OXFORD
INTERNATIONAL
AQA EXAMINATIONS

OXFORD AQA INTERNATIONAL A-LEVEL
CHEMISTRY
(9620)

PAPER 2

Specimen 2018 Morning Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a pencil
- a ruler
- a calculator
- a data booklet

Instructions
- use black ink or ball-point pen
- answer **all** questions
- show all your working.

Information
- The marks for questions are shown in brackets
- The maximum mark for this paper is 70 marks

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

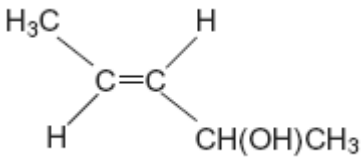
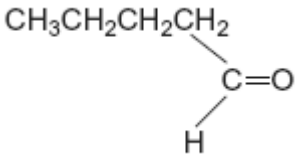
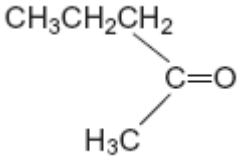
Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Candidate signature _____

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

1 **Table 1** shows the structures of three isomers with the molecular formula $C_5H_{10}O$

Table 1

Isomer **1** 	(*E*)-pent-3-en-2-ol
Isomer **2** 	pentanal
Isomer **3** 	

0 1 . 1 Complete the table by naming Isomer **3**.

[1 mark]

0 1 . 2 The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.
Draw the structure of (*Z*)-pent-3-en-2-ol.

[1 mark]

0 1 . 3 Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

[1 mark]

0 1 . 4 A chemical test can be used to distinguish between separate samples of Isomer **2** and Isomer **3**. Identify a suitable reagent for the test.
State what you would observe with Isomer **2** and with Isomer **3**.

[3 marks]

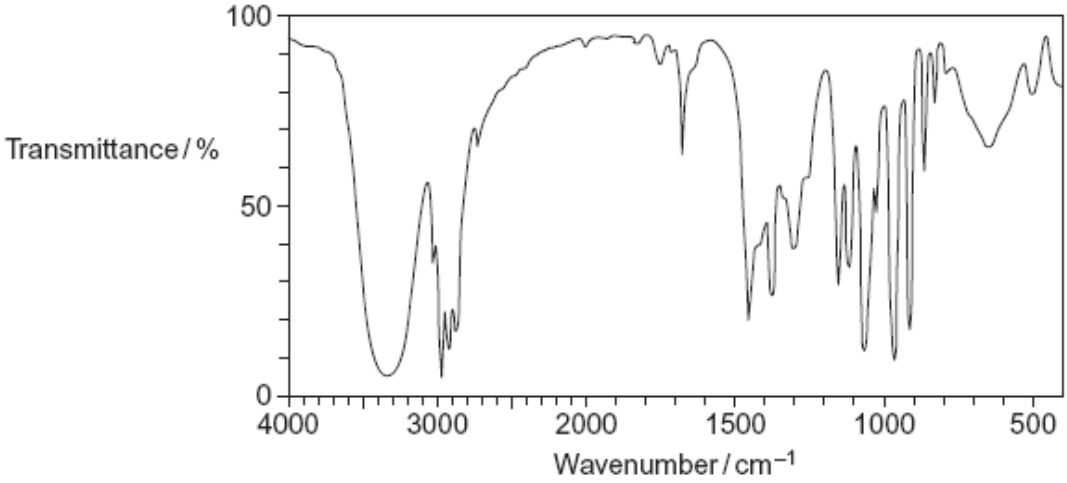
Test reagent

Observation with Isomer **2**

Observation with Isomer **3**

0 1 . 5 The following is the infrared spectrum of one of the isomers **1**, **2** or **3**.

[1 mark]



Deduce which of the isomers (**1**, **2** or **3**) would give this infrared spectrum. You may find it helpful to refer to **Table 1** on the Data Sheet.

Tick (✓) one box.

Isomer **1** ☐

Isomer **2** ☐

Isomer **3** ☐

0 1 . 6 Identify two features of the infrared spectrum that support your deduction.
In each case, identify the functional group responsible.

[2 marks]

Feature 1 and functional group

Feature 2 and functional group

2 Cetane ($C_{16}H_{34}$) is a major component of diesel fuel.

0 2 . 1 Write an equation to show the complete combustion of cetane.

[1 mark]

0 2 . 2 The pollutant gases NO and NO_2 are sometimes present in the exhaust gases of vehicles that use petrol fuel.

Write an equation to show how NO is formed and give a condition needed for its formation.

[2 marks]

Equation

Condition

0 2 . 3 Write an equation to show how NO is removed from the exhaust gases in a catalytic converter. Identify a catalyst used in the converter.

[2 marks]

Equation

Catalyst

0 2 . 4 Deduce an equation to show how NO_2 reacts with water and oxygen to form nitric acid (HNO_3).

[1 mark]

0 2 . 5 Cetane ($C_{16}H_{34}$) can be cracked to produce hexane, butene and ethene. Write an equation to show how one molecule of cetane can be cracked to form hexane, butene and ethene.

[1 mark]

0 2 . 6 State one type of useful solid material that could be formed from alkenes.

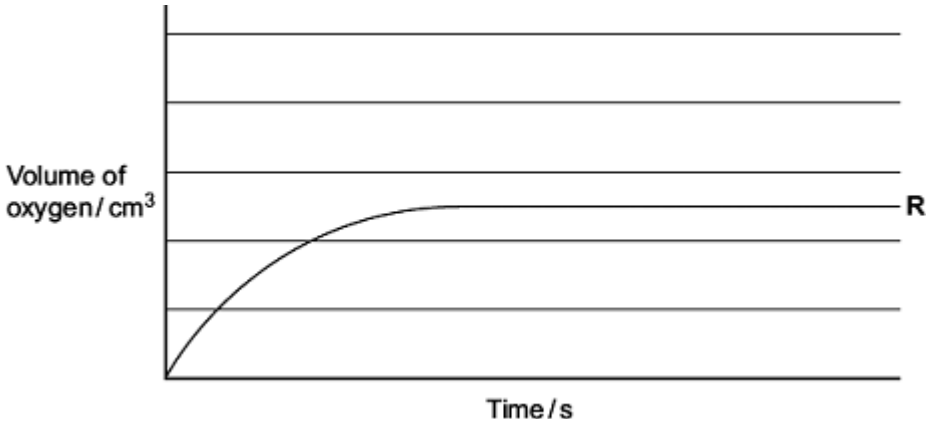
[1 mark]

3 A student carried out an experiment to determine the rate of decomposition of hydrogen peroxide into water and oxygen gas.
The student used 100 cm^3 of a 1.0 mol dm^{-3} solution of hydrogen peroxide at 298K and measured the volume of oxygen collected.
Curve R, in each of Figures 1 and 2, shows how the total volume of oxygen collected changed with time under these conditions.

0 3 . 1 Draw a curve on Figure 1 to show how the total volume of oxygen collected will change with time if the experiment is repeated at 298 K using 100 cm^3 of a 0.4 mol dm^{-3} solution of hydrogen peroxide.

[2 marks]

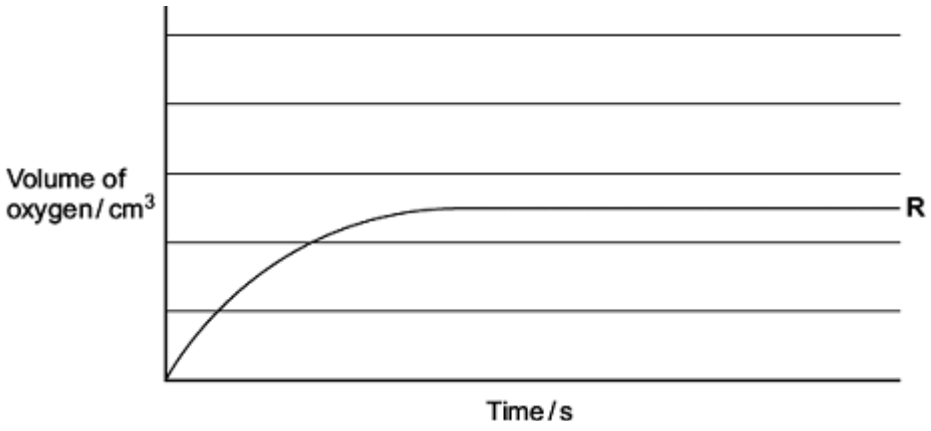
Figure 1



0 3 . 2 Draw a curve on **Figure 2** to show how the total volume of oxygen collected will change with time if the **original** experiment is repeated at a temperature higher than 298 K.
You should assume that the gas is collected at a temperature of 298 K.

[2 marks]

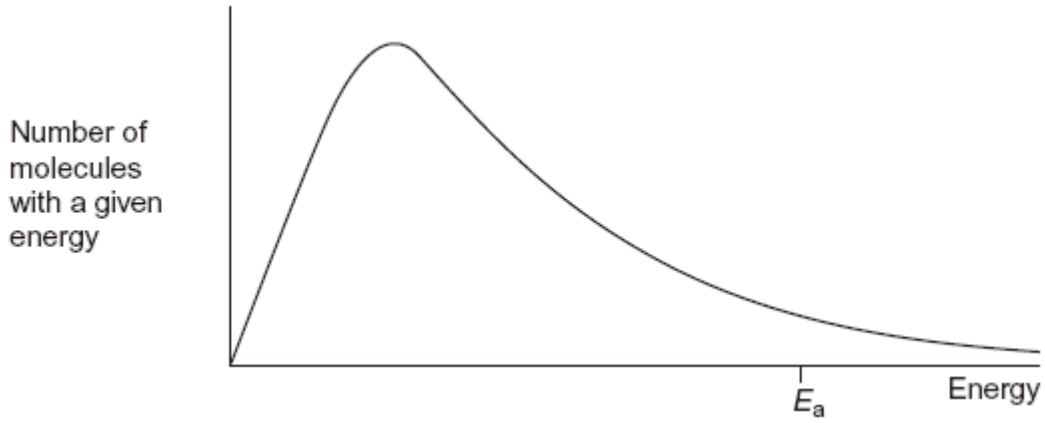
Figure 2



0 3 . 3 Explain why the slope (gradient) of curve **R** decreases as time increases.

[2 marks]

4 The diagram below shows a Maxwell–Boltzmann distribution for a sample of gas at a fixed temperature.
E_a is the activation energy for the decomposition of this gas.



0 4 . 1 On this diagram, sketch the distribution for the same sample of gas at a higher temperature.

[2 marks]

0 4 . 2 With reference to the Maxwell–Boltzmann distribution, explain why an increase in temperature increases the rate of a chemical reaction.

[2 marks]

0 4 . 3 Dinitrogen oxide (N_2O) is used as a rocket fuel. The data in **Table 2** show how the activation energy for the decomposition of dinitrogen oxide differs with different catalysts.

$$2N_2O(g) \longrightarrow 2N_2(g) + O_2(g)$$

[1 mark]

Table 2

	Ea / kJ mol^{-1}
Without a catalyst	245
With a gold catalyst	121
With an iron catalyst	116
With a platinum catalyst	136

Use the data in the table to deduce which is the most effective catalyst for this decomposition.

0 4 . 4 Explain how a catalyst increases the rate of a reaction.

[2 marks]

5 Epoxyethane is formed when ethane is oxidised by air in the presence of a catalyst.
The reaction is exothermic, ΔH = -210 kJ mol^{-1}

0 5 . 1 Write an equation for the reaction.
Name the catalyst used.
Identify the hazards associated with the process

[4 marks]

0 5 . 2 Draw the structure of epoxyethane and explain why the compound is very reactive.

[2 marks]

Structure

Explanation

6

0 6 . 1 Name and outline a mechanism for the reaction of methane with bromine to form bromomethane. Give one condition for this reaction to occur.
Write an equation for each step in your mechanism.

[5 marks]

Turn over for the next question

7 Ethanol can be oxidised by acidified potassium dichromate(VI) to ethanoic acid in a two-step process.

ethanol → ethanol → ethanoic acid

In order to ensure that the oxidation to ethanoic acid is complete, the reaction is carried out under reflux.

0 7 . 1 Describe what happens when a reaction mixture is refluxed and why it is necessary, in this case, for complete oxidation to ethanoic acid.

[3 marks]

0 7 . 2 Write a half equation for the overall oxidation of ethanol into ethanoic acid.

[1 mark]

0 7 . 3 The boiling points of the organic compounds in a reaction mixture are shown in **Table 3**.

[5 marks]

Table 3

Compound	ethanol	ethanal	ethanoic acid
Boiling point / °C	78	21	118

Use these data to describe how you would obtain a sample of ethanal from a mixture of these three compounds. Include in your answer a description of the apparatus you would use and how you would minimise the loss of ethanal. Your description of the apparatus can be either a description in words or a labelled sketch.

0 7 . 4 Use your knowledge of structure and bonding to explain why it is possible to separate ethanal in this way.

[2 marks]

0 7 . 5 A student was provided with separate samples of a secondary alcohol and a tertiary alcohol with the molecular formula $C_5H_{12}O$

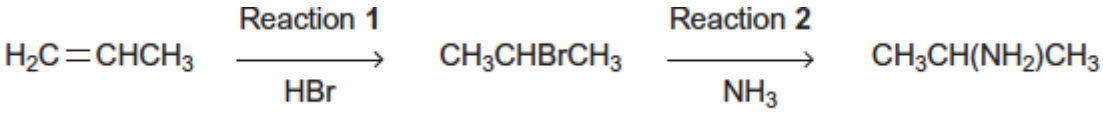
Draw the displayed formula of a secondary alcohol and a tertiary alcohol with the molecular formula $C_5H_{12}O$

Describe the observations when the alcohols are warmed separately with acidified potassium dichromate (VI)

Write an equation for the reaction that would occur. Use [O] to represent the oxidising agent.

[5 marks]

8 Consider the following reactions.



0 8 . 1 Name and outline a mechanism for Reaction 1.

[5 marks]

Name of mechanism

Mechanism

0 8 . 2 Name and outline a mechanism for Reaction **2**.

[5 marks]

Name of mechanism

Mechanism

0 8 . 3 The haloalkane produced in Reaction 1 can be converted back into propene in an elimination reaction using ethanolic potassium hydroxide.

[3 marks]

$$CH_3CHBrCH_3 \xrightarrow{KOH} H_2C{=}CHCH_3$$

Outline a mechanism for this conversion.

END OF QUESTIONS