

Please write clearly in block capitals.

Centre number

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Candidate number

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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	



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

0 1

This question is about hydrocarbons and halogenoalkanes.

0 1 . 1

Hexadecane ($\text{C}_{16}\text{H}_{34}$) 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



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

Turn over ►



0 2

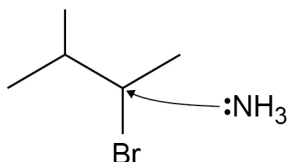
This question is about halogenoalkanes.

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

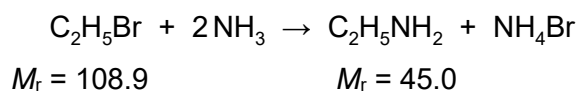
0 2 . 1

Complete the mechanism to show the formation of a primary amine.

[3 marks]



Ethylamine can be prepared from bromoethane as shown:



0 2 . 2

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

[1 mark]

Atom economy _____ %



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

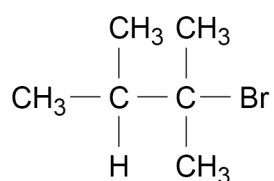
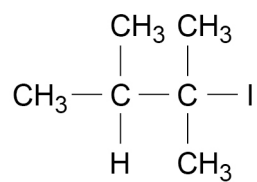
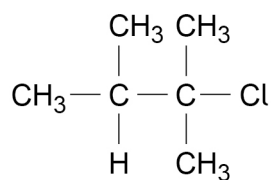
Calculate the percentage yield of the amine formed in this reaction.

[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]


☐

☐

☐

8

Turn over ►



0	3
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This question is about formulas and isomerism.

0	3	.	1
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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
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Draw the displayed formula of **B**.

[1 mark]

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

[1 mark]

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

[1 mark]



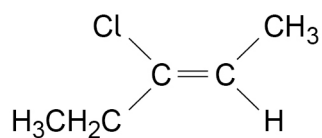
0 3 . 5

Give **two** reasons why *E-Z* isomers exist.**[2 marks]**

Reason 1 _____

Reason 2 _____

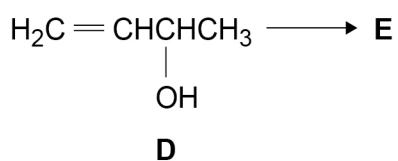
0 3 . 6

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



0 4

This question is about alkenes and alcohols.



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]

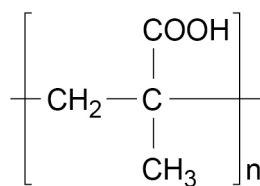
Name **D** _____

Skeletal formula of **E**



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

Turn over ►

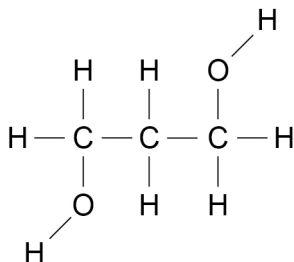


0 6

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 _____ %



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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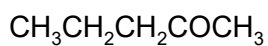
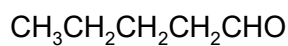
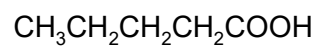
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0 7

The structures of three organic compounds are shown.

**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****Turn over ►**

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

Figure 1

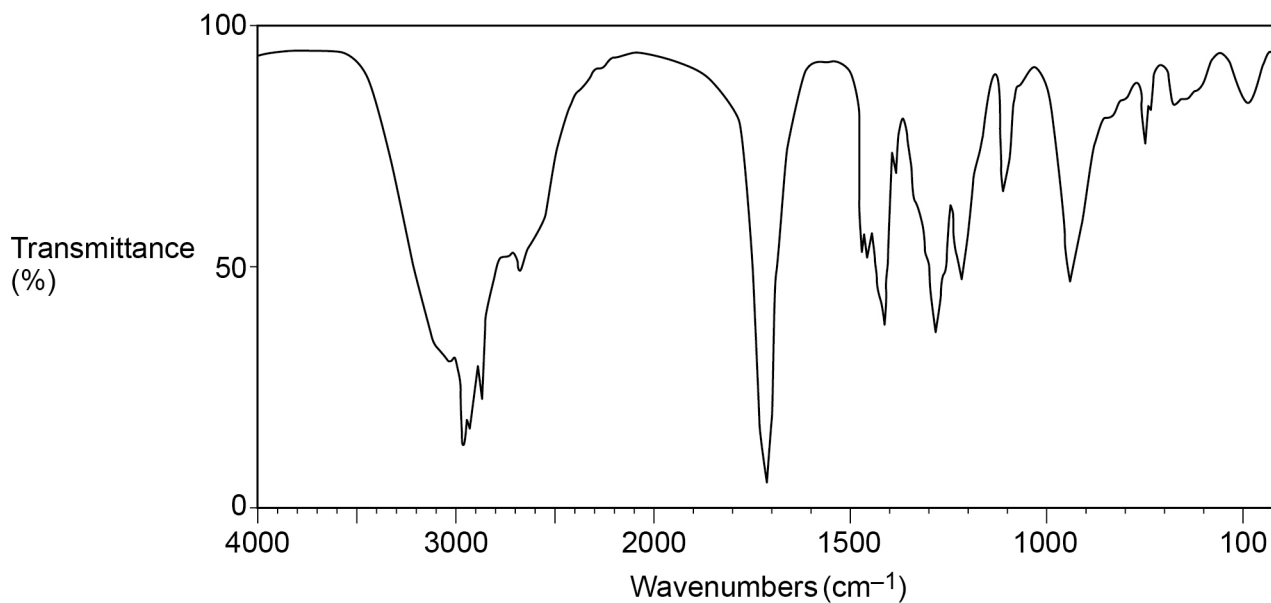
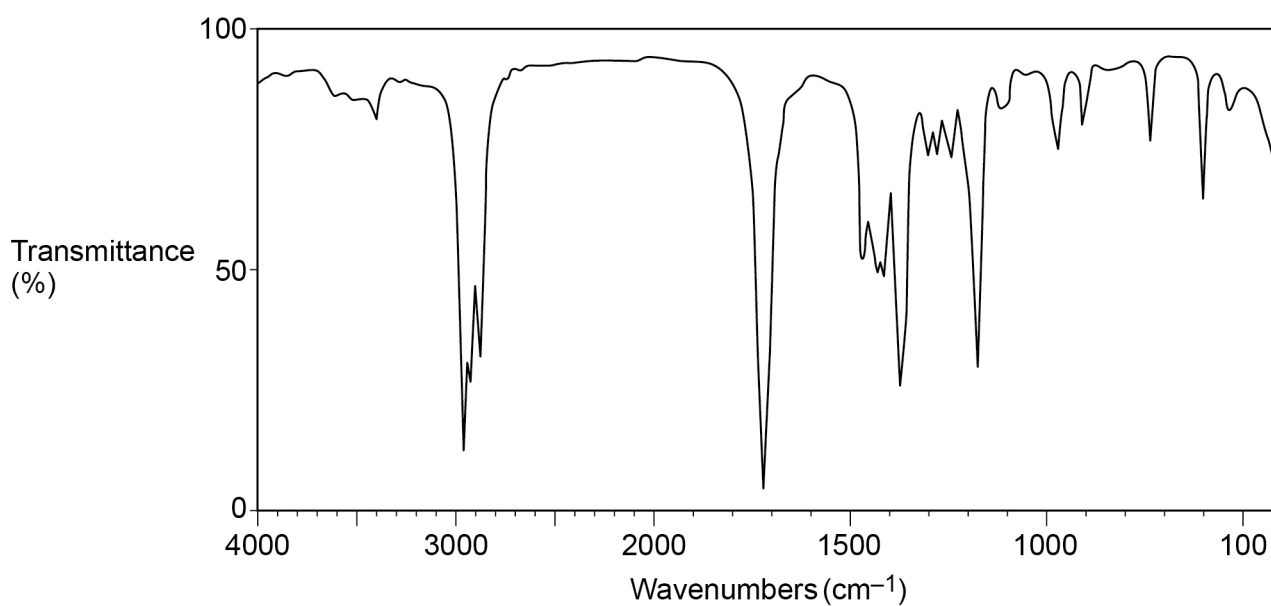


Figure 2



0 7 . 3

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

[1 mark]



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****Turn over ►**

0 8

This question is about chemical equilibrium and rates of reaction.

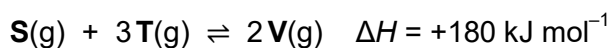
0 8 . 1Give **two** features of a dynamic equilibrium.**[2 marks]**

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**.

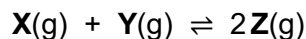
**0 8 . 2**Calculate the amounts, in mol, of **S** and of **T** in the equilibrium mixture.**[2 marks]**Equilibrium mol of **S** _____Equilibrium mol of **T** _____**0 8 . 3**Explain why an increase in temperature will increase the equilibrium yield of **V**.**[2 marks]**



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** = $0.485 \text{ mol dm}^{-3}$ and the concentration of **Y** = $0.287 \text{ mol dm}^{-3}$



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

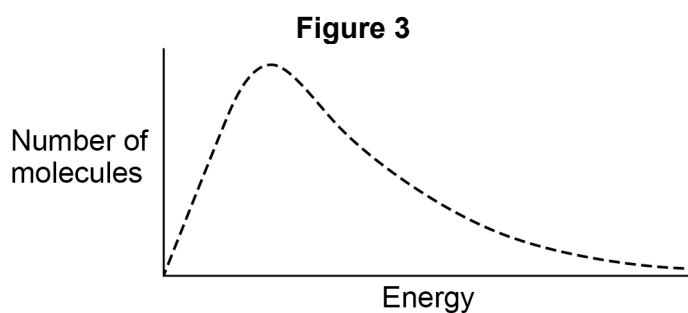
The reaction in Question **08.4** is repeated at the same temperature but in a larger container.

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

[2 marks]

Turn over ►

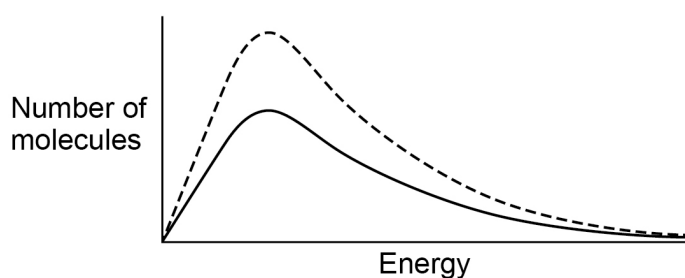
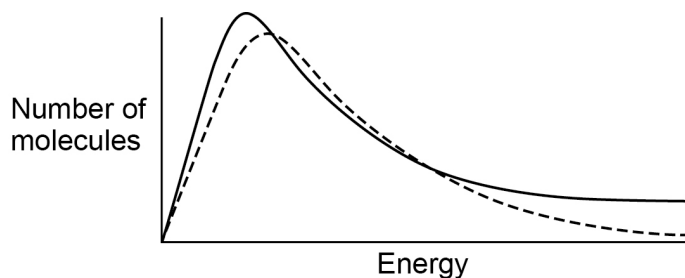
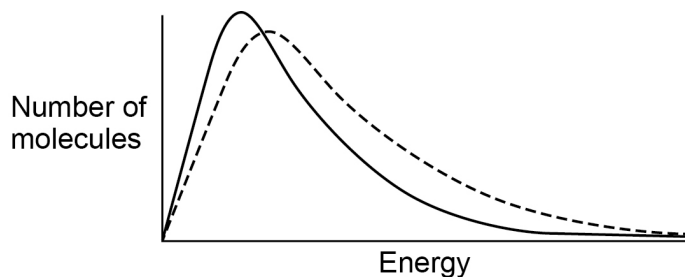
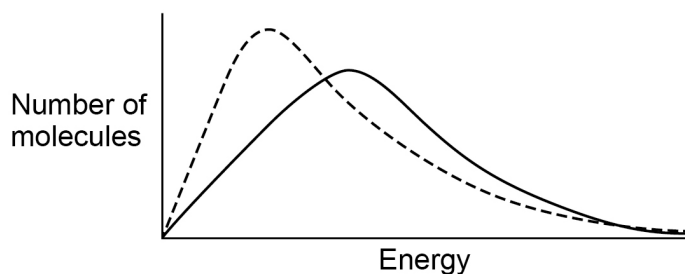
Figure 3 shows the Maxwell–Boltzmann distribution of molecular energies of a gas at 298 K



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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END OF QUESTIONS



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Question number	Additional page, if required. Write the question numbers in the left-hand margin.



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