Surname	Centre Number	Candidate Number
Other Names		2

GCE AS

B410U20-1

S19-B410U20-1

eduqas Part of WJEC

CHEMISTRY – AS component 2
Energy, Rate and Chemistry of Carbon Compounds

THURSDAY, 23 MAY 2019 – MORNING

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 7.**	**10**	
Section B	**8.**	**14**	
	9.	**14**	
	10.	**15**	
	11.	**10**	
	12.	**17**	
	Total	**80**	

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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.

Section A Answer **all** questions in the spaces provided.
Section B Answer **all** questions in the spaces provided.

Candidates are advised to allocate their time appropriately between **Section A (10 marks)** and **Section B (70 marks)**.

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 80.

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.8***(a)*.

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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SECTION A

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

1. Draw the structure of a hydrocarbon that has five carbon atoms and exhibits *E*-*Z* isomerism. [1]

2. Draw the repeat unit of the polymer formed from the monomer CH_3CHCH_2. [1]

3. Species can be classified as electrophiles, nucleophiles or radicals.

(a) Explain what is meant by an *electrophile*. [1]

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(b) Give an example of an electrophile. [1]

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4. 3,4-Dimethylpentan-2-ol is a secondary alcohol.

(a) Draw the **skeletal** formula for 3,4-dimethylpentan-2-ol. [1]

(b) State why it is classified as a secondary alcohol. [1]

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5. *(a)* State Hess's Law. [1]

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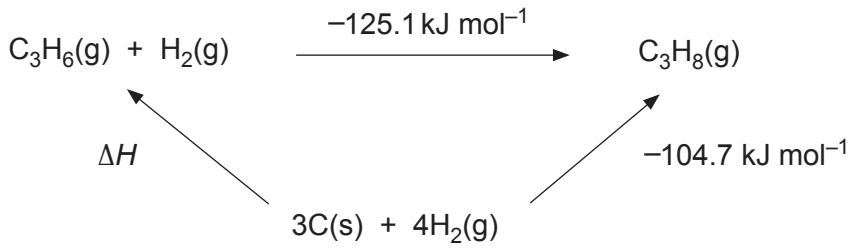
(b) Determine the value of ΔH, in kJ mol^{-1}, in the energy cycle below. [1]



ΔH = ... kJ mol^{-1}

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6. Name **two** compounds formed during the **incomplete** combustion of propane. [1]

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7. Ethanoic acid, CH_3COOH, is a typical organic acid.

Write the equation for the reaction between ethanoic acid and magnesium oxide. [1]

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SECTION B

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

8. *(a)* Discuss how 1-bromobutane can react with hydroxide ions under different conditions to give two different organic products.

Draw the mechanism for the formation of **one** of the organic products. [6 QER]

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(b) Chloroethane is formed when ethane reacts with chlorine in sunlight. However, during the reaction a mixture of products is obtained.

(i) Name the type of reaction mechanism taking place. [1]

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(ii) Explain why butane can also form during this reaction. [2]

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(c) Halogenoalkanes can also be formed from alkenes.

When 3-methylbut-1-ene is reacted with hydrogen bromide a mixture of two different products is formed.

(i) Identify the products. [2]

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(ii) State and explain which of the two products is more likely to be formed. [1]

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(d) Halogenoalkanes containing both chlorine and fluorine are known as CFCs. One of the most abundant CFCs in the atmosphere is trichlorofluoromethane, CCl_3F.

Explain why CCl_3F remains longer in the troposphere (lower atmosphere) of the Earth than in the stratosphere (upper atmosphere). [2]

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9. A student carried out an experiment to determine the enthalpy change of reaction for the decomposition of aqueous hydrogen peroxide.

$$H_2O_2(aq) \longrightarrow H_2O(l) + \tfrac{1}{2}O_2(g)$$

Since the reaction is very slow, she was told to use aqueous iron(III) nitrate as a catalyst. It is an amber colour originally but turns a dark reddish-brown during the decomposition.

She used the following method.

- Use a burette to measure 50.0 cm^3 of aqueous hydrogen peroxide (3 % w/v) into a polystyrene cup.
- Place a 1 °C graduated thermometer in the solution and record the temperature.
- Add 50.0 cm^3 of aqueous iron(III) nitrate to the solution.
- Stir the mixture with the thermometer and record the maximum temperature reached.

Her results are shown below.

Initial temperature of the aqueous hydrogen peroxide = 19.0 °C

Final temperature of the aqueous hydrogen peroxide = 27.5 °C

(a) The student said that it is not necessary to ensure that the hydrogen peroxide and the iron(III) nitrate are at the same temperature before addition.

Is she correct? Justify your answer. [1]

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(b) A concentration of "3 % w/v" means that there are 3 g of hydrogen peroxide in 100 cm^3 of solution.

Calculate the concentration of the aqueous hydrogen peroxide in mol dm^{-3}. [2]

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

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(c) Calculate the value, in kJ mol^{-1}, for the enthalpy change of reaction for the decomposition of hydrogen peroxide.

Give your answer to an **appropriate** number of significant figures. [4]

(If you do not have an answer in part *(b)* assume that the concentration is 0.790 mol dm^{-3}. This is **not** the correct answer.)

ΔH = ... kJ mol^{-1}

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(d) State why she accurately measured the volume of the catalyst. [1]

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(e) State how the student would know that the decomposition reaction had finished. [1]

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(f) Suggest **two** improvements that would make the experiment more accurate. Justify both improvements. [4]

1. .....

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2. .....

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(g) State how the value of the enthalpy change would be affected if the experiment were repeated using a different catalyst. [1]

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10. *(a)* A student is asked to prepare a sample of ethanal by oxidising ethanol.

(i) Write an equation for this reaction. [1]

Use [O] to represent the oxidising agent and show the structure of the organic product.

(ii) Describe, giving brief experimental details, how he can carry out the reaction. [4]

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(iii) Ethanol can also be oxidised to ethanoic acid. Describe how the student could use a chemical test to confirm that his sample of ethanal did **not** contain ethanoic acid. [2]

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(b) State a difference and a similarity between the ^{13}C NMR spectra of ethanal and ethanol. [2]

Difference .....

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Similarity .....

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(c) Ethanol is widely used as a biofuel in some countries.

(i) The equation for its combustion is given below.

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

Use the average bond enthalpy values given in the table below to calculate the enthalpy of combustion for ethanol. [3]

Bond	Average bond enthalpy / kJ mol^{-1}
C—C	348
C—H	412
C—O	360
O—H	463
O═O	496
C═O	743

$\Delta_c H$ ethanol = ... kJ mol^{-1}

(ii) Give a disadvantage of biofuels compared with fossil-based fuels. [1]

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(d) Ethanol and hexan-1-ol are both primary alcohols. Explain why ethanol is soluble in water but hexan-1-ol is not. [2]

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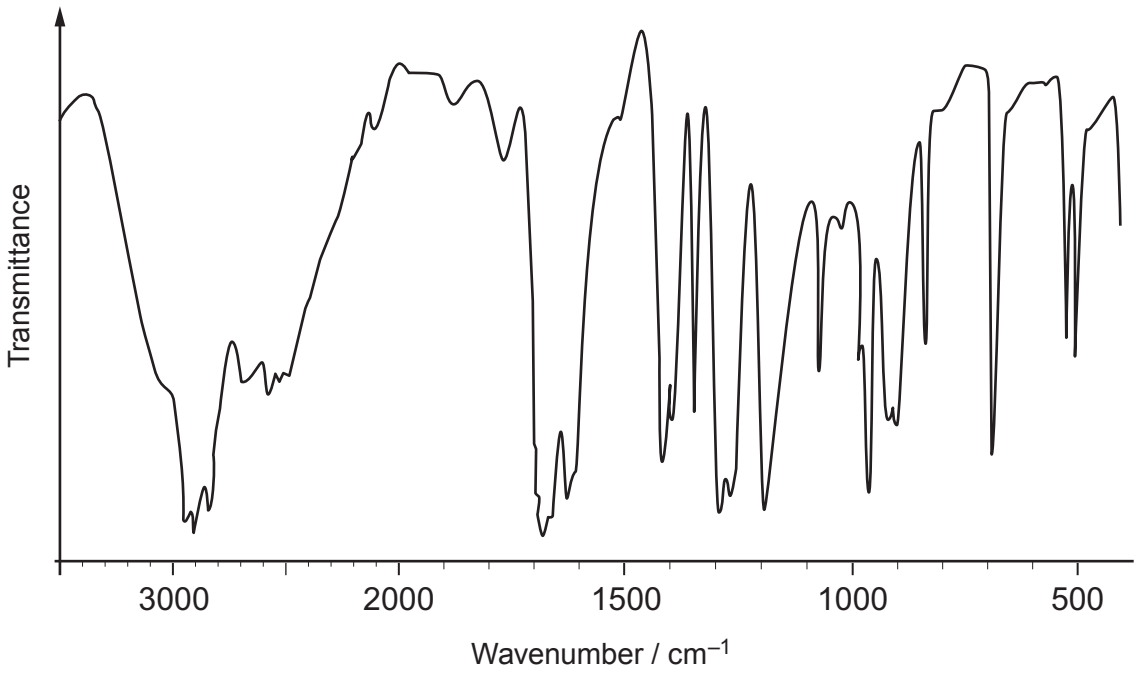
11. Compound **A** contains 55.8 % carbon, 7.00 % hydrogen and 37.2 % oxygen by mass.

Part of its infrared spectrum is shown below.



- An aqueous solution of compound **A** has a pH of less than 7.
- In an addition reaction, 2.00 g of compound **A** reacts with 3.71 g of bromine in a 1 : 1 molar ratio.

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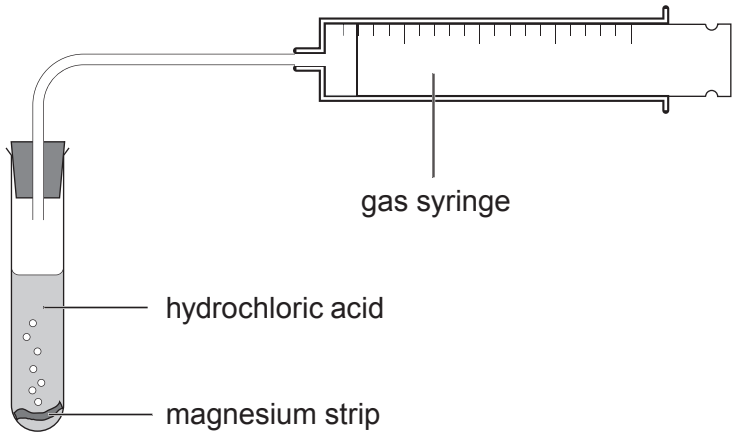
Use all the data given to identify **all** the possible structures of compound **A**. Explain what information can be found from each piece of data. [10]

12. A student carried out an experiment to study the reaction between magnesium and hydrochloric acid.

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g) \qquad \Delta H = -467 \text{ kJ mol}^{-1}$$

He used the following apparatus to measure the volume of hydrogen produced over time.



The experiment was carried out at a temperature of 25 °C and 1 atm pressure. The amount of acid used was sufficient to react with all the magnesium.

These are the results obtained.

Time / s	Volume of hydrogen / cm^3
0	0
10	32
20	50
30	64
40	75
60	88
80	92
100	100
120	100

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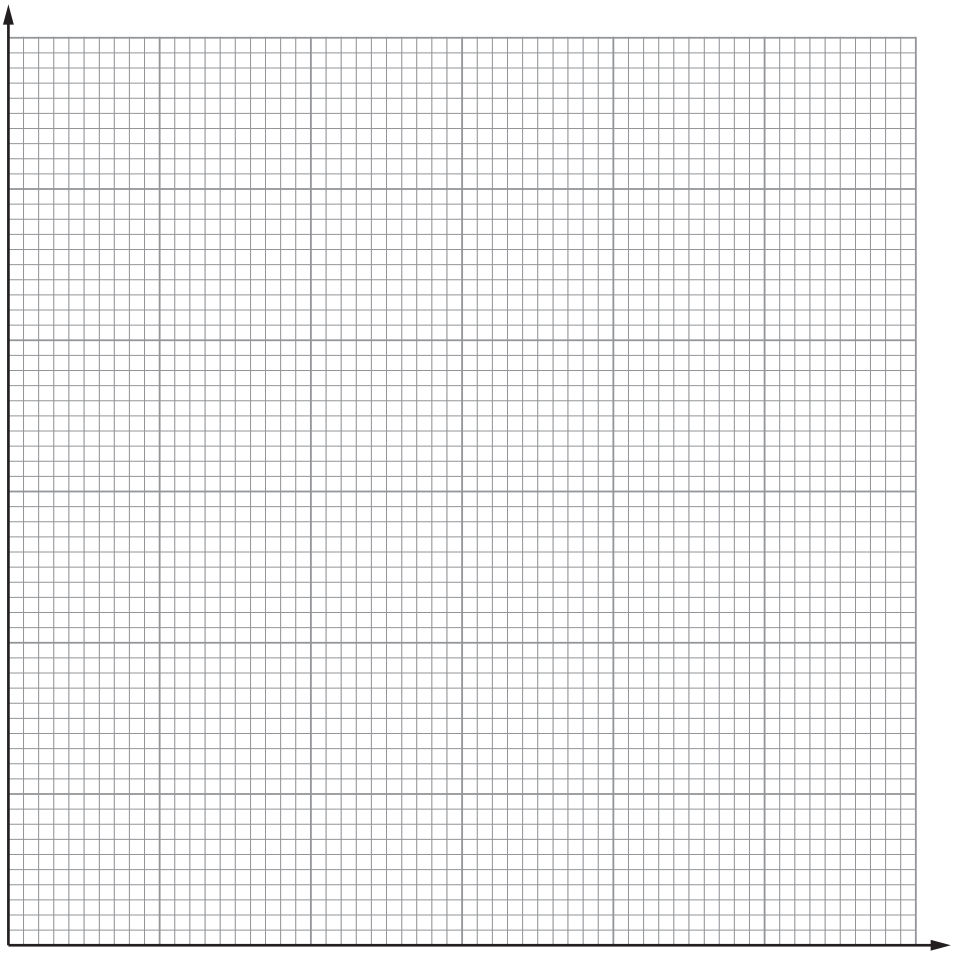
(a) Plot the results for the experiment and draw a line of best fit. Label it **A**. [4]



(b) Use the graph to calculate the rate of reaction at 20 seconds in $cm^3\ s^{-1}$. [2]

Rate = ... $cm^3\ s^{-1}$

(c) When he repeated the experiment, it took him 8 seconds to replace the bung in the tube and start the stopwatch after adding the magnesium.

On the graph, sketch the curve that would be obtained if the results of this experiment were plotted. Label it **B**. [2]

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(d) Calculate the mass of the magnesium strip used in the experiment. [2]

Mass = ... g

(e) The rates of some reactions can be determined from the loss of mass over a period of time. However, the student said that he could not use this method as he only had a two decimal place balance. Is he correct? Justify your answer. [2]

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(f) He repeated the experiment using the same mass of magnesium and the same volume and concentration of acid, in order to collect 100 cm^3 of hydrogen, but over a longer period of time.

State **one** method of slowing down the reaction and use collision theory to explain this change of rate. [3]

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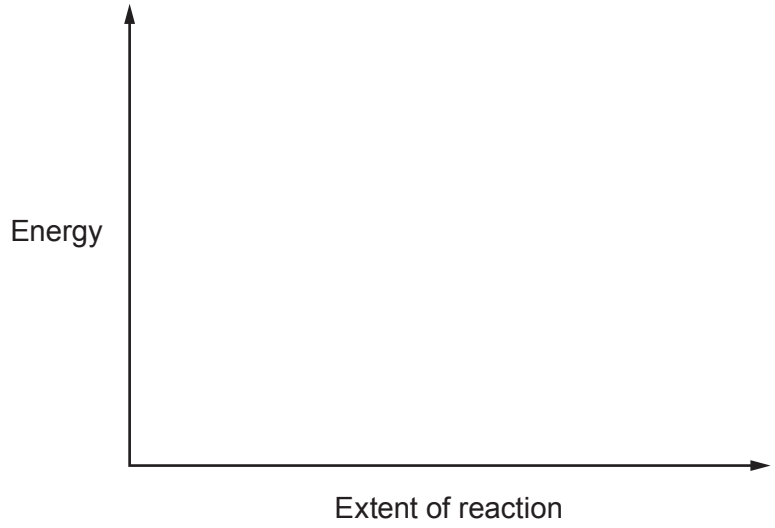
(g) On the axes below, sketch the energy profile for this reaction, labelling the enthalpy change of reaction, $\Delta_r H$. [2]



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