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 16 May 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	
8	
9	
TOTAL	

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

Do not write outside the box

0 1 The halogenoalkane $(CH_3)_3CBr$ reacts with water.

$$(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr$$

0 1 . 1 Use IUPAC rules to name the alcohol produced.

[1 mark]

0 1 . 2 Calculate the percentage atom economy for this reaction as a way of producing this alcohol.
Give your answer to 1 decimal place.

[2 marks]

Atom economy _____ %

0 1 . 3 Use collision theory to suggest why the reaction is very slow at room temperature even if the reactants are mixed thoroughly**.**

[1 mark]

0 1 . 4 Explain why the rate of reaction decreases as the reaction continues.

[2 marks]

Do not write outside the box

0 1 . 5 The same alcohol forms when $(CH_3)_3CCl$ reacts with water.

State why $(CH_3)_3CCl$ reacts more slowly than $(CH_3)_3CBr$

[1 mark]

7

Turn over for the next question

Do not write outside the box

0 2 This question is about alkenes.

But-1-ene reacts with concentrated sulfuric acid in an addition reaction.
The first step in the mechanism involves an electrophile.

0 2 . 1 State the meaning of the term addition reaction and the term electrophile.

[2 marks]

Addition reaction _____

_____

_____

Electrophile _____

_____

0 2 . 2 Outline the mechanism for this reaction to form the major product.

[4 marks]

Do not write outside the box

But-1-ene also reacts with chlorine in an electrophilic addition reaction.

0 2 . 3 Use IUPAC rules to name the product.

[1 mark]

0 2 . 4 Chlorine is a non-polar molecule but can react as an electrophile.

Explain why.

[2 marks]

9

Turn over for the next question

Do not write outside the box

0 3 A student observed some experiments to identify four liquids:

butanal, butanone, butanoic acid and butan-1-ol.

The student's description of the experiments is shown.
The description contains some mistakes.

Experiment 1 to identify butanoic acid

A small amount of each liquid is put into separate test tubes and an aqueous reagent is added.

Experiment 2 to identify butanal

A small amount of the remaining three liquids is put into separate test tubes.
A small amount of Fehling's solution is added to each test tube and warmed.
A brick-red solution forms in one test tube.

Experiment 3 to identify butan-1-ol

A small amount of the remaining two unidentified liquids is put into separate test tubes.
A small amount of acidified potassium dichromate(VI) solution is added to each test tube and warmed.
The colour in one test tube changed from orange to green.

0 3 . 1 Identify a suitable reagent for **Experiment 1**.

Give the observation that would identify one of the liquids as butanoic acid.

[2 marks]

Reagent _____

Observation with butanoic acid _____

_____

0 3 . 2 The observation in **Experiment 2** contains a mistake.

Give the correct observation with butanal.

[1 mark]

_____

_____

Do not write outside the box

0 3 . 3 **Experiment 3** is used to identify butan-1-ol.

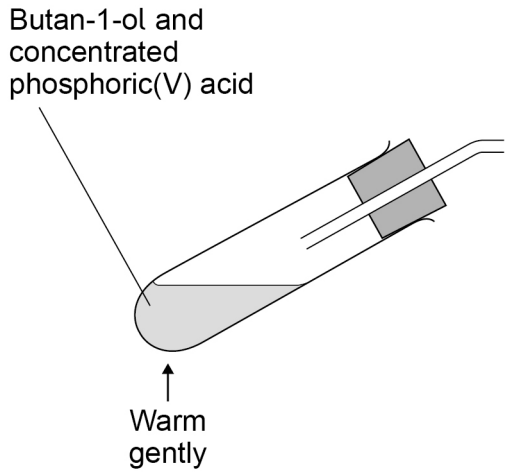
Draw the skeletal formula of the **first** organic product formed in this reaction.

[1 mark]

A teacher demonstrates the acid-catalysed elimination reaction of butan-1-ol using concentrated phosphoric(V) acid.

0 3 . 4 Complete the diagram to show the apparatus that can be used to collect the gas produced over water.

[1 mark]



0 3 . 5 Write an equation for the acid-catalysed elimination reaction of butan-1-ol.

Give the reagent and the observation for a test to identify the functional group in the gas collected.

[3 marks]

Equation

Reagent

Observation

8

Turn over ►

Do not write outside the box

0 4 This question is about epoxyethane.

0 4 . 1 Write an equation for the reaction of ethene with oxygen to form epoxyethane.

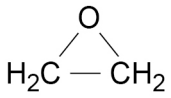
[1 mark]

0 4 . 2 Give **one** condition, other than temperature or pressure, used in the preparation of epoxyethane.

[1 mark]

0 4 . 3 Complete the mechanism to show the reaction of one molecule of epoxyethane with one molecule of water in acidic conditions.

[4 marks]



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0 4 . 4 One molecule of epoxyethane reacts with one molecule of ethanol.

Draw the displayed formula of the product of this reaction.

[1 mark]

7

Turn over for the next question

Do not write outside the box

0 5 Compounds **D** and **E** contain carbon, hydrogen and oxygen only.

0 5 . 1 A 1.159 g sample of **D** (M_r = 122.0) is burnt completely in an excess of oxygen.

1.672 g of carbon dioxide and 0.855 g of water are formed.

Determine the molecular formula of **D**.

[5 marks]

Molecular formula _____

0 5 . 2 The empirical formula of compound **E** (M_r = 62.0) is CH_3O
E is a symmetrical molecule.

The infrared spectrum of **E** has a broad absorption between 3230 – 3550 cm^{-1}

Identify the functional group present in **E**.

Give the structural formula of **E**.

[2 marks]

Functional group _____

Structural formula

7

Do not write outside the box

0 6 This question is about halogenoalkanes.

Methane reacts with chlorine in the presence of UV light to form several products including chloromethane.

0 6 . 1 The initiation step for this reaction is

$$Cl_2 \rightarrow 2Cl^{\bullet}$$

Write an equation for each of the **two** propagation steps to form chloromethane.

[2 marks]

1 _____

2 _____

0 6 . 2 Write an equation for a termination step that forms chloromethane.

[1 mark]

_____

0 6 . 3 Write an equation for a termination step that forms a hydrocarbon.

[1 mark]

_____

0 6 . 4 State why several organic products containing chlorine form when methane reacts with chlorine in the presence of UV light.

[1 mark]

_____

_____

_____

Turn over ►

Do not write outside the box

When warmed, 2-bromopropane reacts with potassium cyanide in a nucleophilic substitution reaction.

0 6 . 5 Give the condition, other than warming, for this reaction.

[1 mark]

0 6 . 6 Draw the structure of the nucleophile in the reaction of 2-bromopropane with potassium cyanide.
Include all lone pairs and the charge on the correct atom.

[1 mark]

0 6 . 7 Use IUPAC rules to name the organic product of the reaction between 2-bromopropane and potassium cyanide.

[1 mark]

0 6 . 8 2-Bromopropane reacts with hot ethanolic sodium hydroxide to form propene.

Name and outline the mechanism for this reaction.

[4 marks]

Name of mechanism _____

Mechanism

Do not write outside the box

0 6 . 9 2-Bromobutane also reacts with hot sodium hydroxide dissolved in ethanol.

In this reaction, three isomeric alkenes are formed.

Explain how all **three** different isomers are formed.
Include the names of the isomers in your answer.

[4 marks]

16

Turn over for the next question

Do not write outside the box

0 7 An equilibrium is established when **P** and **Q** react in aqueous solution to form **R**.

$$\mathbf{P}(aq) + \mathbf{Q}(aq) \rightleftharpoons \mathbf{R}(aq)$$

The equilibrium constant (K_c) can be written as

$$K_c = \frac{[\mathbf{R}]}{[\mathbf{P}][\mathbf{Q}]}$$

0 7 . 1 Some **P** and 0.20 mol of **Q** are mixed and allowed to reach equilibrium.

The volume of the mixture is 500 cm^3

At equilibrium 0.10 mol of **R** is present.

Calculate the amount, in moles, of **P** used at the start.

K_c = 30.0 $mol^{-1}\,dm^3$

[5 marks]

Amount of **P** _____ mol

0 7 . 2 How does the value of K_c change when the concentration of **Q** is increased?

Tick (✓) **one** box.

[1 mark]

K_c decreases. ☐

K_c does not change. ☐

K_c increases. ☐

Do not write outside the box

0 7 . 3 How does the equilibrium concentration of **R** change if a catalyst is added?

Tick (✓) **one** box.

[1 mark]

Concentration of **R** decreases. ☐

Concentration of **R** does not change. ☐

Concentration of **R** increases. ☐

0 7 . 4 The enthalpy change for this reaction, $\Delta H = -29.0\ \text{kJ mol}^{-1}$

Give **one** advantage and **one** disadvantage of using a low temperature to produce **R**.

[2 marks]

Advantage _____

_____

Disadvantage _____

_____

9

Turn over for the next question

Do not write outside the box

0 8 This question is about the atmosphere.

Global warming is caused when some gases in the atmosphere absorb radiation travelling away from the Earth. These gases are called greenhouse gases.

0 8 . 1 Identify the type of radiation absorbed by greenhouse gases.

[1 mark]

0 8 . 2 **Table 1** shows data about some greenhouse gases.

Table 1

Substance	Relative absorption per molecule	Approximate concentration in the atmosphere / parts per million (ppm)
CO_2	1	412
CH_4	30	1.7
N_2O	160	0.31
CCl_2F_2	25 000	0.00024

Use the data in **Table 1** to explain why, of these gases, carbon dioxide has the biggest impact on global warming.

[1 mark]

0 8 . 3 Sulfur dioxide is an atmospheric pollutant.

It is produced by the combustion of CH_3CH_2SH, an impurity in fossil fuels.

Write an equation to show the formation of sulfur dioxide by the complete combustion of CH_3CH_2SH

[1 mark]

0 8 . 4 State how sulfur dioxide is removed from flue gases.

[1 mark]

4

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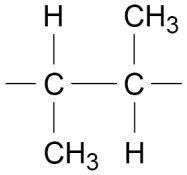
0 9 This question is about polymers formed from alkenes.

0 9 . 1 Name the polymer that has this repeating unit.



[1 mark]

0 9 . 2 State why poly(propene) has a much higher melting point than propene.

[1 mark]

0 9 . 3 Polymer **S** and polymer **T** are made from the same monomer but by different processes.
The chains in **S** are more branched than the chains in **T**.

Suggest **one** difference in the physical properties of **S** compared with **T**.

[1 mark]

3

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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