OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 2: Organic 1 and Physical 1

Tuesday 14 May 2024 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

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

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

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

0 1 This question is about hydrocarbons and halogenoalkanes.

0 1 . 1 Hexadecane ($C_{16}H_{34}$) can be cracked at high temperature in the presence of a catalyst.

Write an equation to show the cracking of one molecule of hexadecane to form

- one molecule of pentane
- one molecule of cyclopentane
- two molecules of another product

Identify a catalyst used in this cracking reaction.

[2 marks]

Equation

_____

Catalyst _____

0 1 . 2 State **one** economic reason for cracking hexadecane.

[1 mark]

_____

_____

0 1 . 3 Butane reacts with chlorine in the presence of ultraviolet light to form 2-chlorobutane.

State why ultraviolet light is needed for this reaction.

[1 mark]

_____

_____

0 1 . 4 Write **two** equations for the propagation steps in the formation of 2-chlorobutane.

[2 marks]

Step 1

_____

Step 2

_____

Do not write outside the box

0 1 . 5 Give the structure of a compound that does **not** contain chlorine **and** can be formed in a termination step in this reaction.

[1 mark]

7

Turn over for the next question

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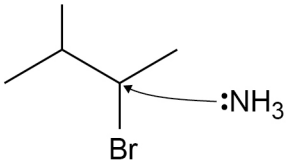
0 2 This question is about halogenoalkanes.

Halogenoalkanes can react with an excess of ammonia to form primary amines.

0 2 . 1 Complete the mechanism to show the formation of a primary amine.

[3 marks]



Ethylamine can be prepared from bromoethane as shown:

$$C_2H_5Br + 2NH_3 \rightarrow C_2H_5NH_2 + NH_4Br$$

$M_r = 108.9$ $M_r = 45.0$

0 2 . 2 Calculate the percentage atom economy for this reaction.
Give the answer to 3 significant figures.

[1 mark]

Atom economy _____ %

Do not write outside the box

0 2 . 3 2.20 g of bromoethane formed 0.570 g of ethylamine.

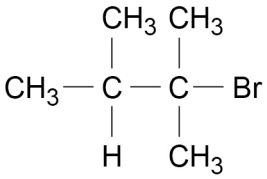
Calculate the percentage yield of the amine formed in this reaction.

[3 marks]

Yield _____ %

0 2 . 4 Tick (✓) **one** box to select which one of these three halogenoalkanes has the fastest reaction with sodium hydroxide.

[1 mark]



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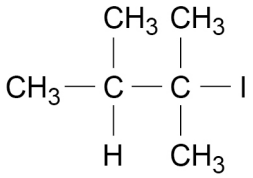

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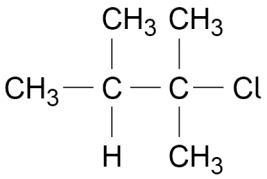

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0 3 This question is about formulas and isomerism.

0 3 . 1 Compound **A** contains 64.8% C, 13.5% H and the rest is oxygen.

Calculate the empirical formula of **A**.

[3 marks]

Empirical formula of **A** _____

Compound **B** is a straight chain hydrocarbon (M_r = 42.0) with empirical formula CH_2

0 3 . 2 Draw the displayed formula of **B**.

[1 mark]

0 3 . 3 Identify the structural isomer of **B**.

[1 mark]

0 3 . 4 State the meaning of the term stereoisomer.

[1 mark]

_____

_____

_____

_____

Do not write outside the box

0 3 . 5 Give **two** reasons why *E-Z* isomers exist.

[2 marks]

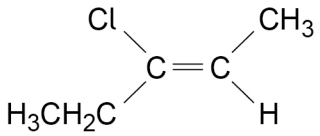
Reason 1 _____

_____

Reason 2 _____

_____

0 3 . 6 Use Cahn–Ingold–Prelog (CIP) priority rules to explain why this compound is the *Z*-isomer.



[3 marks]

_____

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11

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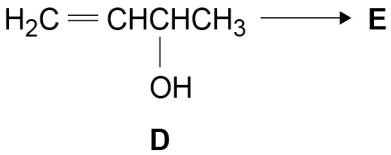
0 4 This question is about alkenes and alcohols.



D

0 4 . 1 The alkene functional group can be identified in a test with bromine.

Name and outline the mechanism when **D** reacts with bromine.

State the observation in this reaction and explain your answer.

[6 marks]

Name of mechanism _____

Mechanism

Observation _____

Explanation _____

_____

_____

0 4 . 2 Compound **D** reacts with concentrated sulfuric acid to form compound **E**.
This is an elimination reaction.

Name **D**.

Draw the skeletal formula of **E**.

[2 marks]

Name **D** _____

Skeletal formula of **E**

8

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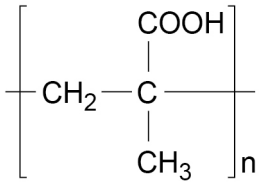
0 5 An addition polymer can be represented by the structure



0 5 . 1 Draw the displayed formula of the monomer of this polymer.

[1 mark]

0 5 . 2 Why is this polymer non-biodegradable despite the presence of polar bonds?

[1 mark]

0 5 . 3 Poly(chloroethene), PVC, is an important addition polymer that can be used to make hard objects.

State what is added to make PVC more flexible.

Explain how this makes PVC more flexible.

[2 marks]

4

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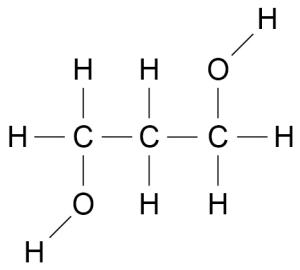
0 6 This question is about alcohols.

0 6 . 1 The displayed formula for propane-1,3-diol is shown.



Suggest suitable test-tube reagent(s) and condition(s) for the oxidation of propane-1,3-diol to form an organic product that has M_r = 104.0

Draw the product formed by this oxidation of propane-1,3-diol.

[3 marks]

Reagent(s) _____

_____

Condition(s) _____

Product

0 6 . 2 Calculate the percentage by mass of oxygen in propane-1,3-diol.

[1 mark]

Oxygen _____ %

Do not write outside the box

Propan-1-ol is another alcohol with three carbons per molecule.

0 6 . 3 Name the strongest type of interaction between **two** molecules of propan-1-ol.

Draw a diagram to show the strongest type of interaction between **two** molecules of propan-1-ol.

[4 marks]

Name of interaction _____

Diagram

0 6 . 4 Write an equation to show the complete combustion of propan-1-ol.

[1 mark]

_____

0 6 . 5 Four isomers with molecular formula $C_5H_{12}O$ are shown.

Tick (✓) **one** box to select the isomer that is the most difficult to oxidise.

[1 mark]

$(CH_3)_2CHCH(CH_3)OH$ ☐

$CH_3CH_2C(CH_3)_2OH$ ☐

$CH_3CH_2CH(CH_3)CH_2OH$ ☐

$CH_3CH_2CH_2CH(CH_3)OH$ ☐

10

Turn over ►

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0 7 The structures of three organic compounds are shown.

$CH_3CH_2CH_2COCH_3$	$CH_3CH_2CH_2CH_2CHO$	$CH_3CH_2CH_2CH_2COOH$
P	**Q**	**R**

0 7 . 1 Give suitable test-tube reagent(s) that could be used to distinguish between **P** and **Q**.

State the observation with **P** and the observation with **Q**.

[3 marks]

Reagent(s) _____

Observation with **P** _____

_____

Observation with **Q** _____

_____

0 7 . 2 Give suitable test-tube reagent(s) that could be used to distinguish between **P** and **R**.

State the observation with **P** and the observation with **R**.

[3 marks]

Reagent(s) _____

Observation with **P** _____

_____

Observation with **R** _____

_____

Question 7 continues on the next page

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The infrared spectra of two of the three compounds **P**, **Q** and **R** are shown in **Figure 1** and **Figure 2**.

Figure 1

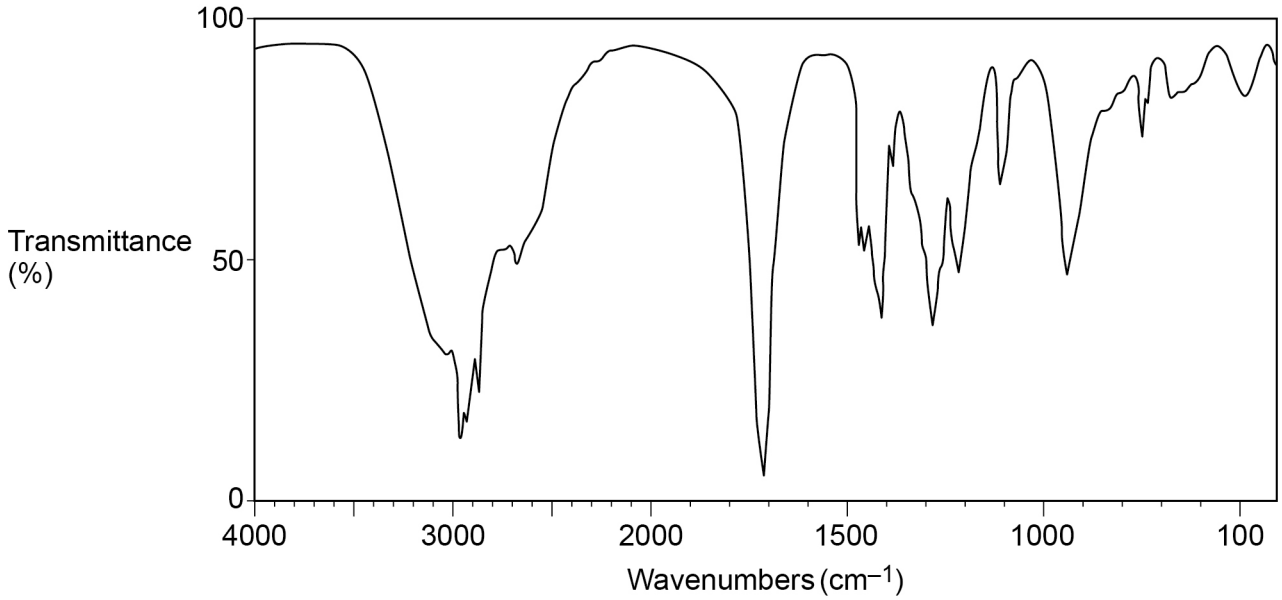
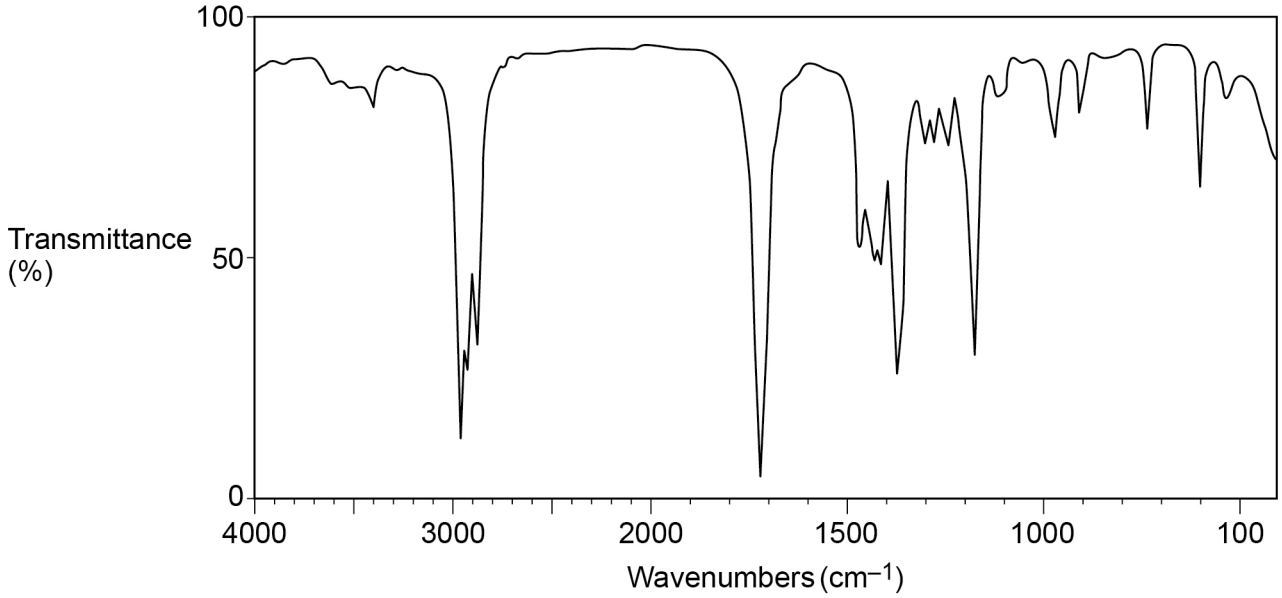


Figure 2



0 7 . 3 Use **Table A** on the Chemistry data sheet to justify why **Figure 1** is the spectrum of **R**.

[1 mark]

_____

_____

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0 7 . 4 Explain how you can confirm whether **Figure 2** is the spectrum of **P** or **Q**.

[2 marks]

_____

_____

_____

_____

9

Turn over for the next question

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0 8 This question is about chemical equilibrium and rates of reaction.

0 8 . 1 Give **two** features of a dynamic equilibrium.

[2 marks]

Feature 1 _____

_____

Feature 2 _____

_____

In an experiment, 1.56 mol of **S** and 2.47 mol of **T** are mixed and allowed to reach equilibrium at a given temperature.

The equilibrium mixture contains 0.760 mol of **V**.

$$\mathbf{S}(g) + 3\,\mathbf{T}(g) \rightleftharpoons 2\,\mathbf{V}(g) \quad \Delta H = +180 \text{ kJ mol}^{-1}$$

0 8 . 2 Calculate the amounts, in mol, of **S** and of **T** in the equilibrium mixture.

[2 marks]

Equilibrium mol of **S** _____

Equilibrium mol of **T** _____

0 8 . 3 Explain why an increase in temperature will increase the equilibrium yield of **V**.

[2 marks]

_____

_____

_____

_____

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0 8 . 4 In a different experiment, a mixture of **X** and **Y** is placed in a container and allowed to reach equilibrium at a given temperature.

At equilibrium the concentration of **X** = 0.485 mol dm^{-3} and the concentration of **Y** = 0.287 mol dm^{-3}

$$\mathbf{X}(g) + \mathbf{Y}(g) \rightleftharpoons 2\mathbf{Z}(g)$$

Give an expression for the equilibrium constant (K_c) for this reaction.

Calculate the equilibrium concentration, in mol dm^{-3}, of **Z**.
At this temperature, the value of K_c = 0.0049

[3 marks]

K_c

Equilibrium concentration of **Z** _____ mol dm^{-3}

0 8 . 5 The reaction in Question **08.4** is very slow to reach equilibrium.

Suggest why.

[1 mark]

_____

_____

0 8 . 6 The reaction in Question **08.4** is repeated at the same temperature but in a larger container.

Explain why the time taken to reach equilibrium will be longer under these conditions.

[2 marks]

_____

_____

_____

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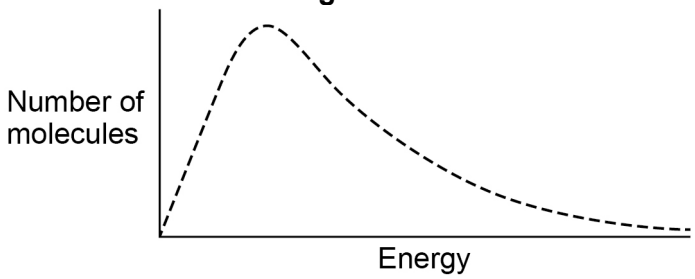
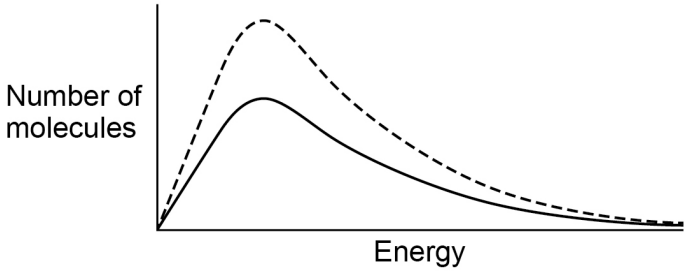
Figure 3 shows the Maxwell–Boltzmann distribution of molecular energies of a gas at 298 K

Figure 3



0 8 . 7 Tick (✓) **one** box to select the curve that represents the distribution of molecular energies of the gas at 198 K

[1 mark]



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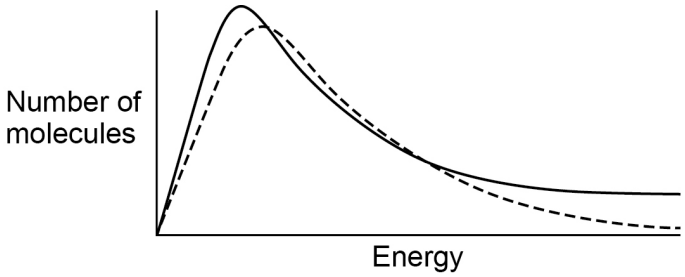

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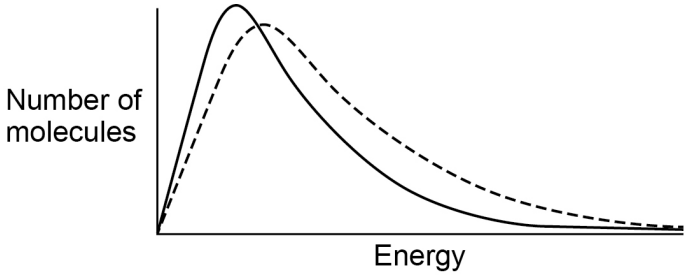

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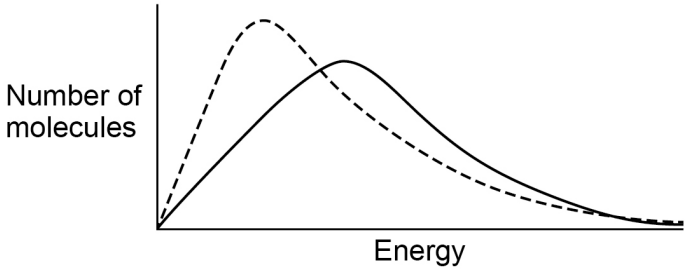

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13

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