

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 9 January 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	
<b>TOTAL</b>	



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

0 1

Alkanes are used as fuels in internal combustion engines in cars.

0 1 . 1

Write an equation to show the incomplete combustion of heptane ( $C_7H_{16}$ ) to form carbon monoxide and water only.

[1 mark]

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0 1 . 2

Some of alkane **A** is found unburned in car exhaust fumes. Analysis shows that 0.0381 mol of **A** has a mass of 4.35 g

Determine the molecular formula of **A**.  
Show your working.

[2 marks]

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

0 1 . 3

Give **one** environmental reason why unburned alkanes are pollutant gases.

[1 mark]

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0 1 . 4

Combustion of alkane fuels can produce sulfur dioxide.

Give **one** environmental reason for removing sulfur dioxide from the gaseous products of fuel combustion.

[1 mark]

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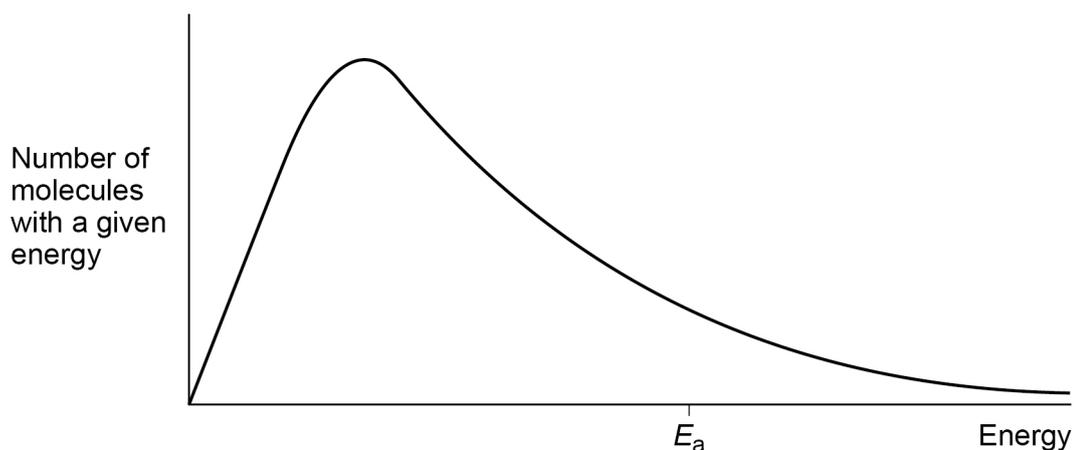
Nitrogen monoxide and carbon monoxide are also produced during the combustion of alkane fuels. These pollutant gases can be removed using a catalytic converter.

**0 1 . 5** Suggest why the reaction is slow when a catalyst is **not** used.

[1 mark]

**Figure 1** shows a Maxwell–Boltzmann distribution for a gaseous mixture of nitrogen monoxide and carbon monoxide at a given temperature.

**Figure 1**



**0 1 . 6** State the effect, if any, to the **area** under the curve when a catalyst is added to this gaseous mixture.

[1 mark]

**0 1 . 7** Explain how a catalyst increases the rate of a reaction.

[3 marks]

**0 1 . 8** Identify a catalyst used in the catalytic converter.

[1 mark]



**0 2** The hydrocarbons in crude oil are separated into fractions by fractional distillation.

**0 2 . 1** State the meaning of fractions.

[1 mark]

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There are three isomers with the molecular formula  $C_5H_{12}$

**0 2 . 2** Explain why dimethylpropane has the lowest boiling point.

[2 marks]

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**0 2 . 3** Draw skeletal formulas of the **two** other isomers with molecular formula  $C_5H_{12}$

[2 marks]

Isomer 1

Isomer 2

**0 2 . 4** Some of the hydrocarbons separated by fractional distillation are cracked.  
One molecule of a hydrocarbon **B** is cracked to produce two molecules of ethene,  
two molecules of propene and one molecule of butane.

Give the molecular formula of hydrocarbon **B**.

State the type of cracking involved.

Suggest why the percentage atom economy for this reaction is 100%

[3 marks]

Molecular formula of **B** \_\_\_\_\_

Type of cracking \_\_\_\_\_

Atom economy reason \_\_\_\_\_

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0 3 This question is about addition polymers.

0 3 . 1 The polymer poly(propene) is produced from propene.

Draw the repeating unit of poly(propene).

[1 mark]

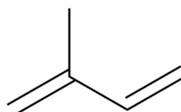
0 3 . 2 Give **one** reason why poly(propene) is unreactive.

[1 mark]

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0 3 . 3 An addition polymer is formed from isoprene.  
The skeletal formula of isoprene is shown.



Use IUPAC rules to name isoprene.

[1 mark]

---

3

Turn over ►



0 4

This question is about halogenoalkanes.

0 4 . 1

Bromoethane reacts with a warm aqueous ethanolic solution of potassium cyanide in a nucleophilic substitution reaction.



Outline a mechanism for the reaction.

[2 marks]

0 4 . 2

State why the reaction of potassium cyanide with iodoethane is faster than the reaction of potassium cyanide with bromoethane.

[1 mark]

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0 4 . 3

2-Bromopropane reacts with a hot ethanolic solution of potassium hydroxide to form propene.

State the role of the hydroxide ion in this reaction.

Write an overall equation for the reaction.

[2 marks]

Role of the hydroxide ion \_\_\_\_\_

Overall equation

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5
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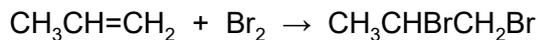


0 5

This question is about the formation of halogenoalkanes.

0 5 . 1

Propene reacts with bromine.



Name and outline the mechanism of this reaction.

**[4 marks]**

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

Mechanism

0 5 . 2

Propene reacts with HBr to form two possible products. The equation shows the formation of the major product.



State the type of intermediate in the formation of the major product.

Explain why this intermediate is more stable than the intermediate that forms the minor product.

**[3 marks]**

Type of intermediate \_\_\_\_\_

Explanation \_\_\_\_\_

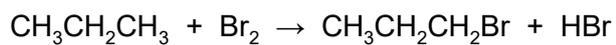
\_\_\_\_\_

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\_\_\_\_\_

**Turn over ►**

**0 5 . 3** Propane can react with bromine in ultraviolet light to form  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$



State the role of ultraviolet light in this reaction.

Outline **two** propagation steps from the mechanism.

**[3 marks]**

Role of ultraviolet light \_\_\_\_\_

Propagation step 1 \_\_\_\_\_

Propagation step 2 \_\_\_\_\_

**10**



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0 6

This question is about alcohols.

0 6 . 1

Alcohol **S** contains 60.0% C, 13.3% H and 26.7% ODetermine the empirical formula of **S**.**[2 marks]**

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

0 6 . 2

Alcohol **S** has  $M_r = 60.0$ Alcohol **S** can be oxidised to form a compound that gives a signal at  $1715\text{ cm}^{-1}$  in its infrared spectrum. The compound does **not** react with Tollens' reagent.Draw the displayed formula of alcohol **S**.**[1 mark]**

0 6 . 3

A position isomer of alcohol **S** is oxidised to give compound **T**.  
**T** reacts with  $\text{NaHCO}_3$ Identify **T**.State what is observed when **T** reacts with  $\text{NaHCO}_3$ **[2 marks]**Identity of **T** \_\_\_\_\_

Observation \_\_\_\_\_



**0 6 . 4** Identify a test-tube reagent, or combination of reagents, that can be used to oxidise primary and secondary alcohols but not tertiary alcohols.

State the colour change that is observed.

**[2 marks]**

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

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

**0 6 . 5** A different alcohol  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH}$  is oxidised to form compound **X**. **X** reacts with Fehling's solution.

Write an equation for this oxidation of  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH}$   
Use [O] to represent the oxidising agent.

Use IUPAC rules to name **X**.

State what is observed when **X** reacts with Fehling's solution.

**[3 marks]**

Equation

\_\_\_\_\_

Name of **X** \_\_\_\_\_

Observation \_\_\_\_\_

**0 6 . 6** Ethanol reacts with epoxyethane to form compound **Z** ( $\text{C}_4\text{H}_{10}\text{O}_2$ )

State the C–O–C bond angle in epoxyethane.

Give the structure of **Z**.

**[2 marks]**

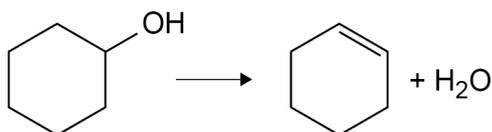
C–O–C bond angle in epoxyethane \_\_\_\_\_

Structure of **Z**



07

Cyclohexene can be made by adding an excess of concentrated sulfuric acid to hot cyclohexanol.



07.1

Name and outline the mechanism for this reaction.

[4 marks]

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

Mechanism

07.2

Identify a reagent, or combination of reagents, that can be used to confirm that an alkene is formed.

State what is observed.

[2 marks]

Reagent \_\_\_\_\_

Observation \_\_\_\_\_

**Table 1** contains data about cyclohexene and cyclohexanol.

Use the information in **Table 1** to help answer Questions **07.3–07.5**.

**Table 1**

Compound	Boiling point / °C	Density / g cm <sup>-3</sup>	<i>M<sub>r</sub></i>
Cyclohexene	82.8	0.811	82.0
Cyclohexanol	161.8	0.948	100.0



07.3

Name a technique that can be used to separate cyclohexene from unreacted cyclohexanol.

[1 mark]

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07.4

Explain, using the information in **Table 1**, how the purity of the separated cyclohexene can be determined.

[1 mark]

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07.5

In an experiment  $15.0 \text{ cm}^3$  of cyclohexanol forms  $9.62 \text{ g}$  of cyclohexene.

Calculate the maximum mass of cyclohexene that can be made from  $15.0 \text{ cm}^3$  of cyclohexanol.

Calculate the percentage yield of cyclohexene in this experiment.

Use data from **Table 1** to answer this question.

[4 marks]

Maximum mass of cyclohexene \_\_\_\_\_ g

Percentage yield of cyclohexene \_\_\_\_\_

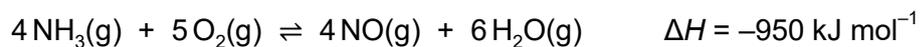
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**0 8**

This question is about chemical equilibria.  
The equation for the reaction between ammonia and oxygen is

**0 8****1**

Write an expression for  $K_c$  for this reaction.

Give the units of  $K_c$

**[2 marks]** $K_c$ 

Units \_\_\_\_\_

**0 8****2**

In an experiment 0.650 mol of  $\text{NH}_3$  and 0.743 mol of  $\text{O}_2$  are mixed and left to reach equilibrium.

The equilibrium mixture contains 0.144 mol of  $\text{NO}$  and 0.216 mol of  $\text{H}_2\text{O}$

Calculate the amount, in mol, of  $\text{NH}_3$  and  $\text{O}_2$  in the equilibrium mixture.

**[2 marks]**Mol  $\text{NH}_3$  \_\_\_\_\_Mol  $\text{O}_2$  \_\_\_\_\_

**0 8 . 3** Explain why the  $K_c$  value for this reaction decreases as the temperature increases.

**[3 marks]**

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**0 8 . 4** Explain why using a catalyst does **not** affect the equilibrium yield of NO

**[1 mark]**

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**0 8 . 5** The table shows three different gaseous equilibria reactions all at the same temperature.

Tick (✓) **one** box to select the reaction where an increase in overall pressure increases the equilibrium yield of **C**.

**[1 mark]**

Reaction	
$A + 2B \rightleftharpoons 4C$	<input type="checkbox"/>
$A + B \rightleftharpoons 2C$	<input type="checkbox"/>
$2A + B \rightleftharpoons C$	<input type="checkbox"/>

**9**

**END OF QUESTIONS**



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