OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 2: Organic 1 and Physical 1

Wednesday 22 May 2019 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.
- 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	
TOTAL	

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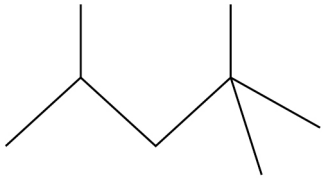
Answer **all** questions in the spaces provided.

0 1 The skeletal formulas and boiling points of two structural isomers, **A** and **B**, are shown below.

A

boiling point = 125 °C

B



boiling point = 99 °C

0 1 . 1 Use molecular formulas to write an equation for the complete combustion of **A**.

[1 mark]

0 1 . 2 Use IUPAC rules to name **B**.

[1 mark]

0 1 . 3 Explain why **A** has a higher boiling point than **B**.

[2 marks]

0 1 . 4 A mixture of **A** and **B** can be separated in the laboratory.

Name the technique that can be used to separate **A** and **B**.

[1 mark]

Do not write outside the box

0 1 . 5 One molecule of an alkane with molecular formula $C_{20}H_{42}$ is cracked.
The products are tetramethylbutane, propene and ethene.

Use molecular formulas to deduce an equation for this reaction.

[1 mark]

_____

0 1 . 6 The cracking reaction in Question **01.5** is carried out at a high temperature.

State **one** other condition needed.

[1 mark]

_____

0 1 . 7 Explain why the atom economy for the reaction in Question **01.5** is 100 %

[1 mark]

_____

_____

_____

_____

Question 1 continues on the next page

Do not write outside the box

0 1 . 8 Isomer **B** reacts with chlorine to produce a compound with M_r = 252.0

This compound contains 38.10% carbon and 5.55% hydrogen by mass.

Calculate the empirical formula and the molecular formula of this compound.
Show your working.

[4 marks]

Empirical formula _____

Molecular formula _____

12

Do not write outside the box

0 2 . 1 Van der Waals' forces exist between all molecules.

Explain how these forces arise.

[3 marks]

0 2 . 2 Draw a diagram to show the strongest intermolecular force between one ammonia molecule and one water molecule.

Include all partial charges and all lone pairs of electrons.

[3 marks]

6

Turn over for the next question

Do not write outside the box

0 3 An alcohol reacts with hot concentrated sulfuric acid to form a mixture of alkenes.

This alcohol also reacts with acidified potassium dichromate(VI) to form an organic compound that does **not** react with Tollens' reagent.

0 3 . 1 Explain how this information shows that this alcohol must be a secondary alcohol.

[2 marks]

0 3 . 2 Pentan-2-ol can be dehydrated by reaction with hot concentrated sulfuric acid to form pent-2-ene and water.

Outline a mechanism for this reaction.

[3 marks]

Do not write outside the box

0 3 . 3 Describe a test-tube reaction that can be used to show that pentan-2-ol has been dehydrated.
Give the result.

[2 marks]

_____

_____

_____

_____

0 3 . 4 Draw the skeletal formula of the product formed when pentan-2-ol reacts with acidified potassium dichromate(VI).

[1 mark]

0 3 . 5 Draw the displayed formula of the tertiary alcohol with molecular formula $C_5H_{12}O$

[1 mark]

9

Do not write outside the box

0 4 A factory uses propane as a fuel.

Mass spectrometry is used to monitor the oxides of nitrogen released in the waste gases from this factory.

0 4 . 1 State the formula of an oxide of nitrogen with $M_r = 44.0$

[1 mark]

0 4 . 2 Some precise atomic masses are given in **Table 1**

Table 1

Element	Precise atomic mass
C	12.011
H	1.008
N	14.007
O	15.999

Explain why precise atomic masses are needed to distinguish between molecular ion peaks of propane, carbon dioxide and the oxide of nitrogen in Question **04.1**

Use the data in **Table 1** to justify your answer.
Show your working.

[3 marks]

Do not write outside the box

0 4 . 3 Nitrogen monoxide (NO) is formed in internal combustion engines.

State **one** essential condition for the formation of NO in an engine.
Write an equation to show the formation of NO in an engine.

[2 marks]

Condition _____

Equation

_____

6

Turn over for the next question

Do not write outside the box

0 5 **F**, **G** and **H** are isomers of C_5H_{10}

$CH_2=C(CH_3)CH_2CH_3$	$CH_3CH=CHCH_2CH_3$	$CH_3CH=C(CH_3)_2$
F	**G**	**H**

0 5 . 1 Use IUPAC rules to name **F**.

[1 mark]

_____

0 5 . 2 **F** reacts with hydrogen bromide.

Name and outline the mechanism for the reaction that forms the major product, **J**.

Explain why **J** is the major product in this reaction.

[7 marks]

Name of mechanism _____

Mechanism

Explanation _____

Do not write outside the box

0 5 . 3 **G** exists as *E* and *Z* isomers.

Draw the structure of the *E* isomer.

[1 mark]

0 5 . 4 Explain why **F** does **not** show *E*–*Z* isomerism.

[1 mark]

_____

_____

_____

0 5 . 5 Draw the structure of an isomer of C_5H_{10} that is **not** an alkene.

[1 mark]

Question 5 continues on the next page

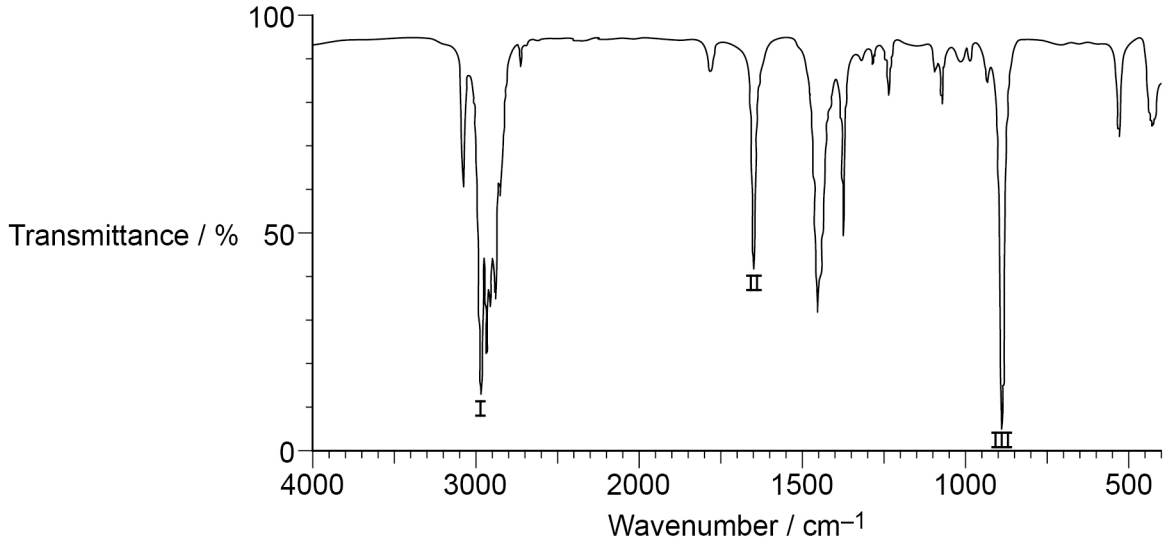
Do not write outside the box

0 5 . 6 Draw one repeating unit of the polymer that can be formed from **H**, $CH_3CH{=}C(CH_3)_2$

[1 mark]

0 5 . 7 **Figure 1** shows the infrared spectrum of **H**.

Figure 1



Use **Table A** on the Data Sheet to identify the absorption that would **not** be present in the polymer.

Tick (✓) **one** box.

[1 mark]

I ☐

II ☐

III ☐

13

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0 6 Hydrogen peroxide (H_2O_2) decomposes, in the presence of a catalyst, to form water and oxygen.

0 6 . 1 Write the equation for the decomposition of hydrogen peroxide.

[1 mark]

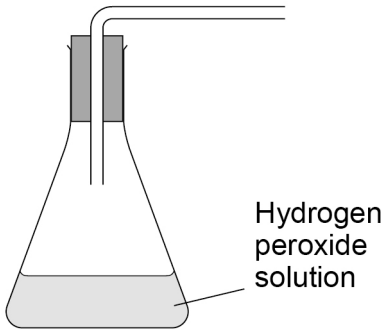
0 6 . 2 Explain why the decomposition of hydrogen peroxide is a redox reaction.

Use oxidation states to justify your answer.

[3 marks]

0 6 . 3 Complete the diagram to show the apparatus a student could use to collect the oxygen formed in this decomposition and measure its volume.

[1 mark]



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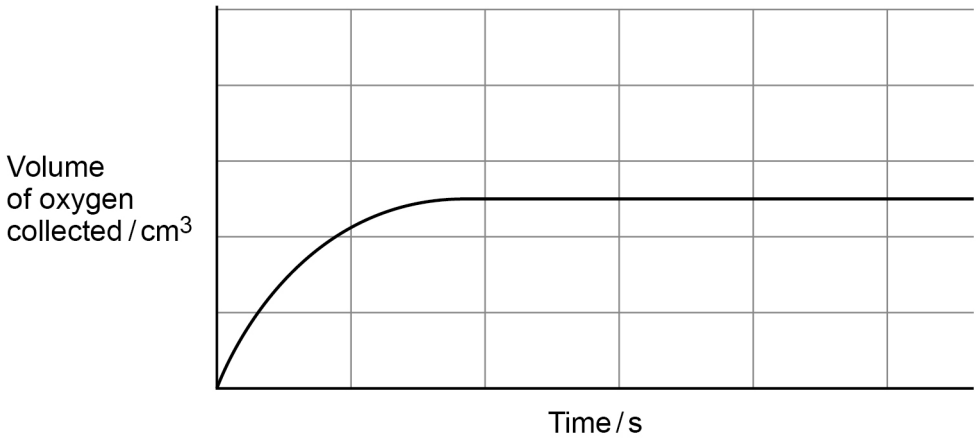
5 cm^3 of a 1.0 mol dm^{-3} solution of hydrogen peroxide decomposes, in the presence of a copper(II) oxide catalyst, at 298 K

Figure 2 shows how the volume of oxygen collected changes with time.

Figure 2



0 6 . 4 Explain why the curve is steepest at the start of the reaction.

[2 marks]

_____

_____

_____

_____

0 6 . 5 The experiment is repeated using 5 cm^3 of a 2.0 mol dm^{-3} solution of hydrogen peroxide under the same conditions as in Question **06.4**

Draw a curve on **Figure 2** to show how the volume of oxygen collected changes with time in this experiment.

[2 marks]

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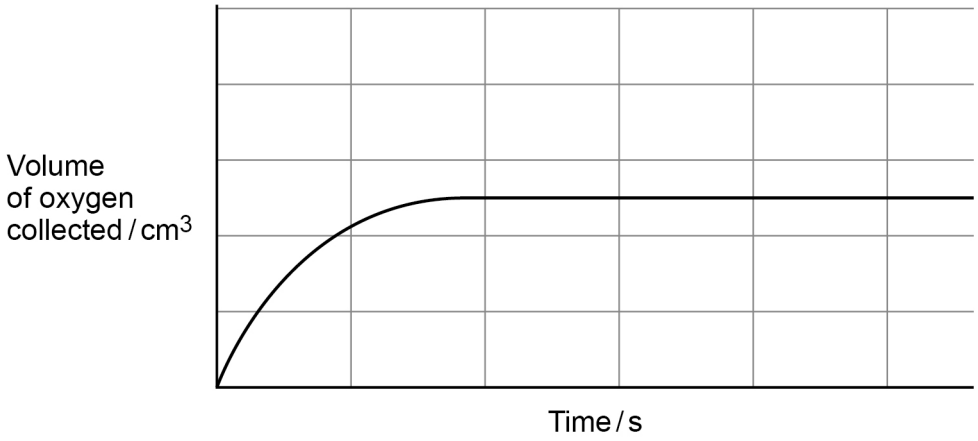
0 6 . 6 **Figure 3** shows the volume of oxygen collected using 5 cm^3 of a 1.0 mol dm^{-3} solution of hydrogen peroxide, in the presence of a copper(II) oxide catalyst, at 298 K

Figure 3



Potassium iodide is a more effective catalyst than copper(II) oxide.

The experiment is repeated using potassium iodide instead of copper(II) oxide.

Draw a curve on **Figure 3** to show how the volume of oxygen collected changes with time in this experiment.

[2 marks]

Do not write outside the box

0 6 . 7 Calculate the maximum volume, in cm^3, of oxygen formed at 298 K and 100 kPa, in the reaction in Question **06.6**

The gas constant, R = 8.31 J K^{-1} mol^{-1}

[3 marks]

Volume _____ cm^3

14

Turn over for the next question

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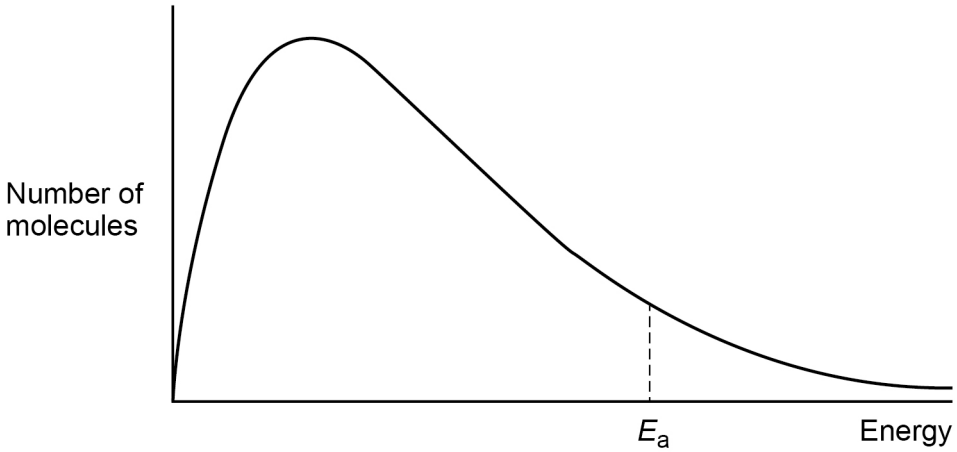
0 7 **Figure 4** shows the Maxwell–Boltzmann distribution for the molecules of a gas in a container of volume V and at temperature T

The activation energy (E_a) for its decomposition is shown.

Figure 4



0 7 . 1 Write the letter **M** on the appropriate axis of **Figure 4** to show the value of the most probable energy of the molecules of the gas at temperature T

[1 mark]

0 7 . 2 The sample of gas at temperature T is placed in a container that has a volume of $2V$

Explain why the Maxwell–Boltzmann distribution does **not** change for the gas in the new container.

[1 mark]

_____

_____

0 7 . 3 State the effect, if any, of an increase in temperature on the value of E_a for this decomposition.

[1 mark]

_____

_____

3

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0 8 This question is about the reactions of halogenoalkanes.

0 8 . 1 Halogenoalkanes react with reagent **Z** to form alcohols or alkenes depending on the conditions.

Identify reagent **Z**.

State the condition(s) that favour the formation of each product.

Name the type of reaction in each case.

[5 marks]

Reagent **Z** _____

Condition(s) to form alcohols _____

_____

Type of reaction to form alcohols _____

Condition(s) to form alkenes _____

_____

Type of reaction to form alkenes _____

0 8 . 2 Write an equation to show the reaction between chloroethane and an excess of ammonia.

Explain why this reaction is slower than the reaction between iodoethane and an excess of ammonia.

[2 marks]

Equation

_____

Explanation _____

_____

_____

7

END OF QUESTIONS

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