Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL – NEW

2410U20-1

S17-2410U20-1

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

FRIDAY, 9 JUNE 2017 – AFTERNOON

1 hour 30 minutes

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1. to 6.**	**10**	
Section B	**7.**	**14**	
	8.	**16**	
	9.	**13**	
	10.	**14**	
	11.	**13**	
	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. Do not use gel pen or correction fluid.

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***(b)*.

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. *(a)* Draw the **displayed** formula of *(E)*-pent-2-ene. [1]

(b) Draw the **skeletal** formula of 3-chlorohex-1-ene. [1]

2. State the molecular formula of a straight-chained saturated halogenoalkane whose molecules each contain 50 carbon atoms and 2 chlorine atoms. [1]

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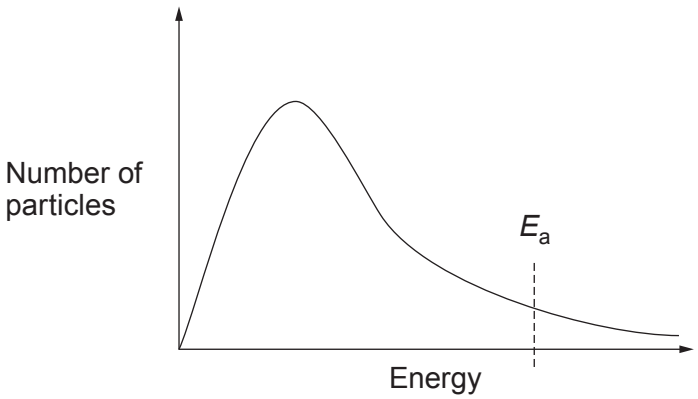
3. The diagram shows the distribution of the energies of particles in a gas at a particular temperature.



On the diagram draw a curve to show the distribution of the energies of the same particles at a higher temperature.

Use the diagram to explain the effect of increasing temperature on the rate of a reaction. [2]

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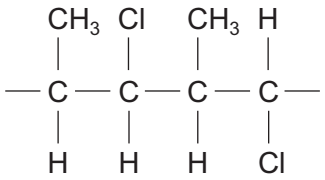
4. A section of polymer is shown.



Draw the structural formula of the monomer used to make this polymer. [1]

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5. Complete the statement below. [2]

To test for the presence of iodine in an organic compound the compound is first heated with ..... . This is followed by adding ..... and then ..... to the mixture. If iodine was present in the organic compound then a ..... precipitate is seen.

6. *(a)* Complete the equation below to show clearly the missing product. [1]

(b) Name the catalyst used in the reaction in part *(a)*. [1]

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SECTION B

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

7. *(a)* Ethanol, C_2H_5OH, is a liquid at room temperature. Write the equation that corresponds to the standard enthalpy change of formation of ethanol. [2]

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(b) Why is it difficult to measure the standard enthalpy change of formation of ethanol directly? [1]

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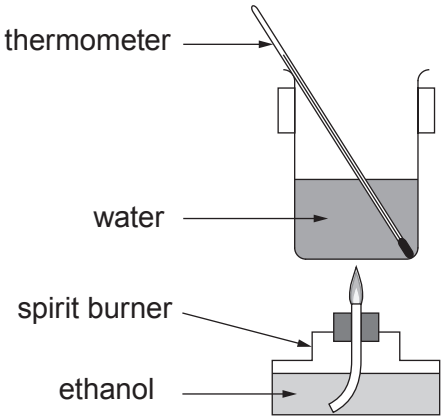
(c) The following apparatus can be used to determine the enthalpy change of combustion of ethanol, $\Delta_c H$.



(i) Explain how the enthalpy change of combustion is calculated from the results collected using this apparatus. [3]

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(ii) Why is it difficult to use this apparatus to determine the enthalpy change of combustion of ethane, C_2H_6? [1]

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(d) Two students carried out an experiment using the apparatus in part *(c)*.

Neither followed the given method correctly. Euan extinguished the flame after only 10 seconds. Carys continued to heat for two minutes after the water had boiled.

Explain the effect that each of the students' errors had on the values they obtained in this experiment. [2]

Effect of Euan's error

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Effect of Carys' error

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(e) Standard enthalpy changes of formation, $\Delta_f H^\theta$, can be found by using standard enthalpy changes of combustion, $\Delta_c H^\theta$.

The table shows some standard enthalpy changes of combustion.

Substance	Standard enthalpy change of combustion / kJ mol^{-1}
carbon, C	–394
hydrogen, H_2	–286
ethanol, C_2H_5OH	–1371

(i) Use these data to calculate the standard enthalpy change of formation of ethanol. Show clearly how you carried out your calculation. [3]

$\Delta_f H^\theta$ = ... kJ mol^{-1}

(ii) Amir said that hydrogen is the best fuel of these three in terms of the energy released by burning equal masses. Is he correct? Justify your answer. [2]

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8. *(a)* Compound **X** is a hydrocarbon that contains 85.6 % of carbon by mass. The relative molecular mass of **X** is in the range 50-60.

11.2 g of compound **X** decolourised exactly 32.0 g of bromine in the absence of light. Further bromine was decolourised when the reaction mixture was placed in direct sunlight.

(i) Find the empirical formula of **X** and hence its molecular formula. Show clearly how you carried out your calculation. [3]

Molecular formula .....

(ii) Explain what can be deduced from the fact that 11.2 g of **X** reacts with exactly 32.0 g of bromine. [2]

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(iii) What type of reaction mechanism occurs when **X** reacts with bromine in the absence of light? [1]

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(iv) What type of reaction mechanism occurs when **X** reacts with more bromine in the presence of sunlight? [1]

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(v) Draw displayed formulae for each of the following. [3]

Compound **X**

The product formed when **X** reacts with bromine in the absence of light

One possible product formed when **X** reacts with excess bromine in the presence of sunlight

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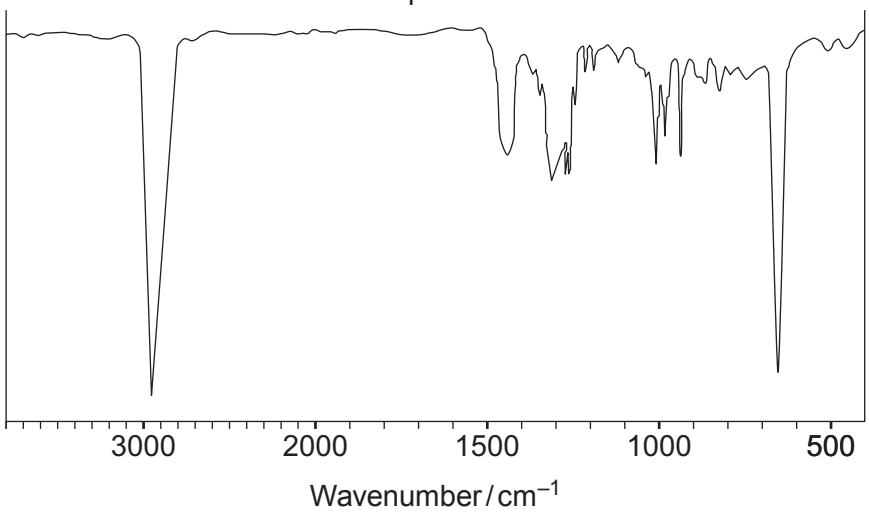
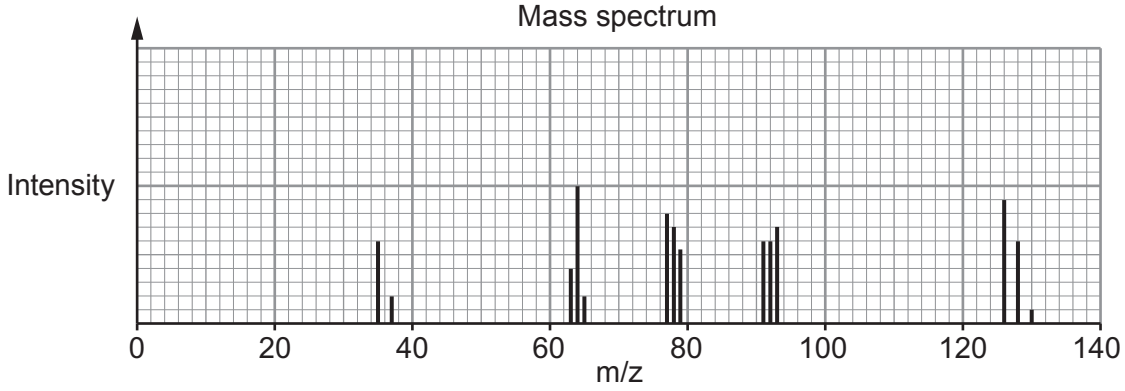
(b) Compound **Y** is a halogenoalkane. A simplified form of the IR spectrum, the mass spectrum, the ^{13}C NMR spectrum and the low resolution ^{1}H NMR spectrum of **Y** are shown below.

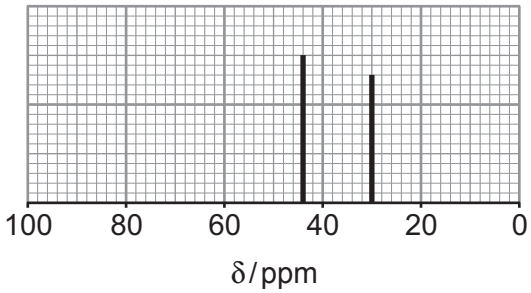
IR spectrum



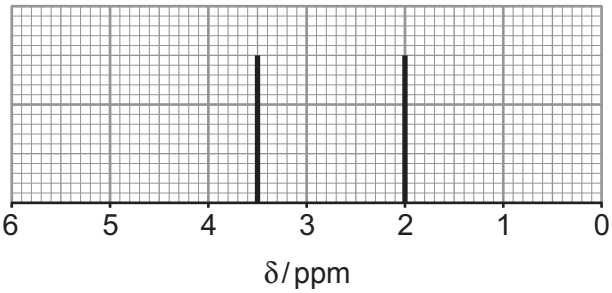
Mass spectrum



^{13}C NMR



^{1}H NMR



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Use these spectra to determine the identity of compound **Y**. You must use evidence from each spectrum and explain how you used it. [6 QER]

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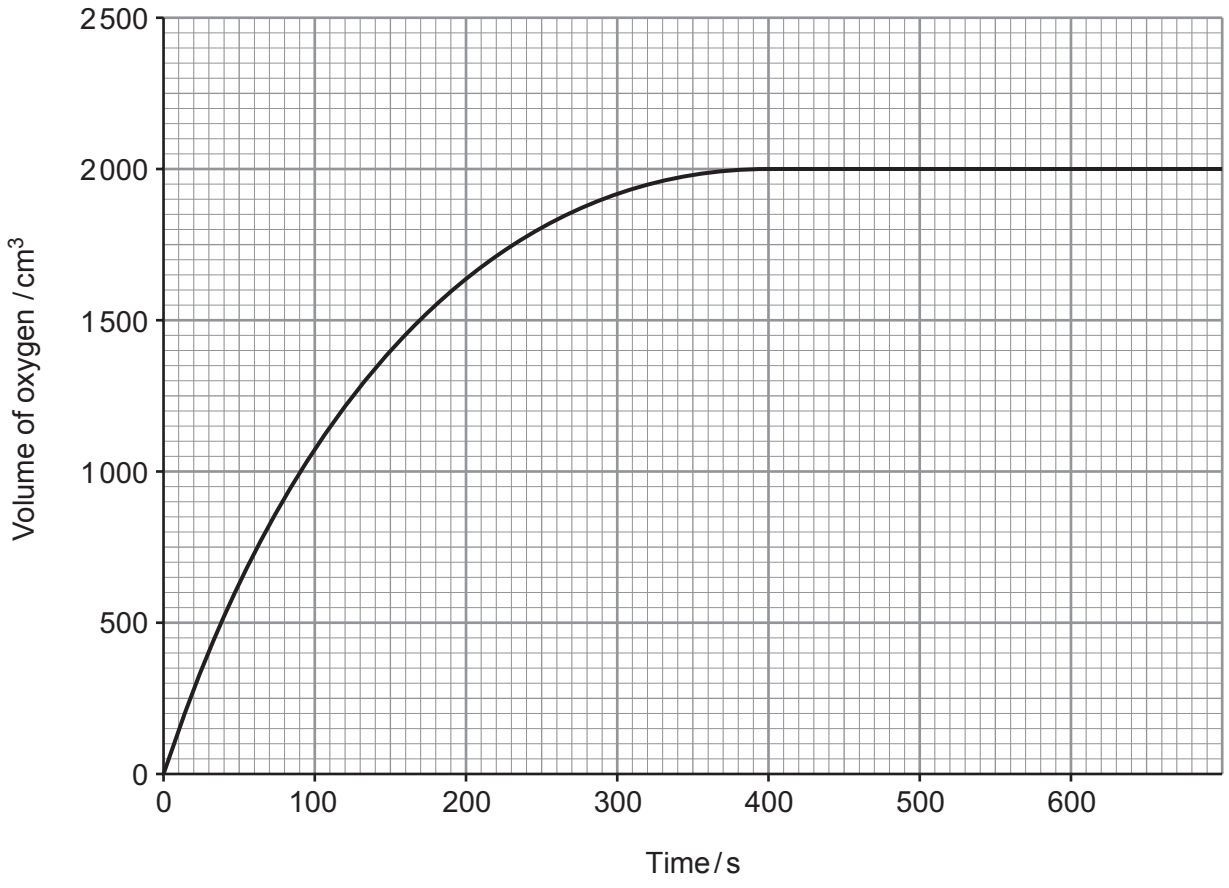
9. A student was investigating the rate of reaction for the catalysed decomposition of hydrogen peroxide to form oxygen.

$$2H_2O_2(aq) \longrightarrow O_2(g) + 2H_2O(l)$$

The student decided to follow the reaction by measuring the volume of oxygen produced at fixed time intervals. He added a spatula measure of manganese(IV) oxide to 100 cm^3 of aqueous hydrogen peroxide solution and started the timer.

(a) Draw a labelled diagram of the apparatus he could use to carry out the experiment and measure the volume of oxygen produced. [2]

(b) The student plotted his results to produce a graph as shown.



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(i) Use the graph to calculate the initial rate of the reaction. Show clearly, on your graph, how you obtained your answer. [2]

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

(ii) Use the graph to calculate the rate of the reaction at 200 seconds. Show clearly, on your graph, how you obtained your answer. [1]

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

(iii) Use collision theory to explain why the rates you have calculated in parts (i) and (ii) are different. [2]

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(iv) Use the graph to calculate the concentration, in mol dm^{-3}, of the hydrogen peroxide solution used by the student. Give your answer correct to **three** significant figures. [3]

Assume that the reaction was carried out at 298 K and 1 atm pressure.

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

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(c) A second student said that she had seen cobalt(II) chloride speed up the rate of production of oxygen very significantly in a different reaction.

Describe how the students could determine if cobalt(II) chloride is a better catalyst than manganese(IV) oxide in the decomposition of hydrogen peroxide. [3]

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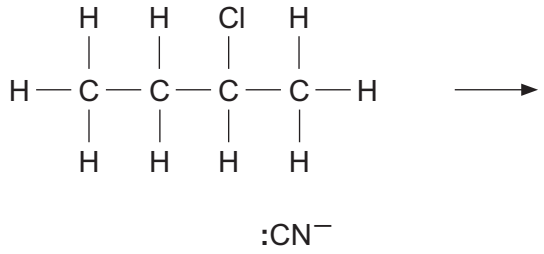
10. *(a)* Halogenoalkanes react with potassium cyanide in a similar way to their reaction with $OH^-(aq)$.

(i) Complete the mechanism of the reaction between 2-chlorobutane and potassium cyanide. You should include relevant dipoles and curly arrows to show the movement of electrons. [4]



(ii) Name the type of reaction mechanism shown in part (i). [1]

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(b) When 2-chlorobutane is heated with sodium hydroxide dissolved in ethanol three different organic products are formed.

(i) Draw the displayed formulae of the **three** products. Name each product. [3]

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

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(c) Until recently chlorofluorocarbons, CFCs, were used in many commercial products but nowadays hydrofluorocarbons, HFCs, are preferred.

Explain why HFCs are preferred to CFCs. You do **not** need to include the mechanism or equation for any reaction which you describe. [5]

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11. *(a)* Ethanol can be prepared by the fermentation of glucose, $C_6H_{12}O_6$. The equation for this reaction is as follows.

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

(i) A student wanted to prepare ethanol and was given the following instructions.

- Mix glucose and water.
- Put the mixture into a stoppered bottle.
- Leave the bottle for several weeks.
- Separate off the ethanol.

Suggest how the student should modify these instructions in order to obtain a good yield of pure ethanol. [3]

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(ii) Calculate the atom economy of this process as a method of preparing ethanol. [2]

Atom economy = ... %

(iii) Ethanol can also be made by the hydration of ethene.

Describe **one** environmental consideration in choosing between fermentation and hydration as methods for ethanol production. [2]

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(b) Alcohols are classified as being primary, secondary or tertiary.

(i) Explain the meaning of *primary* as applied to alcohols. [1]

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(ii) Give the structural formula and name of a tertiary alcohol that contains five carbon atoms. [2]

Name .....

(iii) Describe **one** test that can be used to investigate whether an alcohol is secondary or tertiary. Include the reagents used and the observations for both types of alcohol. [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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