OXFORD

INTERNATIONAL
AQA EXAMINATIONS

Please write clearly in block capitals.

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Forename(s) _____

Candidate signature _____
I declare this is my own work.

INTERNATIONAL AS
CHEMISTRY (9620)

Unit 2: Organic 1 and Physical 1

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.
- All working must be shown.
- 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).
- 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	

Do not write outside the box

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

0 1 This question is about alkanes.

0 1 . 1 Alkanes in crude oil are separated into fractions by fractional distillation.

State the property that allows alkanes to be separated by fractional distillation.

[1 mark]

_____

0 1 . 2 An alkane has M_r = 170.0

Deduce the molecular formula of this alkane.

[2 marks]

Molecular formula _____

0 1 . 3 $C_{14}H_{30}$ is cracked to form pentene and butane.

$$C_{14}H_{30} \rightarrow 2\,C_5H_{10} + C_4H_{10}$$

This reaction requires a large quantity of energy.

Give an economic reason for cracking $C_{14}H_{30}$

[1 mark]

_____

_____

Do not write outside the box

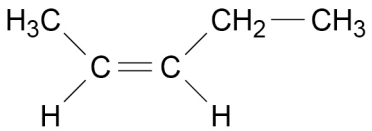
0 1 . 4 Calculate the percentage atom economy for the formation of pentene in the reaction in Question **01.3**.

[2 marks]

Atom economy _____ **%**

X and **Y** are position isomers of C_5H_{10}

The structure of **X** is shown.



0 1 . 5 Draw the structural formula of position isomer **Y**.

[1 mark]

Question 1 continues on the next page

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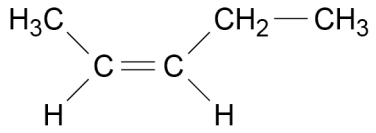
0 1 . 6 The structure of **X** is repeated here.



Explain why there is a stereoisomer of **X**.

Use IUPAC rules to give the full name of **X**.

[3 marks]

Explanation _____

_____

_____

_____

_____

_____

Full name of **X** _____

0 1 . 7 **X** forms an addition polymer.

Draw a repeating unit of this polymer.

[1 mark]

11

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0 2 This question is about 1-bromopropane.

0 2 . 1 Outline a mechanism for the reaction of 1-bromopropane with potassium cyanide.

Use IUPAC rules to name the organic product.

[3 marks]

Mechanism

Name of organic product _____

0 2 . 2 Suggest why the reactions of halogenoalkanes with potassium cyanide are useful in industrial synthesis.

[1 mark]

_____

_____

0 2 . 3 Explain why the reaction of 1-bromopropane with potassium cyanide is faster than the reaction of 1-chloropropane with potassium cyanide.

[1 mark]

_____

_____

0 2 . 4 When heated, 1-bromopropane reacts with potassium hydroxide in an elimination reaction.

State **one** other condition needed for this reaction.

[1 mark]

_____

Do not write outside the box

0 2 . 5 Outline a mechanism for the elimination reaction between 1-bromopropane and potassium hydroxide.

[3 marks]

0 2 . 6 Under different conditions, 1-bromopropane reacts with potassium hydroxide in a substitution reaction.

Draw the displayed formula of the organic product.

[1 mark]

Do not write outside the box

0 2 . 7 Propene and hydrogen bromide react together in an addition reaction to form 1-bromopropane and one other product.

Identify the other product.

Explain why the two products are **not** formed in equal amounts.

[3 marks]

Identity of other product _____

Explanation _____

_____

_____

_____

_____

_____

_____

13

Turn over for the next question

Do not write outside the box

0 3 When methane reacts with steam, in a sealed container, an equilibrium mixture forms.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3\,H_2(g) \qquad \Delta H^{\ominus} = +205 \text{ kJ mol}^{-1}$$

0 3 . 1 Give **two** features of a reaction at equilibrium.

[2 marks]

1 _____

_____

2 _____

_____

0 3 . 2 Which change in condition will increase the equilibrium yield of hydrogen in this reaction?

[1 mark]

Tick (✓) **one** box.

An increase in the total pressure ☐

An increase in the volume of the container ☐

An increase in the amount of catalyst added ☐

0 3 . 3 Explain why an increase in temperature increases the equilibrium yield of hydrogen.

[2 marks]

_____

_____

_____

_____

Do not write outside the box

0 3 . 4 Suggest how the **total** yield of hydrogen can be increased without changing the conditions of the reaction.

[1 mark]

0 3 . 5 Explain how a catalyst increases the rate of production of hydrogen in this reaction.

[2 marks]

8

Turn over for the next question

Do not write outside the box

0 4 . 1 **D** is an organic compound containing only carbon, hydrogen and oxygen.

D contains 62.07% carbon and 10.34% hydrogen by mass.

Determine the empirical formula of **D**.

[3 marks]

Empirical formula _____

0 4 . 2 **E** has the empirical formula C_2H_4O and M_r = 44.0

E reacts with water to form a diol.

Name **E**.

Give **one** use of the diol formed in the reaction of **E** with water.

[2 marks]

Name of **E** _____

Use of diol _____

5

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Turn over for the next question

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0 5 Ethanoic acid reacts with ethanol to form ethyl ethanoate ($CH_3COOC_2H_5$) and water.

$$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

A student completed a titration to determine the concentration of ethanoic acid in the equilibrium mixture.

Method

- Transfer 25.0 cm^3 of the equilibrium mixture to a conical flask and add a few drops of indicator.
- Fill a burette with 1.00 mol dm^{-3} aqueous sodium hydroxide.
- Record the initial reading of the burette.
- Add the aqueous sodium hydroxide slowly to the mixture in the conical flask until the end-point is reached.
- Record the final reading on the burette.
- Repeat until two concordant titres are obtained.

0 5 . 1 Suggest why universal indicator cannot be used as the indicator in this titration.

[1 mark]

0 5 . 2 State what is meant by the word concordant in the term concordant titres.

[1 mark]

0 5 . 3 The burette used has 0.10 cm^3 divisions.

Explain why the total uncertainty in a titre is ±0.15 cm^3

[2 marks]

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0 5 . 4 In a different experiment, 1.00 mol of ethanoic acid is mixed with 2.00 mol of ethanol and 5.00 mol of water in a sealed flask.

At equilibrium, 0.54 mol of ethanoic acid is present.

Calculate the amounts, in moles, of ethanol, ethyl ethanoate and water in this equilibrium mixture.

[2 marks]

$$CH_3COOH(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5(l) + H_2O(l)$$

Ethanol _____ mol

Ethyl ethanoate _____ mol

Water _____ mol

0 5 . 5 Write an expression for the equilibrium constant (K_c) for the reaction.

State why K_c for this reaction has no units.

[2 marks]

K_c

_____

_____

8

Turn over for the next question

Do not write outside the box

0 6 **F** is a hydrocarbon with formula C_5H_{12}

F reacts with bromine in a free-radical substitution reaction to form $C_5H_{11}Br$

0 6 . 1 Write an equation for the initiation step of this reaction.

[1 mark]

_____

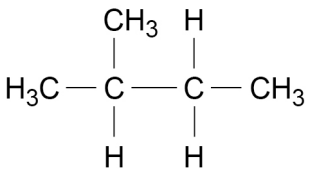
0 6 . 2 Write equations for the **two** propagation steps in this reaction.
Use molecular formulas in your equations.

[2 marks]

1 _____

2 _____

0 6 . 3 There are two branched-chain isomers and one straight-chain isomer with the molecular formula C_5H_{12}
The structure of one of the branched-chain isomers is shown.



Draw the skeletal formula of the other **branched-chain** isomer.

Explain why the straight-chain isomer has a higher boiling point than the branched-chain isomers.

[3 marks]

Skeletal formula

Explanation _____

_____

_____

_____

Do not write outside the box

0 6 . 4 Complete the equation showing an incomplete combustion of **F**.

[1 mark]

$$C_5H_{12} + 7\,O_2 \rightarrow \ \ldots\ldots\ CO_2 + \ \ldots\ldots\ CO + \ \ldots\ldots\ H_2O$$

7

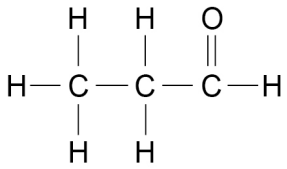
Turn over for the next question

Do not write outside the box

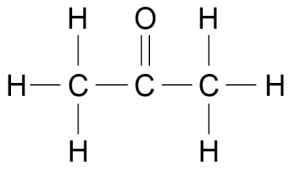
0 7 This question is about isomers with the molecular formula C_3H_6O

The structures of two isomers, **P** and **Q**, are shown.

Isomer **P**



Isomer **Q**



0 7 . 1 The functional groups in **P** and **Q** cause an absorption in their infrared spectra.

Use **Table A** on the Chemistry Data Sheet to identify the wavenumber range for this absorption.

[1 mark]

_____

0 7 . 2 Give a reagent or reagents that can be used in a simple test-tube reaction to distinguish between isomers **P** and **Q**.

State the observation made for each isomer.

[3 marks]

Reagent(s) _____

Observation with **P** _____

Observation with **Q** _____

Do not write outside the box

0 7 . 3 Another isomer of C_3H_6O contains **two** different functional groups.

The functional groups can be identified using bromine water and acidified potassium dichromate(VI).

Complete the table to identify each functional group present.

Deduce a possible structure of this isomer.

[2 marks]

Reagent	**Observation**	**Functional group present**
Bromine water	Orange to colourless solution	
Acidified potassium dichromate(VI)	Orange to green solution	

Structure

6

Turn over for the next question

Do not write outside the box

0 8 **Figure 1** shows a Maxwell–Boltzmann distribution of molecular energies in a sample of gas **H** at temperature *T*.

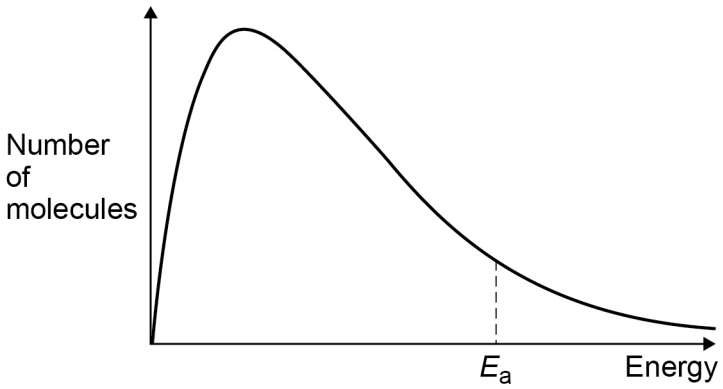
Gas **H** decomposes as shown.

$$\mathbf{H}(g) \rightarrow \mathbf{J}(g) + \mathbf{K}(g)$$

The most probable energy of the gaseous molecules is E_m

The activation energy for the decomposition is E_a

Figure 1



0 8 . 1 State why the curve in **Figure 1** starts at the origin.

[1 mark]

_____

_____

0 8 . 2 The temperature of the reaction mixture is decreased.

State the effect, if any, on the value of E_m and on the number of molecules with E_m

[2 marks]

Effect on E_m _____

Effect on the number of molecules _____

_____

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0 8 . 3 State the effect, if any, of a decrease in temperature on the area under the curve.

Explain your answer.

[2 marks]

Effect _____

Explanation _____

_____

0 8 . 4 The number of molecules in the sample of **H** is increased at temperature *T*.

State the effect, if any, on the value of E_a and on the number of molecules that have energy greater than or equal to E_a

[2 marks]

Effect on E_a _____

Effect on the number of molecules _____

_____

7

Turn over for the next question

Do not write outside the box

0 9 This question is about reactions used to produce ethanol.

0 9 . 1 The reaction to produce ethanol from glucose is shown.

$$C_6H_{12}O_6(aq) \rightarrow 2\,C_2H_5OH(aq) + 2\,CO_2(g)$$

6.30 g of glucose (M_r = 180.0) react to produce 0.23 g of ethanol (M_r = 46.0).

Calculate the percentage yield of ethanol in this reaction.

[4 marks]

_____ %

0 9 . 2 Ethanol can also be produced by the direct hydration of ethene.

Give **one** advantage of producing ethanol from ethene rather than from glucose.

[1 mark]

_____

_____

5

END OF QUESTIONS

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