Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL – NEW

A410U30-1

S17-A410U30-1

CHEMISTRY – A level component 3
Chemistry in Practice

TUESDAY, 27 JUNE 2017 – MORNING

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**17**	
3.	**6**	
4.	**12**	
5.	**4**	
6.	**10**	
Total	**60**	

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01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a:
- calculator;
- **Data Booklet** supplied by WJEC.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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

Answer **all** questions in the spaces provided.

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 60.

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

The assessment of the quality of extended response (QER) will take place in **Q.2**(*c*).

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.

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Answer **all** *questions in the spaces provided.*

1. Hydrated potassium tetraoxalate has the following simplified structure.

$$\left[\begin{array}{l}\text{COOK.COOH}\\ \;| \qquad\quad |\\ \text{COOH.COOH}\end{array}\right] n\,H_2O$$

It reacts with sodium hydroxide according to the following equation.

$$C_4H_3KO_8.nH_2O \quad + \quad 3NaOH \longrightarrow C_4Na_3KO_8.nH_2O \quad + \quad 3H_2O$$

A student carries out a two-part experiment to determine the value of n in hydrated potassium tetraoxalate.

(a) In part 1, the student weighs exactly 1.78 g of the solid and transfers all of it to a 250 cm^3 beaker. She adds 100 cm^3 of deionised water while stirring to ensure that it all dissolves. Describe, giving full practical details, how the volume is made up to **exactly** 250 cm^3. [3]

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(b) In part 2, the student titrates the potassium tetraoxalate solution against a standard solution of sodium hydroxide of concentration 0.100 mol dm^{-3} using a suitable indicator.

She obtains the following results using 25.0 cm^3 samples of the potassium tetraoxalate solution.

	Rough titration	Titration 1	Titration 2	Titration 3	Titration 4
Initial burette reading / cm^3	0.80	23.00	0.40	21.45	2.05
Final burette reading / cm^3	23.00	44.00	21.45	43.25	23.00
Titre volume / cm^3					

Complete the table to show the volume of sodium hydroxide solution used in each titration and calculate an appropriate mean titre. [2]

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Mean titre = ... cm^3

(c) Using the above information, calculate the relative molecular mass of $C_4H_3KO_8.nH_2O$ and hence the value of n. You **must** show clearly how you obtained your answer. [5]

n = ...

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(d) Her teacher carries out the same titration and obtains a titre of 21.10 cm^3. Calculate the maximum percentage error due to a burette with a maximum error of ± 0.05 cm^3 for each reading. [1]

Maximum percentage error = ... %

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2. Metals **X** and **Y** are Group 2 metals. Each one could be Mg, Ca, Sr or Ba.

(a) Metal **X** appears not to react with cold water but reacts rapidly with steam.

Identify metal **X** and give the equation for its reaction with steam. [1]

Metal **X** ....

....

(b) Metal **Y** reacts with cold water according to the following equation.

$$\mathbf{Y}(s) \quad + \quad 2H_2O(l) \longrightarrow \mathbf{Y}(OH)_2(aq) \quad + \quad H_2(g)$$

(i) When 2.27 g of metal **Y** are added to 600 cm^3 of water, the concentration of the metal hydroxide solution formed on complete reaction is 0.0431 mol dm^{-3}. [3]
Identify metal **Y**.

Metal **Y** ....

(ii) When 200 cm^3 of the 0.0431 mol dm^{-3} solution of **Y**$(OH)_2$ formed in part (i) are added to excess sodium carbonate solution, **Y**CO_3 is precipitated as a white solid and separated by filtration. The precipitate is washed with deionised water and heated at 100 °C until the mass of **Y**CO_3 remains constant.

I. Give an equation, including **state symbols**, for the reaction of aqueous **Y**$(OH)_2$ with aqueous sodium carbonate. [1]

....

II. Calculate the maximum mass of **Y**CO_3 formed, giving your answer to **three** significant figures. [3]

Mass = ... g

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(c) Carbonates of Group 2 decompose on heating according to the following general equation.

$$\mathbf{Z}CO_3(s) \longrightarrow \mathbf{Z}O(s) + CO_2(g)$$

Give the trend in thermal stability of the carbonates on going down Group 2 and describe an experiment to show how this pattern could be confirmed.

Your answer should include:

- a detailed description of the method used
- how to collect valid results, identifying the control variable(s)
- the expected observation(s) [6 QER]

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(d) Give a precipitation reaction which can be used as a test for $Ba^{2+}(aq)$ ions, which would not give a positive result for $Mg^{2+}(aq)$ ions. Your answer should include the name of the reagent used, an equation for the precipitation reaction taking place and an explanation for your choice of reaction. [3]

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17

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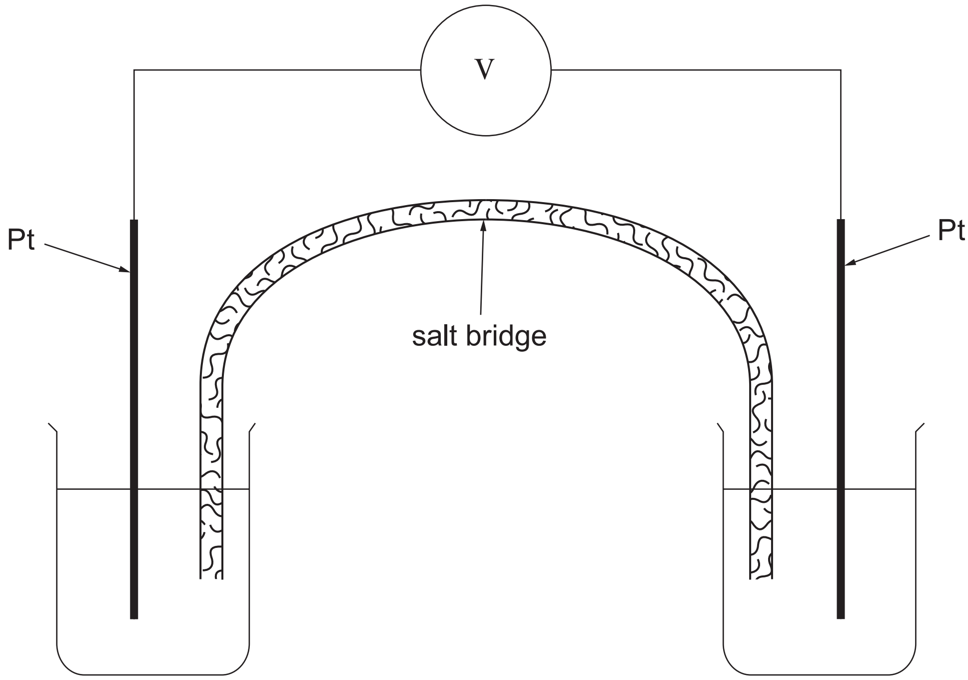
3. A student set up an electrochemical cell made up of the two half-cells for which the half-equations are given below.

$$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq) \qquad E^\theta = +0.77\,V$$

$$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O(l) \qquad E^\theta = +1.52\,V$$



$Fe^{3+}(aq) / Fe^{2+}(aq) | Pt$

Half-cell **A**

$MnO_4^-(aq), 8H^+(aq) / Mn^{2+}(aq), 4H_2O(l) | Pt$

Half-cell **B**

(a) Suggest how the student made the salt bridge. [1]

....

....

(b) Write an equation for the overall cell reaction and calculate the standard cell potential for this cell. [2]

....

Standard cell potential = ... V

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(c) Describe **one** observation the student would have made in each half-cell after the cell had been connected for a period of time. [2]

Half-cell **A** ....

Half-cell **B** ....

(d) The student measured the cell potential and found that it was different from the value calculated in *(b)*. Suggest a reason for this. [1]

....

....

6

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4. The following method was used to determine the molecular and structural formula of a straight chain alkene **U** of general formula C_nH_{2n-2}. **U** reacts with bromine according to the following equation.

$$C_nH_{2n-2} \quad + \quad 2Br_2 \longrightarrow C_nH_{2n-2}Br_4$$

- Step 1: A 3.50 g sample of **U** was treated with 10.0 cm^3 of liquid bromine (an excess) at 20 °C, the reaction being carried out in a fume cupboard.
  (Density of bromine = 3.10 g cm^{-3} at 20 °C)
- Step 2: After the reaction between alkene **U** and bromine was complete, the unreacted bromine was treated with excess aqueous sodium iodide to form iodine.

$$2NaI(aq) \quad + \quad Br_2(l) \longrightarrow 2NaBr(aq) \quad + \quad I_2(aq)$$

- Step 3: The resulting solution was then made up to 250 cm^3 and the concentration of iodine present in solution determined by titration with a standard solution of sodium thiosulfate of concentration 1.05 mol dm^{-3}.

$$I_2(aq) \quad + \quad 2Na_2S_2O_3(aq) \longrightarrow 2NaI(aq) \quad + \quad Na_2S_4O_6(aq)$$

A 25.0 cm^3 sample of the iodine solution required 17.35 cm^3 of the sodium thiosulfate solution for complete reaction.

(a) Complete the risk assessment for step 1 given below. [1]

Hazard	Risk	Control measure
		Reaction must be carried out in the fume cupboard. Wear eye protection and protective gloves.

(b) Use **all** the information provided to answer parts (i)-(iii).

(i) Calculate the total number of moles of bromine added in step 1. [2]

n(Br_2) added = ... mol

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(ii) Calculate the number of moles of bromine that did not react with the alkene and hence the number of moles of bromine that reacted. [4]

$n(Br_2)$ that reacted = ... mol

(iii) Determine the molecular formula of the alkene and hence suggest its structural formula and name. Show your reasoning. [5]

Structural formula

Name ....

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5. Noradrenaline is a hormone that is produced naturally by the body. It is given by injection to treat a life-threatening drop in blood pressure.

A student was given a sample of noradrenaline for chemical testing in the laboratory. He carried out four tests as shown in the chart below.

Complete the chart.

- Describe the observations for tests 1 and 2.
- Identify the reagent(s) used in test 3.
- Draw the structure of the product formed in test 4. [4]

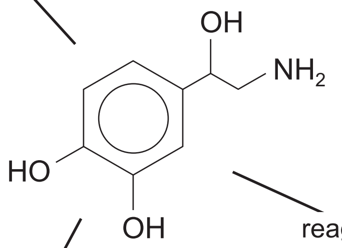
Test 1: Observation

Test 2: Observation

$Na_2Cr_2O_7(aq)$ / $H^+(aq)$
heat

neutral $FeCl_3(aq)$

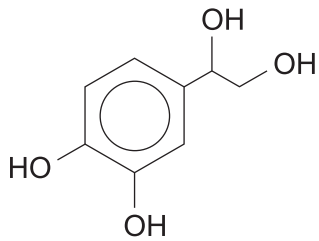
noradrenaline



reagent(s)

dilute HCl(aq)

Test 3:
Bubbles of nitrogen gas produced. Major organic product formed is



Test 4: Structure of the product formed

Test 3: Reagent(s)

6. The purpose of this experiment is to determine the activation energy (E_a) for the reaction of peroxodisulfate(VI) ions $S_2O_8^{2-}$(aq) with iodide ions I^-(aq) using a clock reaction.

Background

The equation for the reaction is as follows.

$$S_2O_8^{2-}(aq) \quad + \quad 2I^-(aq) \longrightarrow 2SO_4^{2-}(aq) \quad + \quad I_2(aq) \qquad \text{reaction 1}$$

A small, known volume of thiosulfate solution $S_2O_3^{2-}$(aq) is added to the reaction mixture which also contains starch indicator. The thiosulfate reacts with the iodine mixture produced in reaction 1 according to the following equation.

$$2S_2O_3^{2-}(aq) \quad + \quad I_2(aq) \longrightarrow S_4O_6^{2-}(aq) \quad + \quad 2I^-(aq) \qquad \text{reaction 2}$$

At the exact instant that all the thiosulfate ions have reacted, free iodine is produced in the reaction solution and the blue-black colour of the iodine-starch complex is seen.

For this clock reaction then

rate of reaction is $\propto \frac{1}{t}$ where t = time for solution to turn blue-black

Method

- Using a burette, 10.00 cm^3 of sodium peroxodisulfate(VI), $S_2O_8^{2-}$(aq), of concentration 0.0200 mol dm^{-3} were added to a boiling tube and placed upright in a water bath at the required temperature.
- Using burettes, 5.00 cm^3 of potassium iodide solution, 5.00 cm^3 of sodium thiosulfate solution and 2.50 cm^3 of starch indicator were placed in a second boiling tube. This boiling tube was also placed upright in the same water bath.
- When the temperature of the two solutions reached the water bath temperature, the contents of the second boiling tube were poured into the first, the contents mixed rapidly and a stop clock started.
- The time taken for the blue-black colour of the starch-iodine complex to appear was recorded.
- This method was repeated at different temperatures.

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Results

Temperature / °C	Time (t) / s	Temperature (T) / K	1/T / K^{-1}	$\log_{10}(1/t)$
20	416	293	0.00341	–2·62
25	289	....	0.00336	–2·46
40	103	313	0.00319	–2·01
45	75	318	0.00315	–1·88
50	55	323	0.00310	....
60	30	333	....	–1·48

(a) Complete the results table. [2]

(b) State **one** factor that needs to remain constant in order to obtain valid results in this experiment. [1]

....

....

(c) The Arrhenius equation can be rearranged as follows:

$$\log_{10}(1/t) = -\frac{E_a}{2.30RT} + \log_{10}A$$

Plot $\log_{10}(1/t)$ against 1/T on the graph paper opposite and hence calculate the activation energy (E_a) for the peroxodisulfate(VI)-iodide reaction.

You **must** show clearly how you obtained your answer. [7]

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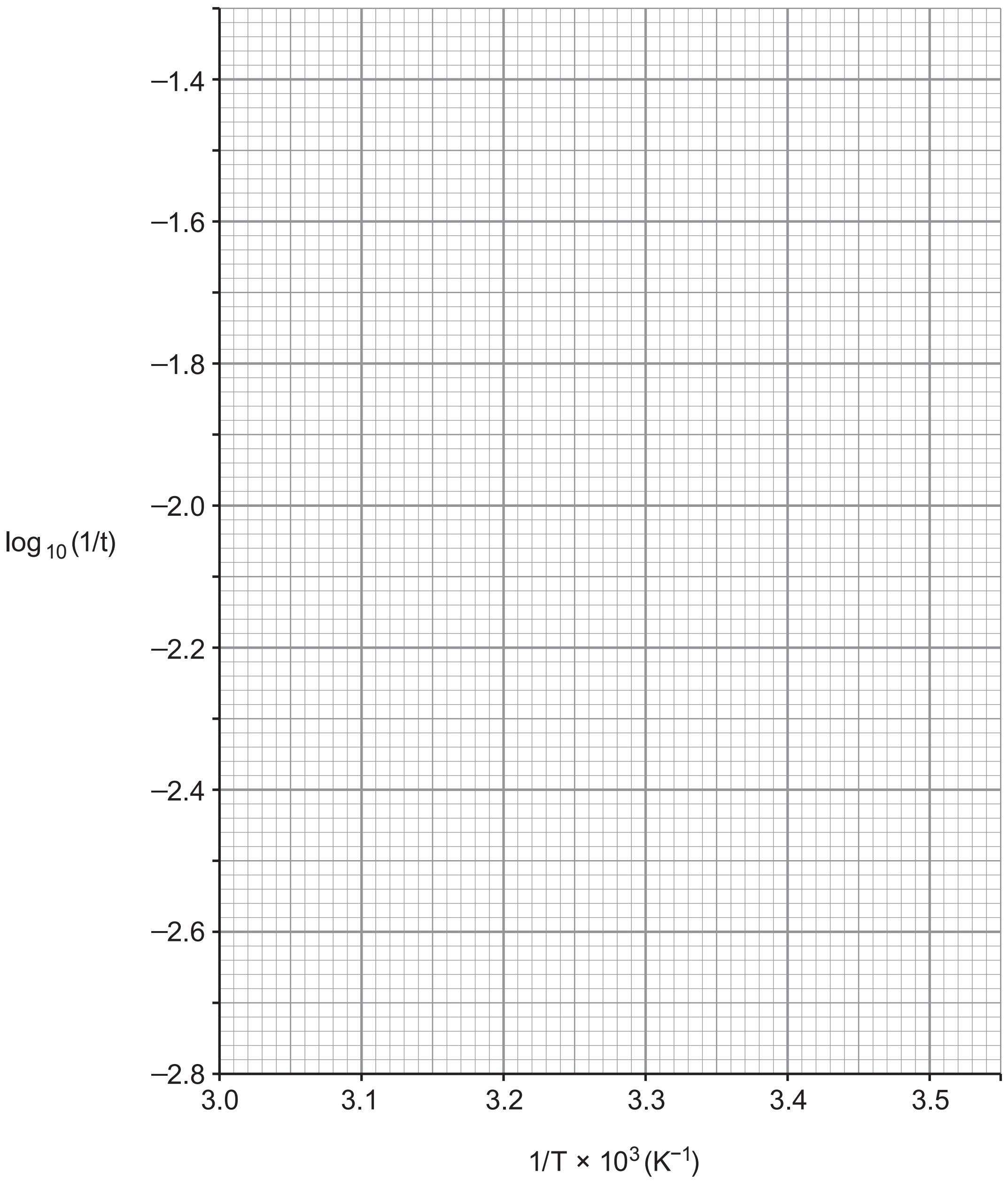

Activation energy (E_a) = ...

Unit ....

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END OF PAPER

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