Surname	Centre Number	Candidate Number
Other Names		2

GCE A LEVEL

1410U50-1A

S19-1410U50-1A

CHEMISTRY – A2 unit 5

Practical Examination

Experimental Task

TEST 1

WEDNESDAY, 8 MAY 2019

3 hours

For Teacher's use only Award a mark of 0 or 1 for each of the following	
Efficient use of solutions (**Parts A & B**)	
Working safely (**Parts A & B**)	

For Examiner's use only	
Mark Awarded	
Total	

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01

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Pencil may be used to draw tables and graphs.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this task is 30.
Your teacher will directly assess your practical skills in **Parts A** and **B**.
The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for orderly presentation in your answers.

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This experimental task is in two parts.

Both parts will examine the rate of reaction between hydrogen peroxide and potassium iodide in acidic solution.

$$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

Iodide ions are oxidised to iodine by hydrogen peroxide in acidic solution. Iodine gives a strongly coloured blue-black complex with starch solution but if a given amount of thiosulfate ions – with which iodine reacts very rapidly – are added, no blue-black colour appears until enough iodine has been formed to react with all the thiosulfate ions.

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

The rate can be followed by measuring the time taken to form the blue-black complex. This represents the time taken to produce a fixed amount of iodine, so that the rate can be calculated as

$$\text{rate} = \frac{\text{amount of iodine}}{\text{time}}$$

As the amount of iodine produced is the same in each reaction

$$\text{rate} = \frac{1}{\text{time}}$$

Part A – To examine the effect of hydrogen peroxide concentration on the rate of reaction of hydrogen peroxide and iodide ions

The results will be analysed graphically to determine the order of reaction with respect to hydrogen peroxide.

Part B – To examine the effect of temperature on the rate of reaction of hydrogen peroxide and iodide ions

The results obtained at different temperatures will be used to graphically calculate the activation energy from the Arrhenius equation.

The apparatus and chemicals required are listed on the following pages.

You should record all observations in the spaces provided and then use the results in the analysis section later in this paper.

Part A – To examine the effect of hydrogen peroxide concentration on the rate of reaction of hydrogen peroxide and iodide ions

Apparatus

You will need eye protection and the following apparatus:

1 × stop clock or stopwatch
1 × 250 cm^3 conical flask
2 × burette & stand
2 × small funnel
2 × 10 cm^3 measuring cylinder
1 × 25 cm^3 measuring cylinder
1 × boiling tube
1 × teat pipette (1 cm^3)
1 × thermometer (± 1°C)

You may use shared burettes if necessary.

Part B – To examine the effect of temperature on the rate of reaction of hydrogen peroxide and iodide ions

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Apparatus

You will need a water bath in addition to the apparatus above.

For water bath:

Bunsen burner, tripod & gauze (or electric heater)
large beaker
clamp & stand

You may use shared electric water baths if available.

Chemicals

You will need:

75 cm^3 of 0.1 mol dm^{-3} hydrogen peroxide
150 cm^3 of 1 mol dm^{-3} sulfuric acid
200 cm^3 of 0.1 mol dm^{-3} potassium iodide
150 cm^3 of 0.005 mol dm^{-3} sodium thiosulfate
150 cm^3 of deionised water
15 cm^3 of starch solution

These volumes are sufficient to carry out **Part A** and **Part B**.

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Part A – To examine the effect of hydrogen peroxide concentration on the rate of reaction of hydrogen peroxide and iodide ions

You will keep the total volume of solution constant at 50 cm^3.

The following volumes should be used in **each** run.

10 cm^3 of sulfuric acid
10 cm^3 of sodium thiosulfate
15 cm^3 of potassium iodide
1 cm^3 of starch solution

The total volume of hydrogen peroxide/water used each time will be 14 cm^3 but the ratio will vary from run to run.

You will carry out the reaction between hydrogen peroxide and potassium iodide **five** times, changing the concentration of hydrogen peroxide each time by varying the volumes of both hydrogen peroxide and water.

You should use 5 cm^3 of hydrogen peroxide and 9 cm^3 of deionised water for your first run. You should choose the volumes of hydrogen peroxide and water to be used for the other **four** runs. They should provide an **appropriate range** of reaction times.

You **do not** need to carry out repeat readings to calculate mean values.

You have access to one burette containing hydrogen peroxide and another containing deionised water.

Record your results clearly in an appropriate table on page 7.

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Turn over.

Procedure

- **Wear eye protection at all times.**
- **Assume that all solutions are toxic and corrosive.**

1. Accurately measure 5 cm^3 of hydrogen peroxide and 9 cm^3 of deionised water from the burettes into a clean boiling tube.

2. Use appropriate measuring cylinders to accurately measure 10 cm^3 of sulfuric acid, 10 cm^3 of sodium thiosulfate and 15 cm^3 of potassium iodide into a conical flask. Add 1 cm^3 of starch solution using a teat pipette.

3. Swirl the mixture gently and record the temperature of the mixture. You will need this for **Part B**. You will not need to measure any further temperature values in **Part A**.

   Temperature = ... °C

4. Pour the hydrogen peroxide solution into the flask, swirl the flask and start the stop clock.

5. Record the time taken for the first permanent appearance of the blue-black colour.

6. Carry out **four** more runs using an **appropriate range** of hydrogen peroxide concentrations.

You will use your results in the **Analysis of Results** section after you have completed **Part B** of this experimental task.

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Results

Draw a table to record solution volumes and reaction times. Include appropriate titles and units throughout.

Record your results clearly in the table. [4]

Examiner only

Results Part A	
	4

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Part B – To examine the effect of temperature on the rate of reaction of hydrogen peroxide and iodide ions

During this part you will carry out the reaction between hydrogen peroxide and potassium iodide at **three** different temperatures – approximately 35 °C, 45 °C and 55 °C.

You will use 5 cm^3 of hydrogen peroxide and 9 cm^3 of deionised water in **each** run.

The volumes of all other solutions will be the same as those used in **Part A** and the total volume of solution will again be 50 cm^3.

10 cm^3 of sulfuric acid
10 cm^3 of sodium thiosulfate
15 cm^3 of potassium iodide
1 cm^3 of starch solution

You **do not** need to carry out repeat readings to calculate mean values.

Record your results clearly in an appropriate table on page 9.

Procedure

- **Wear eye protection at all times.**
- **Assume that all solutions are toxic and corrosive.**

1. Accurately measure 5 cm^3 of hydrogen peroxide and 9 cm^3 of deionised water from the burettes into a clean boiling tube.

2. Use appropriate measuring cylinders to accurately measure 10 cm^3 of sulfuric acid, 10 cm^3 of sodium thiosulfate and 15 cm^3 of potassium iodide into a conical flask. Add 1 cm^3 of starch solution using a teat pipette.

3. Place the flask into a water bath and clamp safely in place. Warm the contents to approximately 35 °C.

4. Carefully remove the flask. Measure and record the **actual temperature** immediately before adding the hydrogen peroxide solution.

5. Pour the hydrogen peroxide solution into the flask, swirl the flask and start the stop clock.

6. Record the time taken for the first permanent appearance of the blue-black colour.

7. Carry out one further run at approximately 45 °C and another at approximately 55 °C. Record the **actual temperatures** used for each run.

You will use your results in the **Analysis of Results** section.

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Results

Draw a table to record **actual temperatures** and reaction times. Include appropriate titles and units throughout.

Include the result for 5 cm^3 of hydrogen peroxide and 9 cm^3 of deionised water and the relevant temperature from **Part A**. [4]

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Results Part B	4

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Analysis of Results

Part A – To examine the effect of hydrogen peroxide concentration on the rate of reaction of hydrogen peroxide and iodide ions

(i) Complete the table below.

Calculate the concentration of hydrogen peroxide in each of the 50 cm^3 portions used in the five runs in **Part A**. The first one where 5 cm^3 of hydrogen peroxide was used has been done for you.

Calculate the rate in each of the runs.

$$\text{rate} = \frac{1}{\text{time}}$$

Concentration of hydrogen peroxide, H_2O_2 / mol dm^{-3}	Rate / s^{-1}
0.010	

[3]

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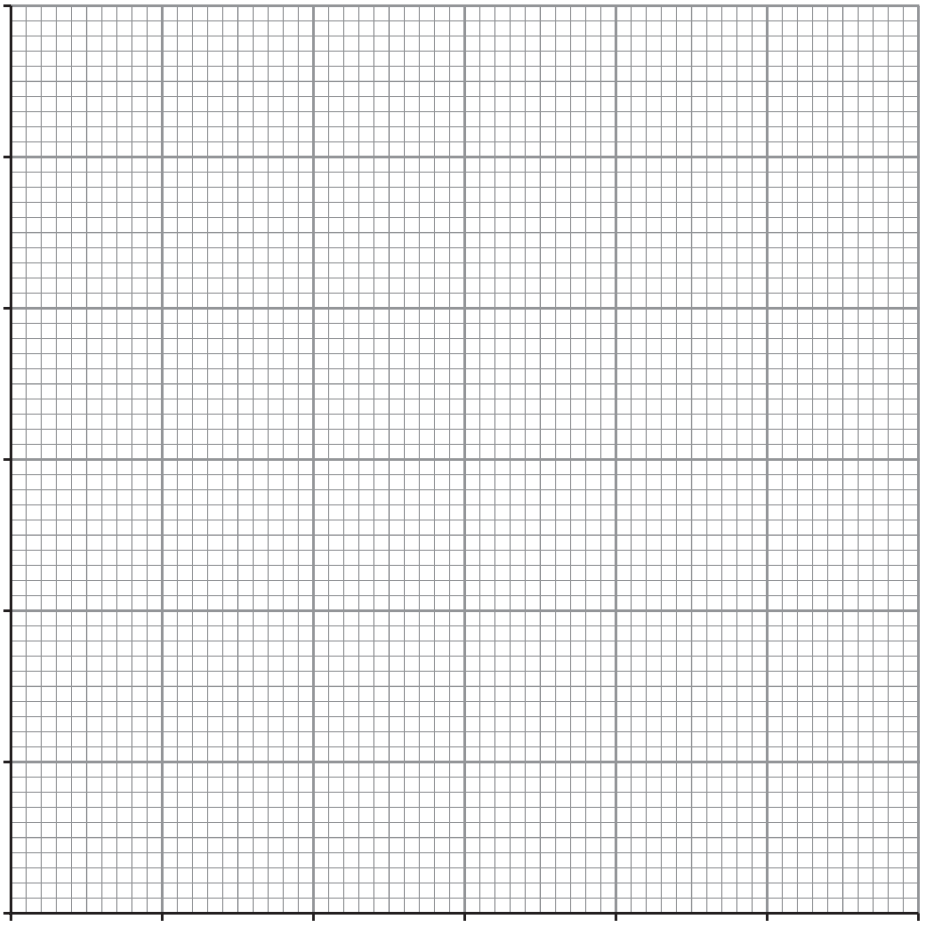
(ii) Plot a graph of rate against hydrogen peroxide concentration on the grid below. [3]



(iii) Use this graph to deduce the order of reaction with respect to hydrogen peroxide. Explain your answer. [1]

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Turn over.

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Part B – To examine the effect of temperature on the rate of reaction of hydrogen peroxide and iodide ions

(iv) Complete the table below.

Use the relationship in the **Data Booklet** to record your temperature, *T*, in K. Calculate $\frac{1}{T}$.

Calculate the rate $\left(\frac{1}{\text{time}}\right)$ for each run and hence ln(rate).

Temperature / K	$\frac{1}{T}$ / K^{-1}	Rate / s^{-1}	ln(Rate)

[4]

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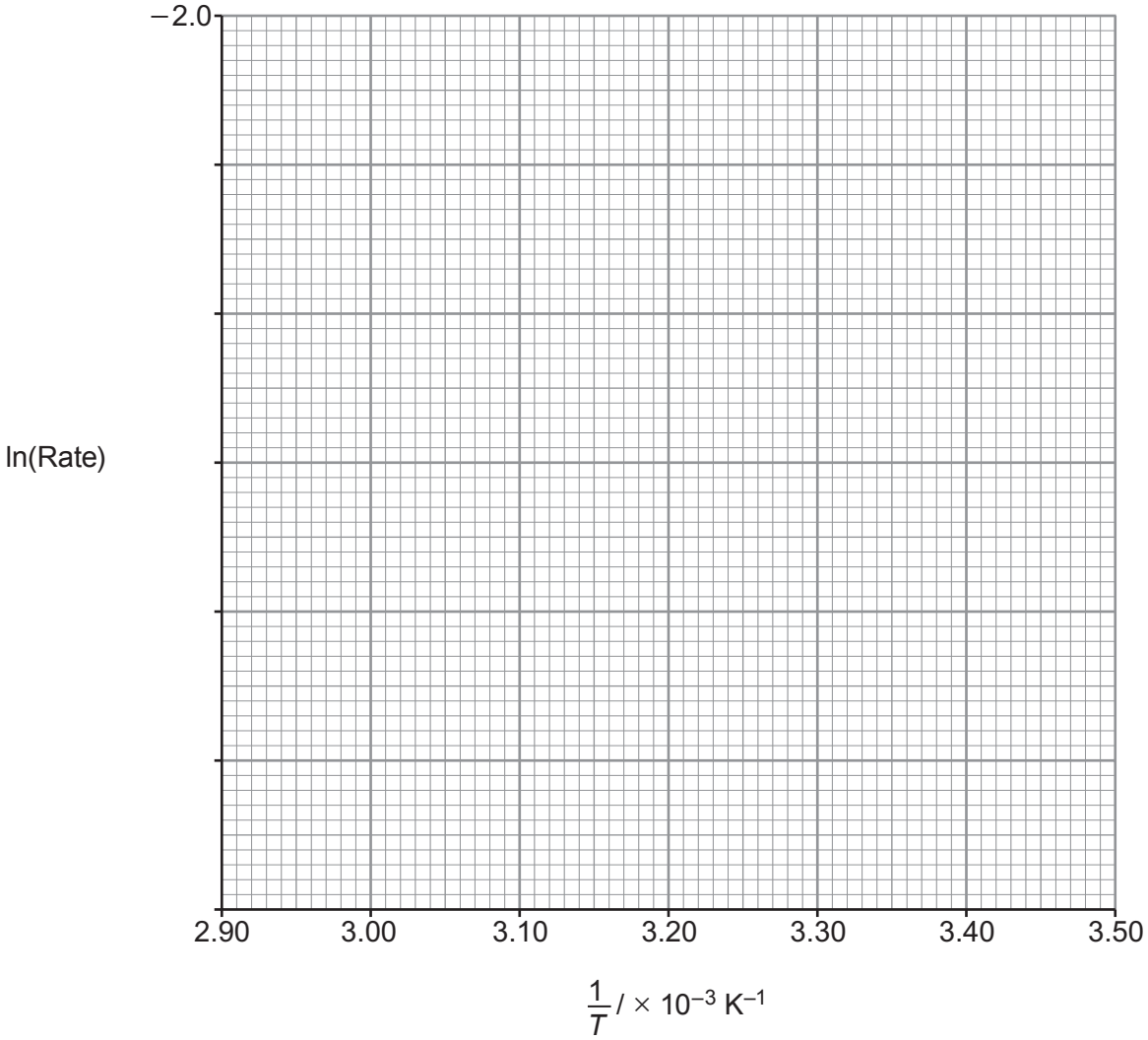
(v) Plot ln(rate) against $\frac{1}{T}$ on the grid below. Draw a line of best fit. [4]



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(vi) As the rate is directly proportional to the rate constant, it can be assumed that the graph represents an Arrhenius plot. Consequently, the gradient represents $\frac{-E_a}{R}$.

Use the gradient to calculate the activation energy for the reaction between hydrogen peroxide and iodide ions. Give your answer in **kJ mol^{-1}**. [2]

Activation energy = ... kJ mol^{-1}

(vii) If the order of reaction with respect to iodide ions is 2 and with respect to acid is 0, use this and your answer to part (iii) to suggest an equation that represents the rate determining step for the reaction. [1]

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(viii) Explain why the mixture of 5 cm^3 of hydrogen peroxide and 9 cm^3 of water was chosen for **Part B**. [2]

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END OF PAPER

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