

Please write clearly in block capitals.

Centre number

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Candidate number

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Candidate signature

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I declare this is my own work.

# INTERNATIONAL AS CHEMISTRY (9620)

## Unit 2: Organic 1 and Physical 1

Thursday 9 January 2025 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	
9	
<b>TOTAL</b>	



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

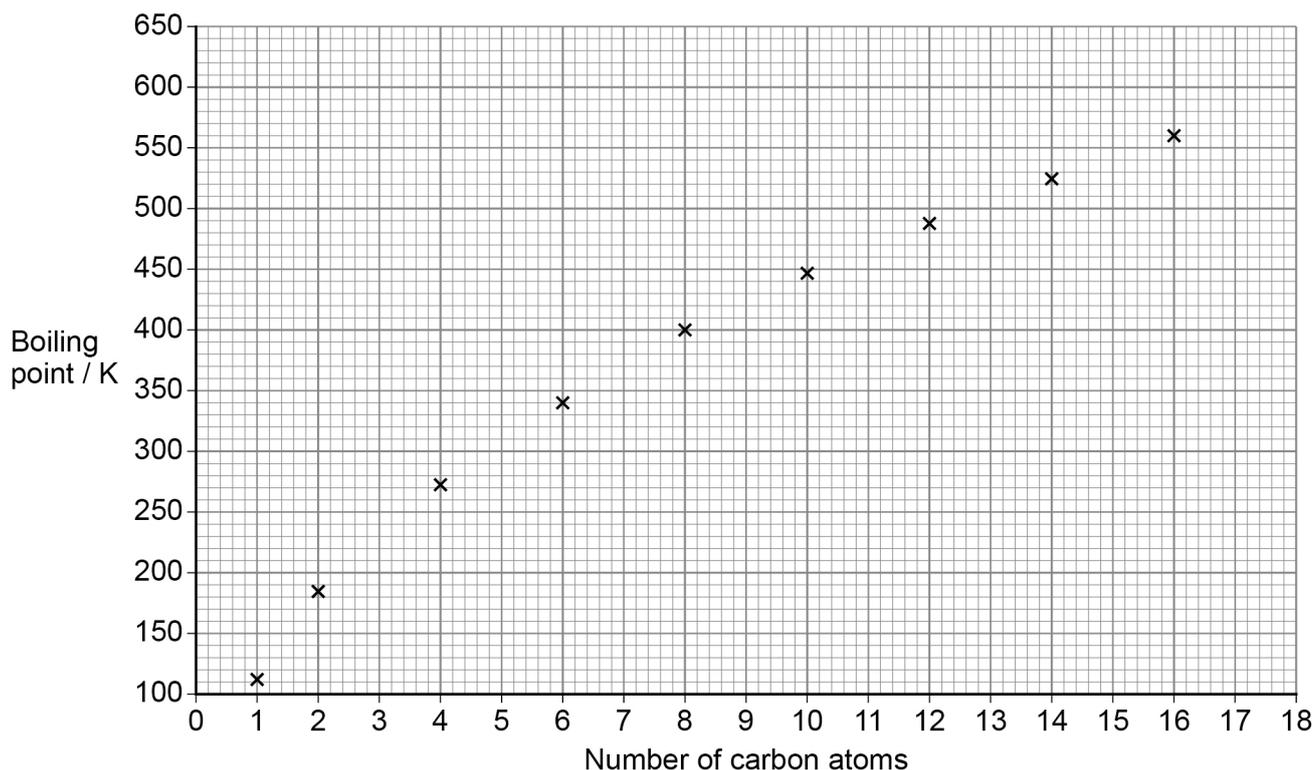
**0 1**

This question is about hydrocarbons.

**Figure 1** shows a graph of the boiling points of some straight chain alkanes.

Octadecane ( $C_{18}H_{38}$ ) is a straight chain alkane.

**Figure 1**



**0 1**

**1**

Draw a line of best fit on **Figure 1**.

Continue the line to determine a value for the boiling point of octadecane.

**[2 marks]**

Boiling point of octadecane \_\_\_\_\_ K

**0 1**

**2**

Name a process that can be used to separate octadecane from a mixture of alkanes.

**[1 mark]**

\_\_\_\_\_



Alkanes are burned in air in internal combustion engines of cars.

0 1 . 3

Identify **two** toxic gases that are formed in internal combustion engines of cars.

Write **one** equation to show how **both** toxic gases can be removed by a catalytic converter in these cars.

Identify the catalyst used in the catalytic converter.

[3 marks]

Toxic gases \_\_\_\_\_

Equation

Catalyst \_\_\_\_\_

0 1 . 4

Write an equation for the complete combustion of octadecane ( $C_{18}H_{38}$ )

[1 mark]

0 1 . 5

Write an equation for the cracking of one molecule of octadecane to give one molecule of decane ( $C_{10}H_{22}$ ), one molecule of pentene and one other product.

[1 mark]

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8

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0 2

This question is about isomers.

0 2 . 1

Compounds **D** and **E** have the molecular formula  $C_4H_{10}$   
**D** has a higher boiling point than **E**.

Draw the skeletal formula of **D** and the skeletal formula of **E**.

**[2 marks]****D****E**

0 2 . 2

Compounds **F** and **G** have the molecular formula  $C_4H_8$   
Bromine water turns colourless when added to **F** but there is no visible change with **G**.

Draw a structure for **F** and a structure for **G**.

**[2 marks]****F****G**

0 2 . 3

Define stereoisomerism

**[1 mark]**

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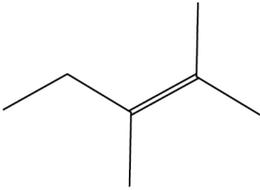
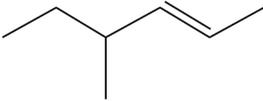
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**0 2 . 4** Table 1 shows the skeletal formulas of three isomeric alkenes.

**Table 1**

A	B	C
		

Tick (✓) **one** box to choose the alkene, **A**, **B** or **C**, that can show *E-Z* isomerism.

[1 mark]

**A**

**B**

**C**

**0 2 . 5** Draw the structure of *Z*-5-methylhex-2-ene.

[1 mark]

      
7

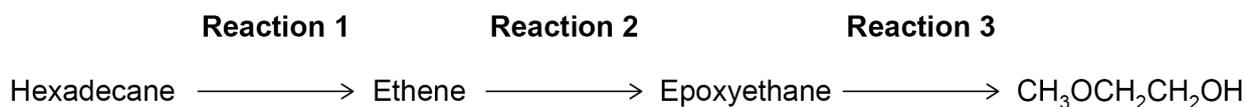
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0 3

A reaction sequence starting from hexadecane ( $C_{16}H_{34}$ ) is shown in **Figure 2**.

**Figure 2**



0 3 . 1

In **Reaction 1** the only products are octane ( $C_8H_{18}$ ) and ethene.

Write an equation using molecular formula for **Reaction 1**.

[1 mark]

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0 3 . 2

Write an equation for **Reaction 2**.

Show the displayed formula of epoxyethane in your answer.

[1 mark]

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0 3 . 3

Name the catalysts used in **Reaction 1** and in **Reaction 2**.

[2 marks]

Catalyst in **Reaction 1** \_\_\_\_\_

Catalyst in **Reaction 2** \_\_\_\_\_

0 3 . 4

Identify the substance that reacts with epoxyethane in **Reaction 3**.

[1 mark]

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0 4

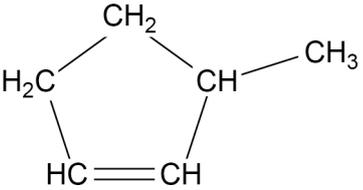
This question is about polymers.

0 4 . 1

Complete **Table 2** to show the

- structure of the monomer used to form polymer **K**
- repeating unit of the polymer formed from monomer **L**

**[2 marks]****Table 2**

Monomer	Repeating unit of the polymer
Structure of the monomer used to form polymer <b>K</b>	Polymer <b>K</b>  $  \begin{array}{c}  \text{C}_2\text{H}_5 \quad \text{H} \\    \quad   \\  \text{--- C --- C ---} \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $
Monomer <b>L</b>  	Repeating unit of the polymer formed from monomer <b>L</b>

0 4 . 2

State why polymer **K** in Question **04.1** is not biodegradable.**[1 mark]**


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**0 4 . 3** Table 3 shows data from the analysis of a hydrocarbon.

**Table 3**

Element	% by mass
Carbon	88.9
Hydrogen	11.1

The mass spectrum of the hydrocarbon gives  $M_r = 54.0$

Calculate the empirical formula **and** the molecular formula of the hydrocarbon.  
Show your working.

**[3 marks]**

Empirical formula \_\_\_\_\_

Molecular formula \_\_\_\_\_

6

Turn over ►



0 5

This question is about rates of reaction of halogenoalkanes.

0 5 . 1

Define rate of reaction.

[1 mark]

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A student investigates the reactivity of halogenoalkanes.

- The student adds a halogenoalkane to ethanol and sodium hydroxide solution in a test tube.
- The student warms the mixture in the test tube at approximately 60 °C
- The halogenoalkane is hydrolysed.

0 5 . 2

Suggest how the student should heat the test tube safely.

[1 mark]

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Nitric acid and silver nitrate solution are added to the test tube in Question **05.2** to form a precipitate.

The time for a precipitate to appear is recorded.

The experiment is repeated with other halogenoalkanes.

The rate of reaction for each halogenoalkane is calculated and the results are shown in **Table 4**.

**Table 4**

Halogenoalkane	Rate of formation of precipitate / s <sup>-1</sup>
1	0.0042
2	0.0054
3	0.0087

0 5 . 3

State the halogenoalkane that reacts in the shortest time.

[1 mark]

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Samples of 1-chloropropane, 1-bromopropane and 1-iodopropane are tested in this experiment.

0 5 . 4

Suggest why 1-iodopropane has the fastest reaction rate.

[1 mark]

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0 5 . 5

Explain why these reactions are slower at a lower temperature. You must refer to particles in your answer.

[2 marks]

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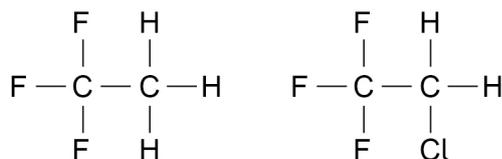
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6

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Turn over ►



**0 6**Compounds **M** and **N** are gaseous organic compounds.**0 6 . 1**Calculate the percentage by mass of fluorine in **M** ( $M_r = 84.0$ ).  
Give your answer to 3 significant figures.**[1 mark]**

Percentage by mass of fluorine \_\_\_\_\_

**0 6 . 2**Suggest why **M** does not damage the ozone layer.**[1 mark]**

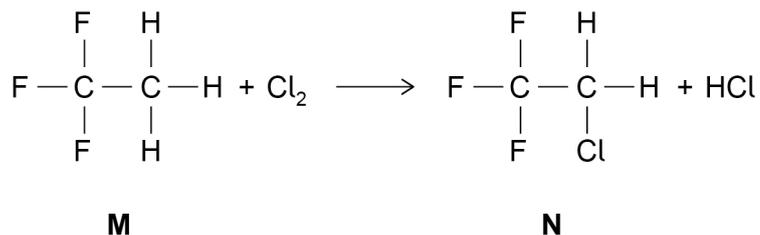

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**M** can be converted to **N** in the presence of chlorine and ultraviolet light.



**0 6 . 3** Name the mechanism for this reaction.

[1 mark]

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**0 6 . 4** 2.64 g of **M** ( $M_r = 84.0$ ) are reacted with chlorine.  
The percentage yield of **N** is 93.0%

Calculate the mass, in g, of **N** formed in this reaction.

[3 marks]

Mass of **N** \_\_\_\_\_ g

**0 6 . 5** A sample of **M** and chlorine are reacted in a sealed 10 dm<sup>3</sup> container at a given temperature and in the presence of ultraviolet light.

State why the rate of reaction will increase if the reaction is repeated in a 5 dm<sup>3</sup> container.

[1 mark]

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7

Turn over ►



0 7

This question is about alkenes and halogenoalkanes.

0 7 . 1

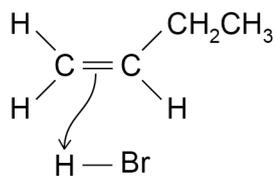
Alkenes react with hydrogen halides to produce halogenoalkanes.

Name and complete the mechanism to show the major product formed in the reaction between but-1-ene and hydrogen bromide.

**[4 marks]**

Name of mechanism \_\_\_\_\_

Mechanism



Halogenoalkanes can react under different conditions to make products with different functional groups.

0 7 . 2

Give the meaning of functional group as applied to an organic molecule.

[1 mark]

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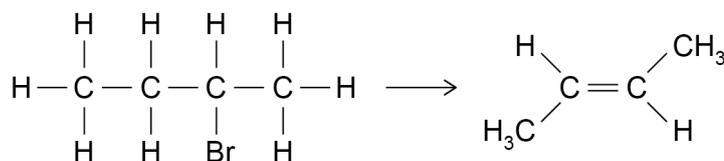


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0 7 . 3

Give the reagent and **one** condition required for the following change.

[2 marks]



Reagent \_\_\_\_\_

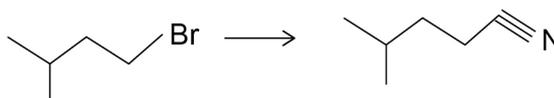
Condition \_\_\_\_\_

0 7 . 4

Give the reagent and **one** condition required for the following change.

Use IUPAC rules to name the organic product.

[3 marks]



Reagent \_\_\_\_\_

Condition \_\_\_\_\_

IUPAC name of product \_\_\_\_\_

10

Turn over ►

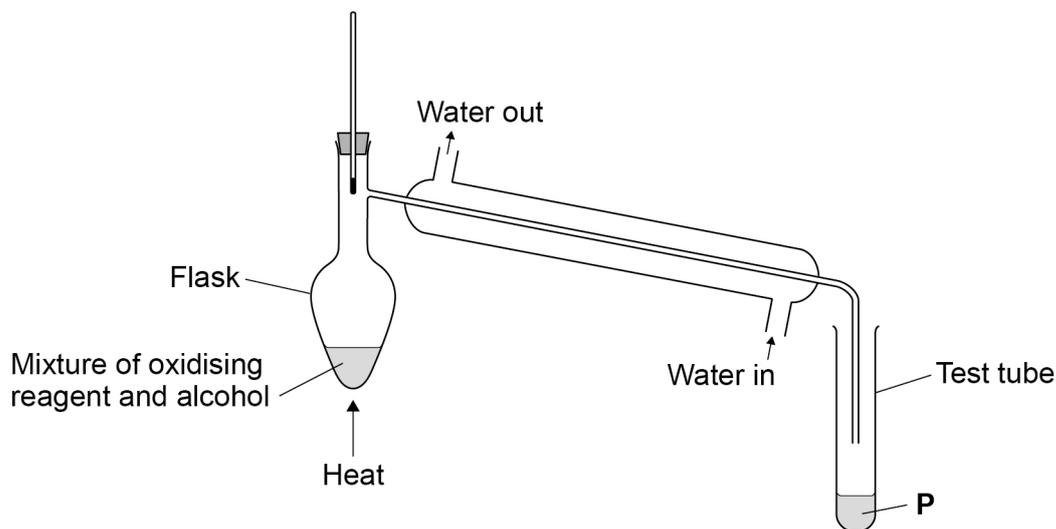


0 8

This question is about alcohols and their oxidation products.

**Figure 3** shows the equipment that can be used to oxidise alcohols.

**Figure 3**



0 8

1

Suggest one way to increase the yield of product **P** collected in the test tube in **Figure 3**.

[1 mark]

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0 8

2

Name the practical technique used to obtain **P**.

State the reagent (or combination of reagents) used in the flask to oxidise the alcohol.

Describe the colour change observed in this reaction.

[3 marks]

Practical technique \_\_\_\_\_

Reagent(s) \_\_\_\_\_

Colour change \_\_\_\_\_



0 8 . 3

The carboxylic acid functional group can be identified by its reaction with aqueous  $\text{NaHCO}_3$

Give the observation when propanoic acid reacts with aqueous  $\text{NaHCO}_3$

Write an equation for this reaction.

**[2 marks]**

Observation \_\_\_\_\_

Equation \_\_\_\_\_

0 8 . 4

Identify the organic product of the reaction of 2-methylbutanal with Fehling's solution.

State what is observed in this reaction.

**[2 marks]**

Organic product \_\_\_\_\_

Observation \_\_\_\_\_

0 8 . 5

An alcohol with molecular formula  $\text{C}_4\text{H}_{10}\text{O}$  does **not** react with the oxidising reagents used in this question.

Draw the displayed formula of this alcohol.

**[1 mark]**

0 9

This question is about the equilibrium



0 9 . 1

A student adds 2.0 mol of  $\text{X}_2$  to 3.0 mol of  $\text{Y}$ .

The mixture is placed in a sealed container at a given temperature to reach equilibrium.

The equilibrium mixture contains 1.5 mol of  $\text{X}_2$ Complete **Table 5** to show the amount, in mol, of each substance at equilibrium.**[2 marks]****Table 5**

	$\text{X}_2$	$\text{Y}$	$\text{Z}$
Initial amount / mol	2.0	3.0	0.0
Equilibrium amount / mol	1.5		

0 9 . 2

The student repeats the experiment with different amounts of  $\text{X}_2$  and  $\text{Y}$  at a different temperature.At equilibrium, the concentration of  $\text{X}_2 = 0.150 \text{ mol dm}^{-3}$ and the concentration of  $\text{Y} = 0.0520 \text{ mol dm}^{-3}$ At this temperature, the value of the equilibrium constant,  $K_c = 290 \text{ mol}^{-1} \text{ dm}^3$ Write the expression for the equilibrium constant,  $K_c$ Calculate the concentration of  $\text{Z}$ , in  $\text{mol dm}^{-3}$ , at equilibrium.**[3 marks]** $K_c$ 

Calculation

Concentration of  $\text{Z}$  \_\_\_\_\_  $\text{mol dm}^{-3}$ 

**Table 6** shows the value of the equilibrium constant ( $K_c$ ) at different temperatures.

**Table 6**

Temperature / K	$K_c / \text{mol}^{-1} \text{dm}^3$
300	780
500	160
700	55

**0 9 . 3** State how the equilibrium concentration of **Z** changes as the temperature increases.

Explain your answer.

**[3 marks]**

Change in equilibrium concentration of **Z** \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**0 9 . 4** The student repeats the experiment under different conditions.

Complete **Table 7** to state the effect on the value of equilibrium constant ( $K_c$ ) and the position of the equilibrium when

- a catalyst is added
- the volume of the container is increased.

**[2 marks]**

**Table 7**

	Effect on $K_c$	Effect on position of equilibrium
Catalyst is added		
Volume of the container is increased		

**Question 9 continues on the next page**

**Turn over ►**



The equilibrium is repeated here.



At 300 K, the value of the equilibrium constant,  $K_c = 780 \text{ mol}^{-1} \text{ dm}^3$

0 9 . 5

Calculate a value for the equilibrium constant ( $K_c$ ) for the reverse reaction at 300 K  
and give the units for this  $K_c$

[2 marks]

$K_c$  \_\_\_\_\_

Units \_\_\_\_\_

12

END OF QUESTIONS



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