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 10 January 2023 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	
TOTAL	

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

0 1 This question is about hydrocarbons.

0 1 . 1 Some hydrocarbons are saturated.

State the meaning of saturated.

[1 mark]

0 1 . 2 Draw the chain isomer of butane.

[1 mark]

0 1 . 3 Hydrocarbons are often used as fuels.

Write an equation for the incomplete combustion of butane producing a toxic gas.

[1 mark]

0 1 . 4 Sulfur impurities in fuels can cause air pollution when the fuel is burned in power stations.

Identify the pollutant formed.

Write an equation to show how this pollutant is removed from the air.

Name the type of reaction that occurs when this pollutant is removed.

[3 marks]

Pollutant _____

Equation _____

Type of reaction _____

Do not write outside the box

0 1 . 5 Complete combustion of a hydrocarbon produces 5.500 g carbon dioxide and 1.125 g water.

Calculate the empirical formula of the hydrocarbon.

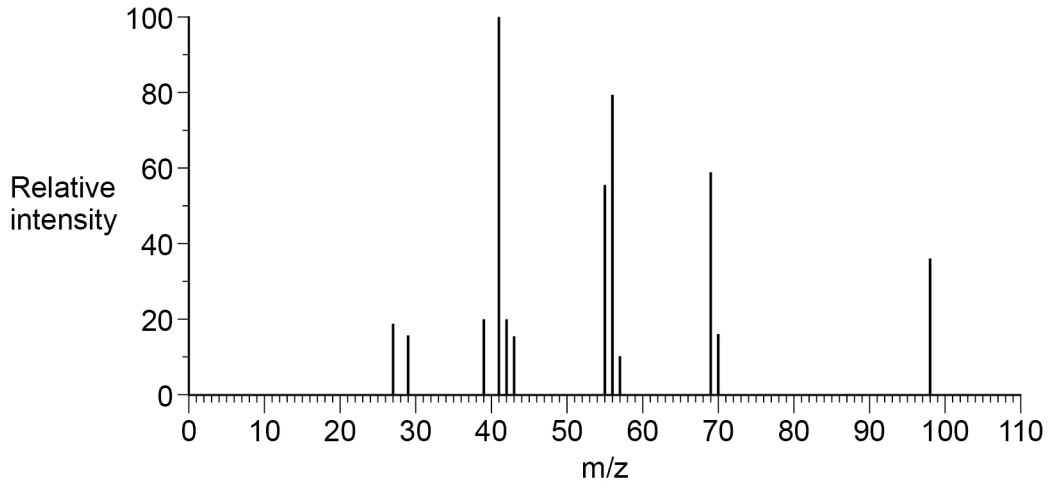
[3 marks]

Empirical formula _____

0 1 . 6 A different hydrocarbon has an empirical formula of CH_2

The mass spectrum of this hydrocarbon obtained by electron impact ionisation is shown in **Figure 1**.

Figure 1



Use **Figure 1** to determine the formula of the molecular ion of this hydrocarbon.

Show your working.

[2 marks]

Molecular ion formula _____

11

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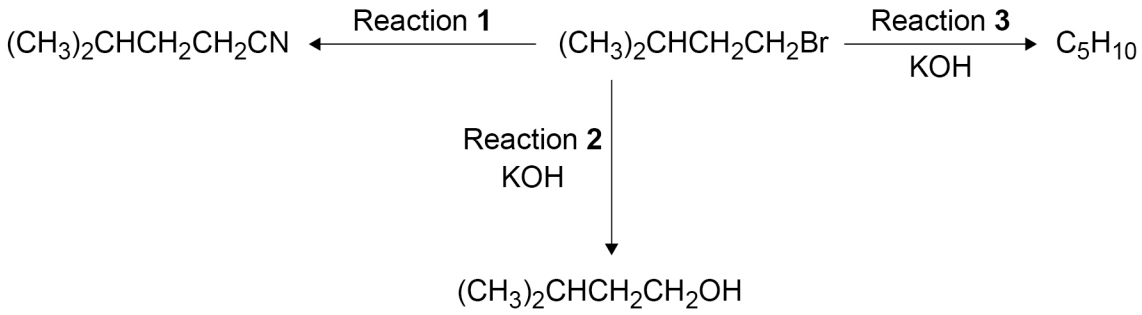
0 2 This question is about some reactions of the bromoalkane $(CH_3)_2CHCH_2CH_2Br$

Figure 2 shows the reactions of the bromoalkane $(CH_3)_2CHCH_2CH_2Br$

Figure 2



0 2 . 1 Use IUPAC rules to name the product $(CH_3)_2CHCH_2CH_2CN$ in Reaction **1**.

[1 mark]

0 2 . 2 3.75 g of $(CH_3)_2CHCH_2CH_2Br$ form 2.05 g of $(CH_3)_2CHCH_2CH_2CN$ in Reaction **1**.

$$(CH_3)_2CHCH_2CH_2Br + KCN \rightarrow (CH_3)_2CHCH_2CH_2CN + KBr$$

Calculate the percentage yield of $(CH_3)_2CHCH_2CH_2CN$ in this reaction.
Give your answer to 3 significant figures.

M_r $(CH_3)_2CHCH_2CH_2Br$ = 150.9

[3 marks]

Percentage yield

Do not write outside the box

0 2 . 3 Calculate the percentage atom economy for the formation of $(CH_3)_2CHCH_2CH_2CN$ in Reaction **1**.

$$(CH_3)_2CHCH_2CH_2Br + KCN \rightarrow (CH_3)_2CHCH_2CH_2CN + KBr$$

M_r $(CH_3)_2CHCH_2CH_2Br$ = 150.9

[2 marks]

Atom economy _____ %

0 2 . 4 Give **one** condition needed to give a high yield of $(CH_3)_2CHCH_2CH_2OH$ in Reaction **2**.

State and explain in words the role of the hydroxide ion in this reaction.

[3 marks]

Condition _____

Role _____

Explanation _____

_____

_____

_____

0 2 . 5 Give a condition needed for a high yield of C_5H_{10} in Reaction **3**.

[1 mark]

_____

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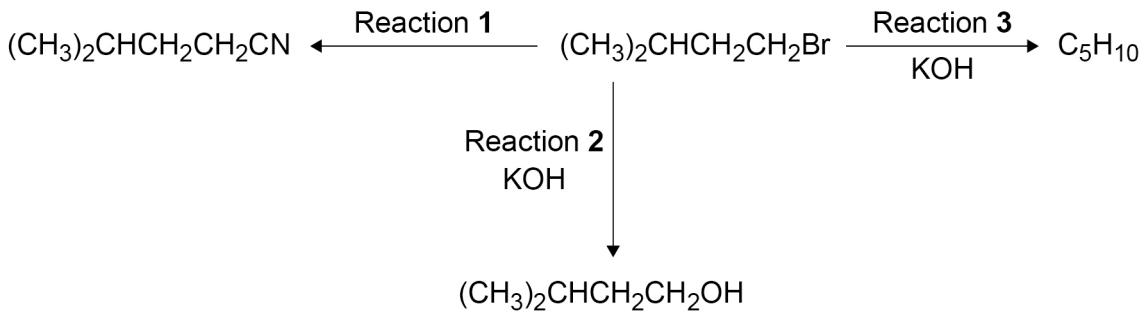
Figure 2 is repeated here.

Figure 2

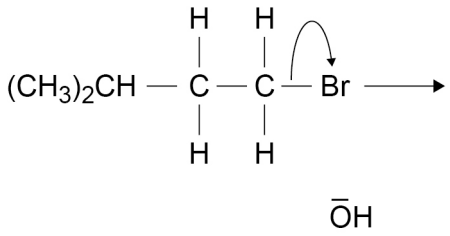


0 2 . 6 Name and complete the mechanism for Reaction **3**.

[3 marks]

Name _____

Mechanism



0 2 . 7 Halogenoalkanes can be used to make amines.

Complete the equation for the reaction of $(CH_3)_2CHCH_2CH_2Br$ to make a primary amine.

[2 marks]

$(CH_3)_2CHCH_2CH_2Br$ + _____

15

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0 3 This question is about alcohols.

Alcohols **P** and **Q** are isomers with the molecular formula C_3H_8O

Alcohol **P** can be oxidised to form compound **R**.

Alcohol **Q** can be oxidised to form compound **S**.

Butan-1-ol can be oxidised to form compound **T**.

Use the information in **Table 1** to help you answer Questions **03.1**–**03.3**.

Table 1

Alcohol	Oxidation product	Observation when oxidation product is reacted with $NaHCO_3$	Observation when oxidation product is reacted with Tollens' reagent
P	**R**	Effervescence	No visible change
Q	**S**	No visible change	No visible change
Butan-1-ol	**T**	No visible change	Silver mirror

0 3 . 1 Give the reagent(s) used to oxidise alcohols **P**, **Q** and butan-1-ol.

State the colour change observed in the reaction mixture in the oxidation of these alcohols.

Draw the structure of the oxidation product **R**.

[3 marks]

Reagent(s) _____

Colour change _____

Structure of oxidation product **R**

Do not write outside the box

0 3 . 2 Draw the displayed formula of alcohol **Q**.

State the class of alcohol **Q**.

[2 marks]

Displayed formula

Class _____

0 3 . 3 Write an equation for the oxidation of butan-1-ol ($CH_3CH_2CH_2CH_2OH$) to form **T**.

You should use [O] to represent the oxidising agent.

State the practical technique used to obtain **T** from the reaction mixture.

[2 marks]

Equation

_____

Practical technique _____

0 3 . 4 Pentan-1-ol ($CH_3CH_2CH_2CH_2CH_2OH$) and butanoic acid ($CH_3CH_2CH_2COOH$) both have a relative molecular mass of 88 to the nearest whole number.

Calculate the relative molecular mass of pentan-1-ol and butanoic acid to show that high-resolution mass spectrometry can be used to distinguish between these two compounds.

Relative atomic masses (A_r): H = 1.0078 C = 12.0096 O = 15.9990

[2 marks]

Pentan-1-ol

_____

Butanoic acid

_____

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Dehydration of an alcohol forms an alkene.

0 3 . 5 Use **Table A** on the Chemistry Data Sheet to show how infrared spectroscopy can be used to confirm that all the alcohol has reacted to form an alkene.

[2 marks]

0 3 . 6 Identify a reagent that can be used in a simple test-tube reaction to confirm that an alkene is formed.

State what is observed.

[2 marks]

Reagent _____

Observation _____

13

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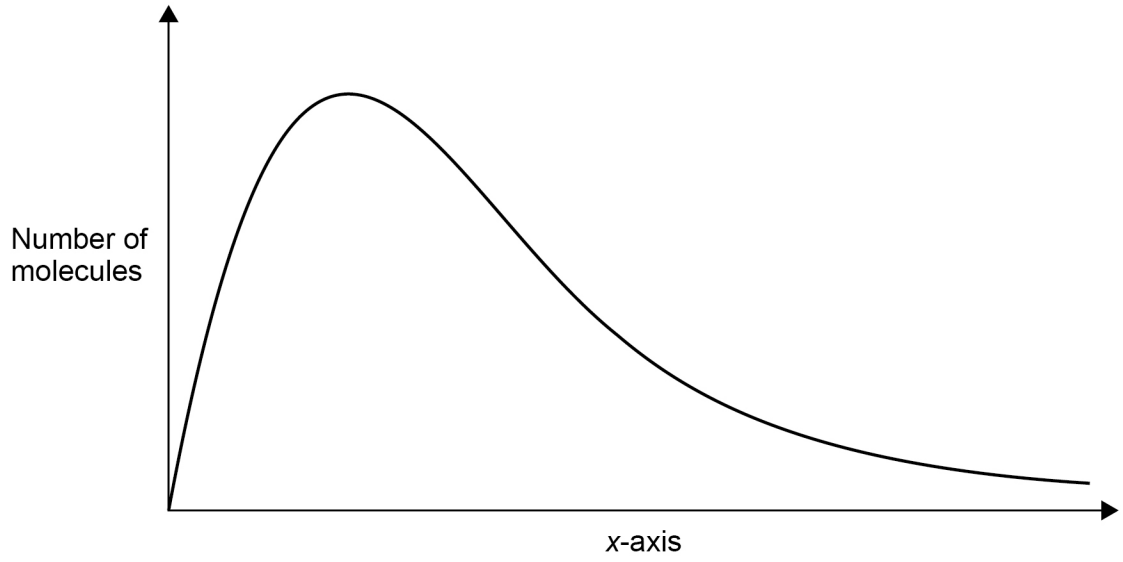
0 4 This question is about rates of reaction.

0 4 . 1 State the meaning of activation energy.

[1 mark]

0 4 . 2 **Figure 3** shows the Maxwell-Boltzmann distribution of molecular energies in a sample of hydrogen gas at 298 K

Figure 3



Give a label for the *x*-axis

[1 mark]

0 4 . 3 On **Figure 3** sketch a distribution of molecular energies for this sample of hydrogen gas at a lower temperature.

[2 marks]

Do not write outside the box

0 4 . 4 Use **Figure 3** to explain why a small decrease in temperature causes a large decrease in the rate of a reaction.

[2 marks]

0 4 . 5 How would the curve for a sample of nitrogen gas containing an equal number of moles at 298 K compare with the curve in **Figure 3**?

Tick (✓) **one** box.

[1 mark]

☐ The maximum for the curve for nitrogen would be higher.

☐ The maximum for the curve for nitrogen would be the same.

☐ The maximum for the curve for nitrogen would be lower.

7

Turn over for the next question

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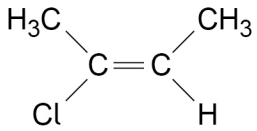
0 5 This question is about alkenes.

Some alkenes have stereoisomers.

0 5 . 1 State the meaning of stereoisomer.

[1 mark]

0 5 . 2 Use Cahn-Ingold-Prelog rules to give the full IUPAC name of the alkene



[1 mark]

0 5 . 3 Propene reacts with concentrated sulfuric acid to form two different products.

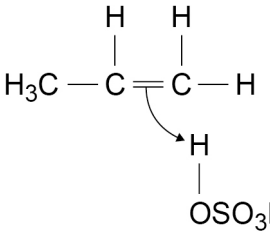
Name and complete the mechanism for the reaction to show the formation of the major product.

Explain why this is the major product.

[6 marks]

Name of mechanism

Mechanism



Explanation

8

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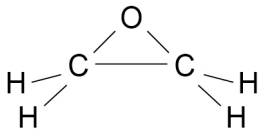
0 6 The structure of epoxyethane is shown.



0 6 . 1 Identify the catalyst used in the industrial manufacture of epoxyethane from ethene and oxygen.

Suggest a reason why the catalyst is spread over a solid support.

[2 marks]

Catalyst _____

Reason _____

_____

0 6 . 2 State the C–O–C bond angle in epoxyethane.

Explain why epoxyethane is very reactive.

[2 marks]

Bond angle in epoxyethane _____

Explanation _____

_____

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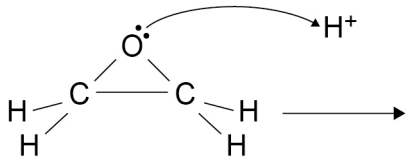
0 6 . 3 Epoxyethane reacts with water to form ethane-1,2-diol.

Complete the mechanism for the reaction of epoxyethane with water to form ethane-1,2-diol.

[2 marks]

Mechanism



0 6 . 4 Epoxyethane also reacts with methanol.

Draw the skeletal formula of the product formed when one mole of methanol reacts with one mole of epoxyethane.

[2 marks]

8

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0 7 This question is about the chemical equilibrium between NO_2 and N_2O_4

$$2\,NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -57\ kJ\ mol^{-1}$$

0 7 . 1 Explain why increasing the temperature decreases the equilibrium yield of N_2O_4

[2 marks]

0 7 . 2 A sample of NO_2 is allowed to reach equilibrium in a container of volume 0.5 dm^3 at a given temperature.

The equilibrium mixture contains 0.15 mol of NO_2 and 0.42 mol of N_2O_4

Give an expression for the equilibrium constant, K_c, for this equilibrium.

Calculate a value for K_c for this equilibrium at this temperature.

State the units of K_c

[4 marks]

K_c

Value of K_c _____

Units _____

Do not write outside the box

A different mixture of NO_2 and N_2O_4 is in equilibrium.

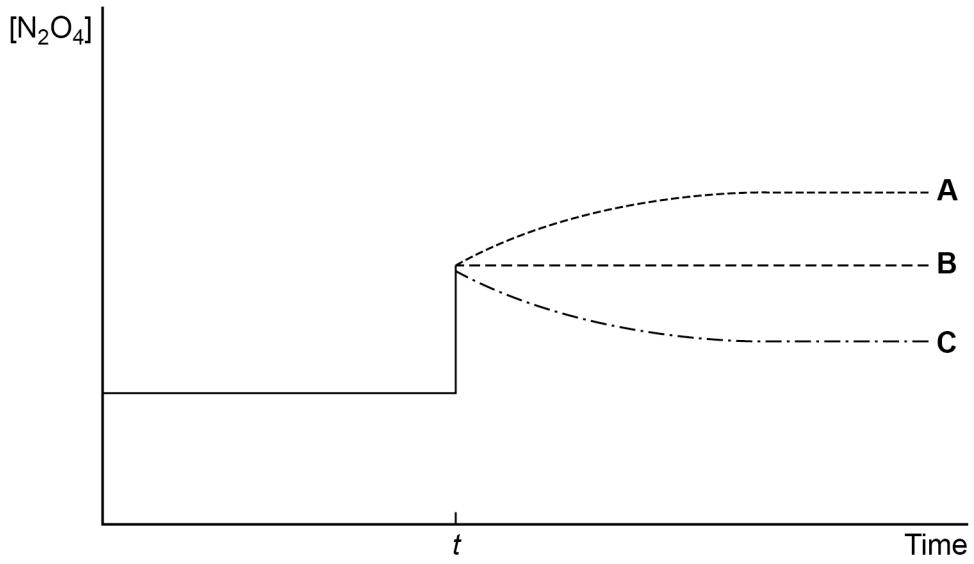
$$2\,NO_2(g) \rightleftharpoons N_2O_4(g)$$

The volume of this mixture is made **smaller** rapidly at time *t*.

The temperature is kept constant.

Figure 4 shows how the concentration of N_2O_4 varies with time during the experiment.

Figure 4



0 7 . 3 Identify the feature of **Figure 4** that shows that the mixture is in equilibrium before time *t*.

[1 mark]

0 7 . 4 Identify which dotted line, **A**, **B**, or **C**, on **Figure 4** shows how the concentration of N_2O_4 varies after the volume is made **smaller** at time *t*.

[1 mark]

Dotted line _____

8

END OF QUESTIONS

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