OXFORD

INTERNATIONAL
AQA EXAMINATIONS

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 11 January 2022 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	
TOTAL	

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

Do not write outside the box

0 1 This question is about alkanes.

Alkanes are a homologous series of hydrocarbons with the general formula C_nH_{2n+2}

0 1 . 1 State **two** other properties of a homologous series.

[2 marks]

1 _____

_____

2 _____

_____

0 1 . 2 Explain why C_7H_{16} has a higher boiling point than C_5H_{12}

[2 marks]

_____

_____

_____

_____

0 1 . 3 Long chain alkanes are cracked to make other products.

Complete **Table 1** to state the type of cracking used in industry to form each type of product.

[1 mark]

Table 1

Product type	Type of cracking
Alkenes	
Aromatic hydrocarbons, cycloalkanes	

Do not write outside the box

0 1 . 4 $C_{12}H_{26}$ is cracked to make only two products.
These products are formed in a 2:1 mol ratio.
One of the products has M_r = 28.0 and empirical formula CH_2

Complete the equation for this reaction.

[2 marks]

$C_{12}H_{26} \rightarrow$ _____ + _____

Combustion of alkanes, in internal combustion engines, produces pollutant gases.
These gases can be removed using a catalytic converter.

0 1 . 5 State why the catalyst is coated on a honeycomb structure.

[1 mark]

_____

_____

0 1 . 6 Unburned alkanes and nitrogen oxides react together in the catalytic converter.

Complete the equation.

[1 mark]

$C_{11}H_{24}$ + _____ NO → _____ N_2 + _____ CO_2 + _____ H_2O

9

Turn over for the next question

Do not write outside the box

0 2 This question is about alkenes.

0 2 . 1 3-Methylbut-1-ene reacts with hydrogen bromide to form two isomeric halogenoalkanes.

Name and outline the mechanism for the reaction of 3-methylbut-1-ene with hydrogen bromide to form the major product.

[4 marks]

Name of Mechanism _____

Mechanism

0 2 . 2 Draw the skeletal formula for the **minor** product formed in Question **02.1**.

Explain how this product is formed.

[2 marks]

Skeletal formula

Explanation _____

_____

_____

_____

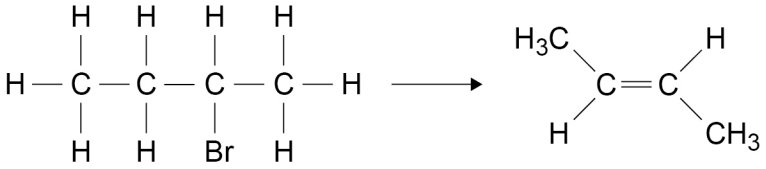
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0 2 . 3 2-Bromobutane reacts in an elimination reaction to form an alkene.

Complete the mechanism in **Figure 1** by adding the reacting species and curly arrows.

[3 marks]

Figure 1



0 2 . 4 Use IUPAC rules to give the full name of the alkene formed in **Figure 1**.

[1 mark]

0 2 . 5 Another alkene can be formed in the reaction in Question **02.3**.
This alkene does **not** exist as a pair of stereoisomers.

Draw the structure of this alkene.

Explain why this alkene does **not** exist as a pair of stereoisomers.

[2 marks]

Alkene

Explanation

Do not write outside the box

0 2 . 6 Identify a reagent that could be used in a simple test-tube reaction to show that an alkene is formed.

State what is observed.

[2 marks]

Reagent _____

Observation _____

_____

_____

Polymers can be formed from alkenes.

0 2 . 7 Draw the repeating unit of the polymer formed from 2-methylpropene.

[1 mark]

0 2 . 8 State why polymers formed from alkenes are unreactive.

[1 mark]

_____

_____

16

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0 3 This question is about making ethanol.

One method to make ethanol is the hydration of ethene using concentrated phosphoric acid as a catalyst.

$$CH_2{=}CH_2(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g)$$

0 3 . 1 Define the term activation energy.

[1 mark]

0 3 . 2 Explain how a small increase in temperature causes a large increase in the rate of this reaction.

[2 marks]

0 3 . 3 Predict and explain the effect, if any, of a catalyst on the equilibrium yield of ethanol in this reaction.

[2 marks]

Prediction

Explanation

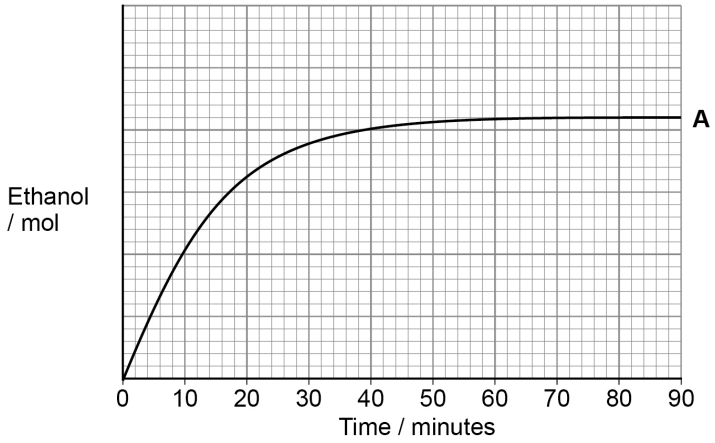
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0 3 . 4 Curve **A** in **Figure 2** shows how the amount of ethanol formed in this reaction changes with time at a fixed temperature.

State the time when equilibrium is reached.

[1 mark]

Figure 2



Time _____ minutes

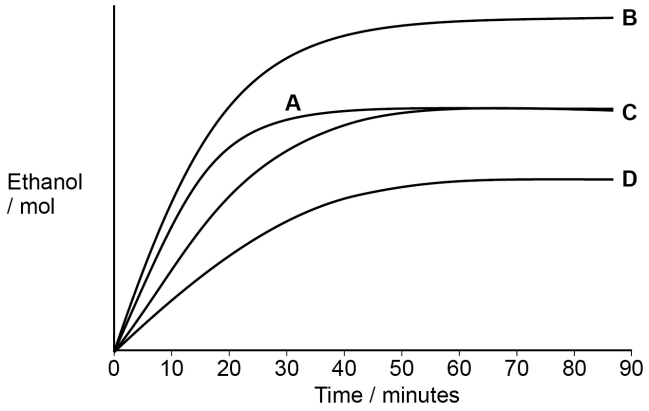
0 3 . 5 **Figure 3** shows the amount of ethanol formed in similar experiments, with the same initial amounts of ethene and hydrogen, but under different conditions.

Identify which curve, **B**, **C** or **D** in **Figure 3,** represents the amount of ethanol formed in this reaction when carried out in a larger container at the same temperature.

Explain your answer.

[2 marks]

Figure 3



Identity of curve _____

Explanation _____

_____

_____

Turn over ►

Do not write outside the box

0 3 . 6 The enthalpy change for the reaction is shown.

$$CH_2{=}CH_2(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g) \quad \Delta H^{\ominus} = -45 \text{ kJ mol}^{-1}$$

Tick (✓) **one** box in **Table 2** to identify the conditions that would give the maximum yield of ethanol in this reaction.

Explain why, other than to prevent polymerisation of propene, these conditions are **not** used in industry.

[3 marks]

Table 2

Temperature	Pressure	Tick (✓) one box
High	Low	
High	High	
Low	High	
Low	Low	

Explanation _____

_____

_____

_____

0 3 . 7 Ethanol can be made by a different process before being burned as a fuel.

Step **1**: $6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$

Step **2**: $C_6H_{12}O_6 \rightarrow 2\,CH_3CH_2OH + 2\,CO_2$

Step **3**: $2\,CH_3CH_2OH + 6\,O_2 \rightarrow 6\,H_2O + 4\,CO_2$

Carbon-neutral means there are no extra carbon dioxide emissions to the atmosphere.

Use the three steps to show that the ethanol made and burned in this process can be described as a carbon-neutral fuel.

[2 marks]

_____

_____

_____

_____

13

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0 4 This question is about butan-1-ol (C_4H_9OH) and its isomers.

0 4 . 1 Complete **Table 3** by drawing the structures for the isomers of butan-1-ol.

[3 marks]

Table 3

Isomer of butan-1-ol	Structure
Position isomer	
Functional group isomer	
Alcohol that cannot be oxidised	

0 4 . 2 The isomers of butan-1-ol can be distinguished from each other by infrared spectroscopy.

Explain how infrared spectroscopy can be used to distinguish between butan-1-ol and its position isomer.

[2 marks]

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0 4 . 3 C_4H_9OH is oxidised to form compound **G** (C_4H_8O).
G is obtained by distillation from the reaction mixture.

Give the reagent(s) used to oxidise butan-1-ol.

State what is observed in the reaction mixture.

Draw the displayed formula of **G**.

[3 marks]

Reagent(s) _____

Observation _____

_____

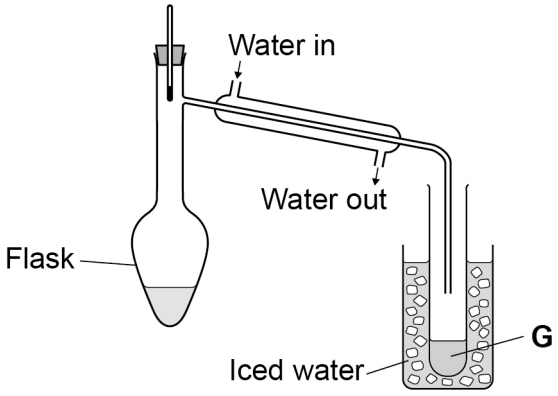
Displayed formula

0 4 . 4 **Figure 4** shows a distillation apparatus.

State one change that should be made in **Figure 4** to improve the yield of **G**.

[1 mark]

Figure 4



_____

_____

0 4 . 5 State why anti-bumping granules are used in the flask.

[1 mark]

_____

_____

Turn over ►

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An equation for the reaction in Question **04.3** is shown.

$$C_4H_9OH + [O] \rightarrow C_4H_8O + H_2O$$

G

0 4 . 6 In an experiment, 2.50 g of **G** are obtained.
This mass is 40.0% of the maximum theoretical yield.

Calculate the maximum theoretical yield of **G** in grams.

[1 mark]

Maximum theoretical yield _____ g

0 4 . 7 The oxidation reaction of butan-1-ol is repeated.

In this experiment, the maximum theoretical yield of **G** is 5.50 g

Calculate the starting volume, in cm^3, of butan-1-ol used in this experiment.
Give your answer to 3 significant figures.

The density of C_4H_9OH = 0.810 g cm^{-3}
The relative molecular masses, M_r of C_4H_9OH = 74.0 and M_r of **G** (C_4H_8O) = 72.0

[3 marks]

Volume _____ cm^3

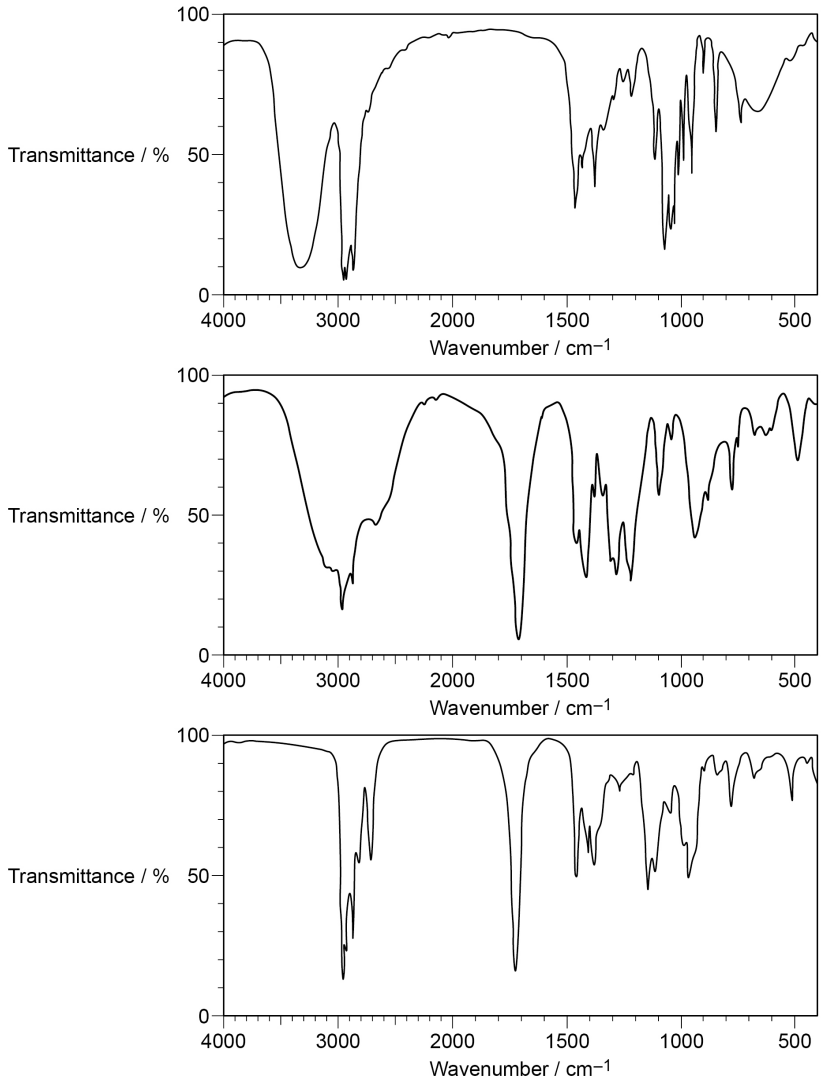
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G (C_4H_8O) can be oxidised to make compound **J**.

0 4 . 8 Use **Table A** on the Chemistry Data Sheet to select the infrared spectrum for compound **J.**

Tick (✓) **one** box.

[1 mark]



☐

☐

☐

0 4 . 9 Identify a reagent that could be used in a simple test-tube reaction to confirm the functional group in **J**.

State what is observed.

[2 marks]

Reagent _____

Observation _____

_____

_____

17

Turn over ►

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0 5 This question is about halogenoalkanes.

A student reacts three halogenoalkanes, 1-chlorobutane, 1-bromobutane and 1-iodobutane, with sodium hydroxide under similar conditions.

0 5 . 1 State which halogenoalkane reacts with sodium hydroxide at the fastest rate.

Give a reason for your answer.

[2 marks]

Halogenoalkane _____

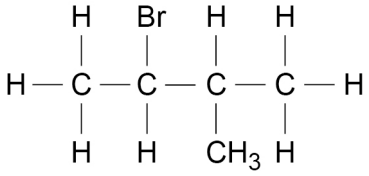
Reason _____

_____

0 5 . 2 Use IUPAC rules to name halogenoalkane **M**.

Calculate the percentage by mass of bromine in **M**.

[3 marks]



M

Name _____

Calculation

_____ %

Do not write outside the box

0 5 . 3 **M** reacts in a nucleophilic substitution reaction with sodium hydroxide.

State the conditions and outline the mechanism for the reaction.

[3 marks]

Conditions _____

Mechanism

8

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0 6 This question is about the equilibrium

$$2\,P(g) + Q(g) \rightleftharpoons 2\,R(g)$$

0 6 . 1 Give an expression for the equilibrium constant (K_c) for this equilibrium.
State the units.

[2 marks]

K_c

Units _____

0 6 . 2 A gaseous mixture of 0.580 mol of **P** and 0.430 mol of **Q** is placed in a container.
The equilibrium mixture contains 0.360 mol of **R**.

Calculate the amount, in moles, of **P** and of **Q** in the equilibrium mixture.

[2 marks]

Amount of **P** _____ mol

Amount of **Q** _____ mol

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0 6 . 3 The reaction is repeated in a container of volume 8.00 dm^3

This equilibrium mixture contains 0.268 mol of **P**, 0.347 mol of **Q** and 0.174 mol of **R**.

Use your expression for K_c in Question **06.1** to calculate a value for K_c

[2 marks]

K_c _____

0 6 . 4 Under different conditions, the value of the equilibrium constant, $K_c = 13.0$

Deduce the value of the equilibrium constant (K_c) for the reverse of this reaction under these conditions.

[1 mark]

K_c _____

7

END OF QUESTIONS

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