**

Question 3 (c) continued

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

Concentration = _____ g dm^{-3}
[2 marks]

Total for Question 3 = 12 marks

END OF PAPER

TOTAL 30 MARKS

(Turn over)

[illegible]

(Turn over)

[illegible]



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Diagram Booklet

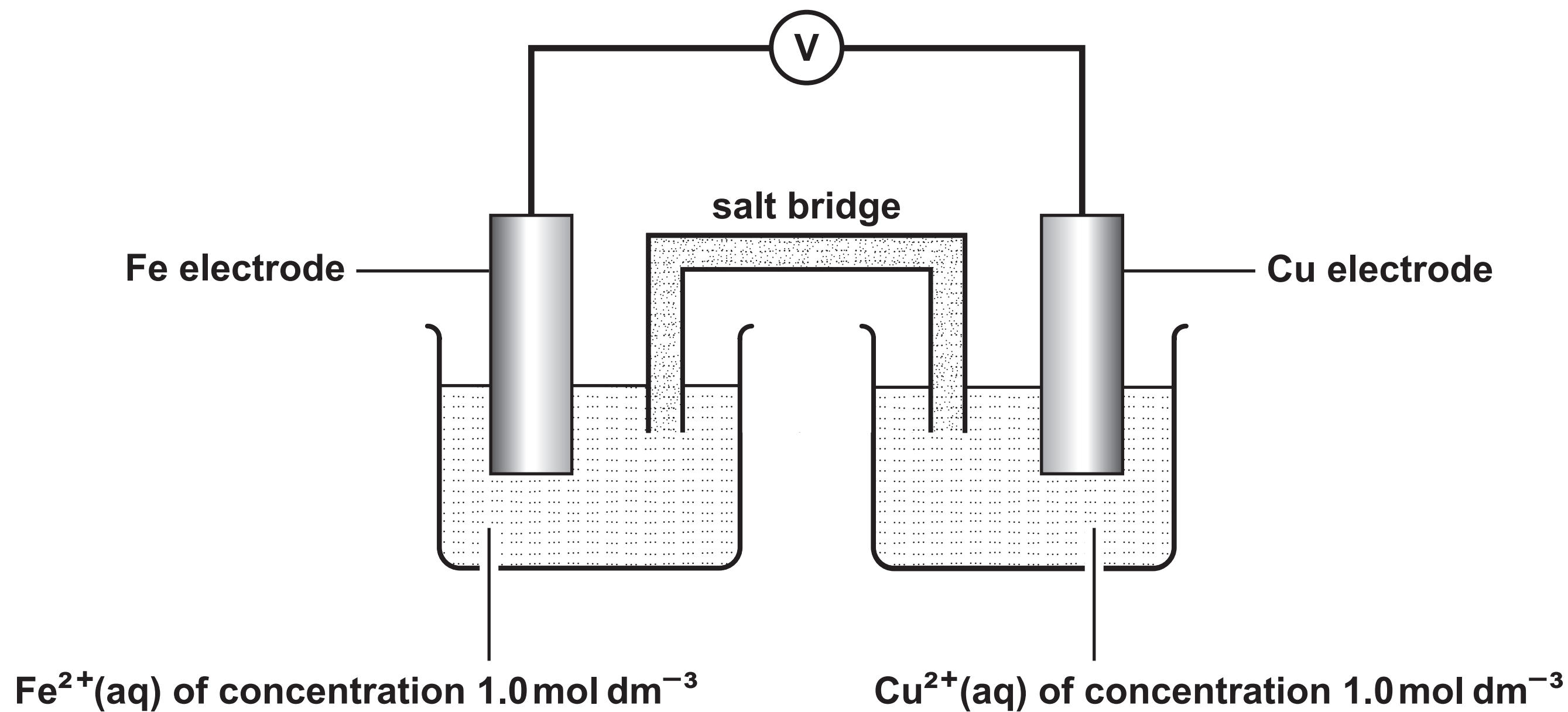
Surname: _____

First name(s): _____

Centre Number: _____

Candidate Number: 2 _____

Question 1



Question 2 (d)
RESULTS

Mass of $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$

Mass of empty weighing bottle / g	6.542
Mass of weighing bottle and $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ / g	10.054
Mass of weighing bottle and residue / g	6.573
Mass of $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ / g	_____

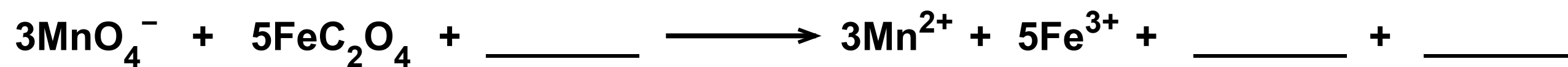
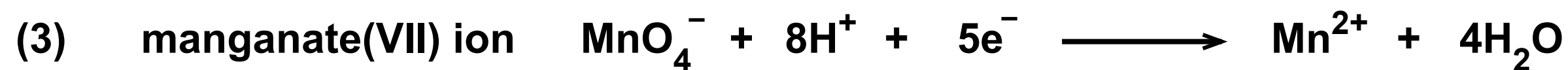
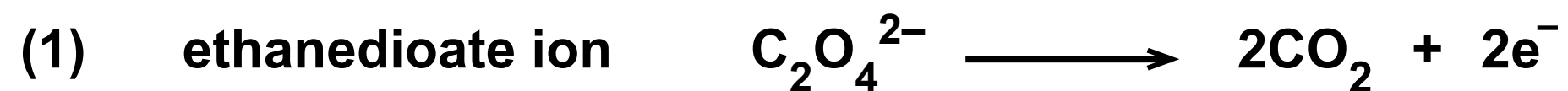
Titrations

Concentration of $\text{KMnO}_4(\text{aq}) = 0.0215 \text{ mol dm}^{-3}$

	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

Question 2 (e)

REDOX HALF – EQUATIONS



Question 2

Titration method	
1	Accurately weigh between 3.350 g and 3.500 g of solid iron(II) ethanedioate hydrate, $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$, in a weighing bottle.
2	Transfer the solid to a small beaker, re-weigh the weighing bottle and record the exact mass of $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ 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, $\text{KMnO}_4(\text{aq})$, to rinse a burette.
5	Fill the burette with $\text{KMnO}_4(\text{aq})$, remove the funnel and record the initial burette reading.
6	Use a volumetric pipette to transfer 25.0 cm^3 of the $\text{FeC}_2\text{O}_4 \cdot x\text{H}_2\text{O}$ solution into a conical flask and warm the contents to 70°C before titration.
7	Titrate the contents of the conical flask with $\text{KMnO}_4(\text{aq})$ 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 $\text{KMnO}_4(\text{aq})$ dropwise until the first permanent colour change and record the final burette reading.
10	Repeat steps 5 – 9 to obtain concordant results.

Question 3

	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		