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 12 January 2021 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	
TOTAL	

Do not write outside the box

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

0 1 This question is about halogenoalkanes.

0 1 . 1 A halogenoalkane can be formed from an alkane in a free–radical substitution reaction.

Describe how a covalent bond breaks to form two free–radicals.

Name this step in the mechanism.

[2 marks]

How a covalent bond breaks _____

_____

Name of step _____

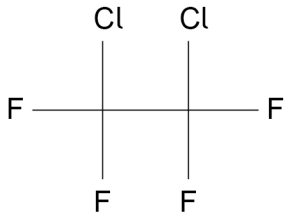
0 1 . 2 One molecule of a chloroalkane contains seven carbon atoms and one chlorine atom.

Deduce the relative molecular mass of the chloroalkane.

[2 marks]

Relative molecular mass _____

0 1 . 3 The skeletal formula of a halogenoalkane is shown.



Use IUPAC rules to name this halogenoalkane.

[1 mark]

_____

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0 1 . 4 1-Bromobutane reacts with a solution of sodium hydroxide to form an alcohol.

Outline the mechanism for this reaction.

[2 marks]

Mechanism

0 1 . 5 1-Bromobutane can also react with sodium hydroxide to form an alkene.

State the role of sodium hydroxide in this reaction.

Give the condition that would produce the maximum yield of alkene.

[2 marks]

Role _____

Condition _____

9

Turn over for the next question

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0 2 This question is about the equilibrium

$$\mathbf{D}(aq) + 2\,\mathbf{E}(aq) \rightleftharpoons \mathbf{F}(aq) \qquad \Delta H = -35\ \text{kJ mol}^{-1}$$

0 2 . 1 State **two** features of a reaction at equilibrium.

[2 marks]

1 _____

_____

2 _____

_____

0 2 . 2 A student adds 0.30 mol of **D** to a solution containing 0.40 mol of **E** and shakes the mixture.

At equilibrium, the mixture contains 0.15 mol of **F**.

Deduce the amount, in mol, of **D** and **E** in the equilibrium mixture.

[2 marks]

D _____ mol

E _____ mol

Do not write outside the box

0 2 . 3 A different mixture of **D** and **E** is allowed to reach equilibrium.

At equilibrium, the concentration of **D** = 0.80 mol dm^{-3} and the concentration of **F** = 0.40 mol dm^{-3}

The equilibrium constant, K_c = 4.2 mol^{-2} dm^6

Give the expression for the equilibrium constant (K_c) for this reaction.

Calculate the equilibrium concentration, in mol dm^{-3}, of **E**.

[3 marks]

K_c

Calculation

Concentration of **E**_____ mol dm^{-3}

Turn over ►

Do not write outside the box

The equation and information about this equilibrium is repeated here

$$\mathbf{D}(aq) + 2\,\mathbf{E}(aq) \rightleftharpoons \mathbf{F}(aq) \qquad \Delta H = -35\ \text{kJ mol}^{-1}$$

Another equilibrium mixture is established.

0 2 . 4 Some more **E** is added to this equilibrium mixture.

State how the value of K_c would change, if at all.

Place a tick (✓) in the correct box.

[1 mark]

K_c increases	
K_c stays the same	
K_c decreases	

D and **E** are white solids that dissolve readily in water to give colourless solutions. An aqueous solution of **F** is blue.

0 2 . 5 Some solid **D** is added to this equilibrium mixture.

State how the colour of this equilibrium mixture would change, if at all.

Place a tick (✓) in the correct box.

[1 mark]

Colour becomes more blue	
No change in colour	
Colour becomes less blue	

0 2 . 6 The equilibrium mixture is warmed.

Explain why the colour becomes less blue.

[3 marks]

_____

_____

_____

_____

_____

_____

12

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Turn over for the next question

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0 3 This question is about rate of reaction.

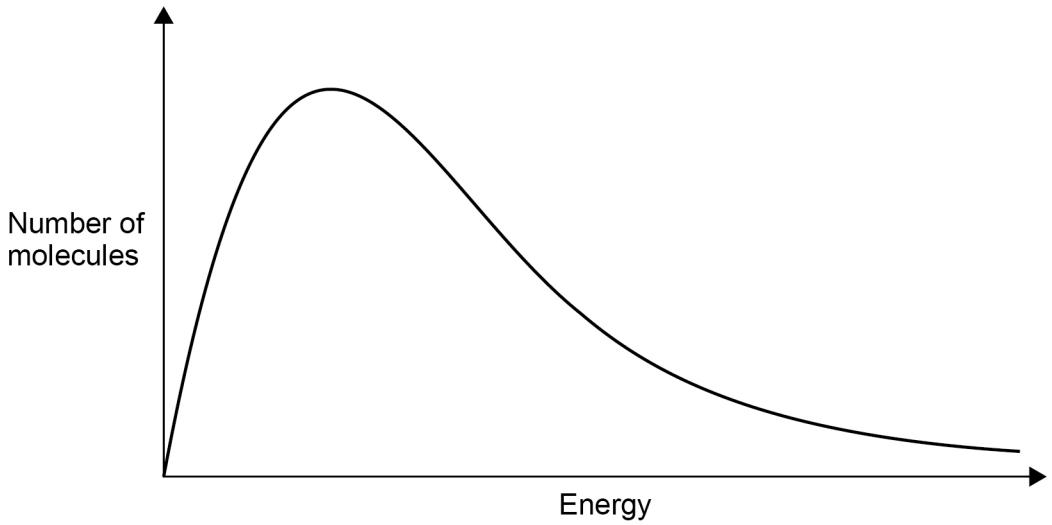
0 3 . 1 **Figure 1** shows the Maxwell–Boltzmann distribution of molecular energies in a gas.

Add labels to **Figure 1** to show the activation energy with a catalyst, and without a catalyst, for a reaction involving this gas.

Use **Figure 1** to explain how adding a catalyst increases the rate of this reaction.

[4 marks]

Figure 1



Explanation _____

_____

_____

_____

_____

_____

_____

_____

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0 3 . 2 The amount of catalyst remains constant throughout this reaction but the rate of reaction decreases.

Explain, using collision theory, why the rate of reaction decreases.

[2 marks]

0 3 . 3 Explain why a small increase in temperature has a bigger effect on the rate of a reaction than a small increase in the concentration of a reactant.

Use collision theory and the Maxwell–Boltzmann distribution of molecular energies in a gas in your answer.

[2 marks]

8

Turn over for the next question

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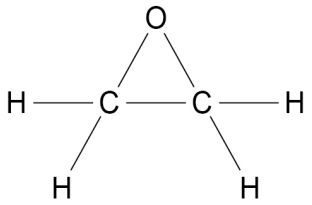
0 4 The structure of epoxyethane is shown.



0 4 . 1 Write an equation to show the formation of epoxyethane from ethene.

[1 mark]

_____

0 4 . 2 State the C–O–C bond angle in epoxyethane.

Explain why epoxyethane is very reactive.

[2 marks]

Bond angle _____

Explanation _____

_____

_____

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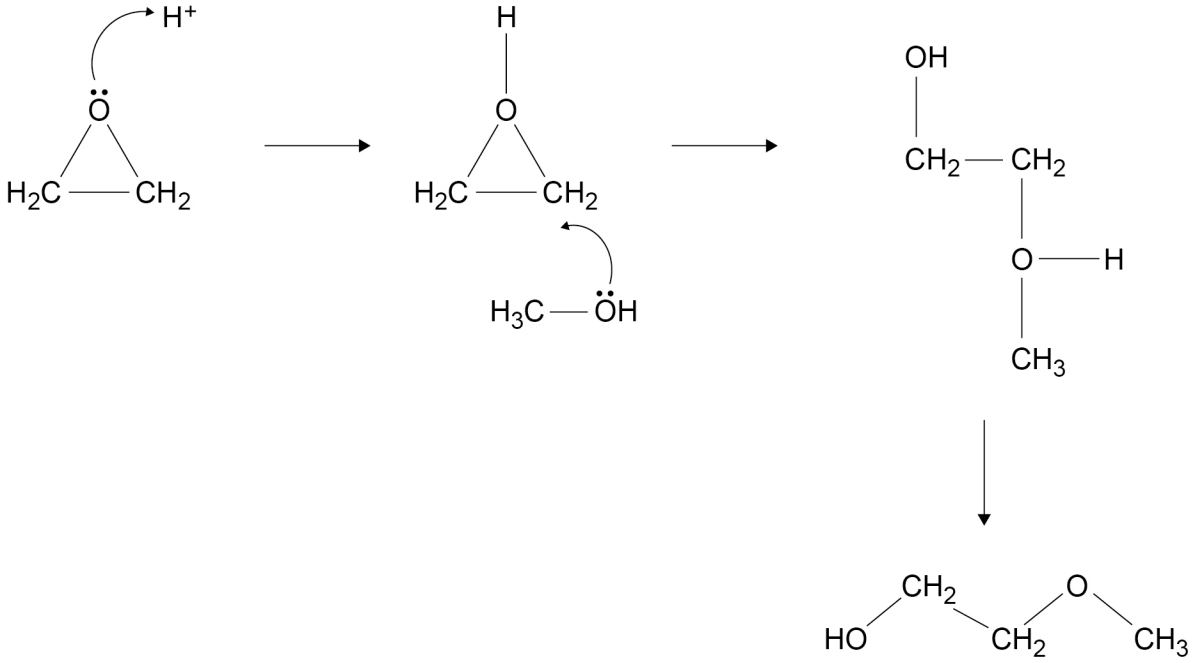
0 4 . 3 In acidic conditions, epoxyethane reacts with methanol.

An incomplete mechanism for this reaction is shown.

Complete the mechanism by adding appropriate curly arrows and charges.

[2 marks]



0 4 . 4 Give **one** use of the product formed in Question **04.3**.

[1 mark]

_____

6

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0 5 This question is about addition polymers.

The addition polymer poly(propene) can be formed from propan-1-ol as shown

$$H_3C-CH_2-CH_2-OH \xrightarrow[\textbf{Step 1}]{} H_3C-CH=CH_2 \xrightarrow[\textbf{Step 2}]{} \text{poly(propene)}$$

0 5 . 1 Name the mechanism in **Step 1**.

Give a reagent for **Step 1**.

[2 marks]

Name of mechanism _____

Reagent _____

0 5 . 2 Draw the repeating unit of poly(propene).

[1 mark]

0 5 . 3 State **one** physical property and **one** chemical property of the polymer, poly(propene), that differs from the properties of the monomer, propene.

[2 marks]

Physical property of polymer _____

_____

Chemical property of polymer _____

_____

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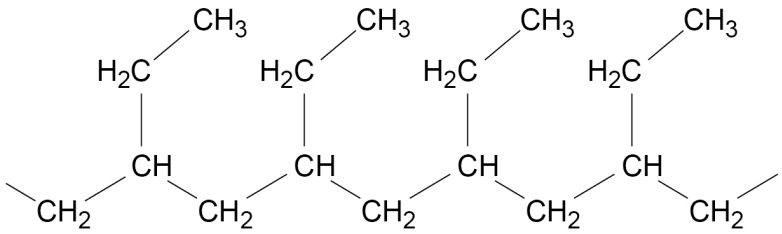
0 5 . 4 A section of a different addition polymer is shown.



Draw the skeletal formula of the monomer.

[1 mark]

0 5 . 5 Poly(chloroethene), PVC, is an important addition polymer that has many uses.

Name the type of substance added to PVC to make it more flexible.

Explain how this type of substance makes PVC more flexible.

[2 marks]

Type of substance _____

_____

Explanation _____

_____

8

Do not write outside the box

0 6 This question is about an experiment to prepare propanal by the oxidation of propan-1-ol.

0 6 . 1 Identify an oxidising agent for this reaction.

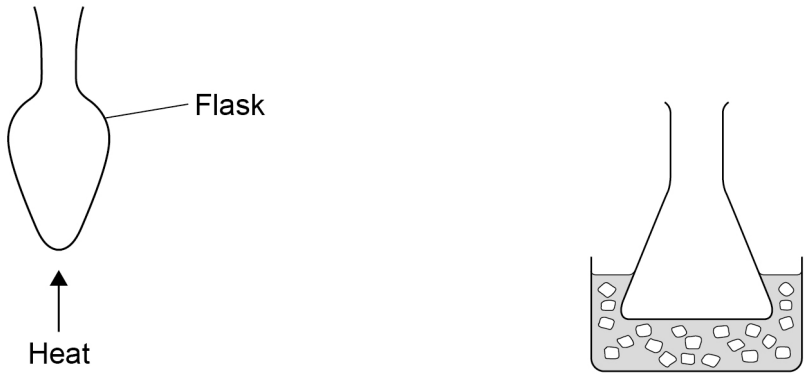
[1 mark]

_____

0 6 . 2 The propanal is prepared in a flask and collected by distillation.

Complete the diagram to show the apparatus needed to collect propanal by distillation. Label your diagram.

[2 marks]



0 6 . 3 Suggest why the conical flask used to collect the propanal is placed in an ice bath.

[1 mark]

_____

_____

Do not write outside the box

0 6 . 4 A student oxidises 5.00 cm^3 of propan-1-ol and collects 2.68 g of propanal.

Calculate the student's percentage yield.
Give your answer to 3 significant figures.

For propan-1-ol, density = 0.803 g cm^{-3}; M_r = 60.0
For propanal, M_r = 58.0

[3 marks]

Percentage yield_____

0 6 . 5 Propanoic acid can also be formed by the oxidation of propan-1-ol.

Describe how you could use infrared spectroscopy to show that the propanal collected is not contaminated by any propanoic acid.

[1 mark]

_____

_____

_____

0 6 . 6 State how the apparatus you have drawn in Question **06.2** should be changed so that propanoic acid is formed instead of propanal.

Explain your answer.

[2 marks]

_____

_____

_____

_____

10

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0 7 This question is about alkenes.

0 7 . 1 Write an equation for the complete combustion of the alkene C_6H_{12}

Calculate the mass of carbon dioxide formed when 5.6 g of C_6H_{12} combusts completely.

Show your working.

[3 marks]

Equation

_____

Calculation

Mass of carbon dioxide_____ g

Octane (C_8H_{18}) can be cracked.

0 7 . 2 In a cracking reaction, one molecule of octane is cracked to form one molecule of propene and one molecule of an alkane.

Write an equation for this reaction.

Give **one** condition needed for this reaction.

[2 marks]

Equation

_____

Condition _____

Do not write outside the box

0 7 . 3 Identify a reagent that could be used in a simple test-tube reaction to show that octane had been cracked.

State what is observed.

[2 marks]

Reagent _____

Observation _____

0 7 . 4 The first step in the reaction of propene with hydrogen bromide allows two possible carbocation intermediates to form.

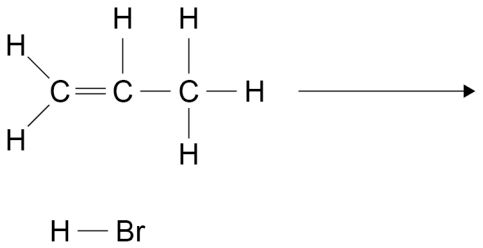
Complete the diagrams, adding appropriate curly arrows and charges, to show how each of these carbocations form.

State whether the more stable carbocation is primary, secondary or tertiary.

Name the major product formed in this reaction.

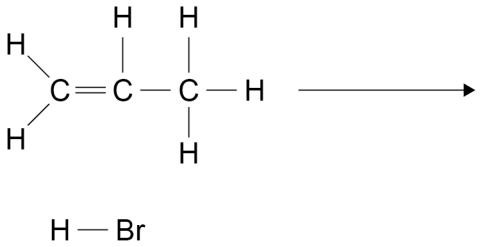
[4 marks]

carbocation 1



H — Br

carbocation 2



H — Br

More stable carbocation _____

Name of major product _____

11

Turn over ►

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0 8 This question is about butanal and butanone.

0 8 . 1 Identify the type of structural isomerism shown by butanal and butanone.

[1 mark]

_____

0 8 . 2 Identify a reagent that can be used in a simple test-tube reaction to distinguish between butanal and butanone.

State what is observed in each case.

[3 marks]

Reagent _____

Observation with butanal _____

_____

Observation with butanone _____

_____

G is a non-cyclic structural isomer of butanal that does not have an absorption at 1680–1750 cm^{-1} in its infrared spectrum.

0 8 . 3 Calculate the *m/z* value for the molecular ion peak of **G** in its mass spectrum.

[1 mark]

m/z _____

0 8 . 4 Give the wavenumber of one absorption that would be present in the infrared spectrum of **G** but **not** in that of butanal.

Do **not** include absorptions in the fingerprint region.

[1 mark]

_____ cm^{-1}

6

END OF QUESTIONS

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