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

Monday 20 January 2020 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** | |

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

*Do not write outside the box*

**0 1** Hydrocarbon **A** is obtained by the cracking of an alkane.

**0 1 . 1** State what is meant by the term cracking.

Give **one** reason why some alkanes are cracked.

**[2 marks]**

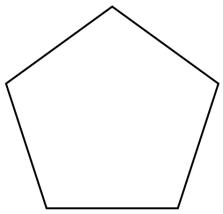
Meaning of the term cracking _____

_____

Reason for cracking _____

_____

The skeletal formula of **A** is shown.



**0 1 . 2** Draw the skeletal formula of an isomer of **A** that is **not** a cyclic alkane.

**[1 mark]**

*Do not write outside the box*

**0 1 . 3** Identify a reagent that can be used in a simple test-tube reaction to distinguish between **A** and an isomer of **A** that is **not** a cyclic alkane.

State what is observed.

**[3 marks]**

Reagent _____

Observation with **A** _____

_____

Observation with an isomer of **A** that is **not** a cyclic alkane _____

_____

**0 1 . 4** A cracking reaction forms **A**, ethane and ethene in a 1:1:2 ratio.

Write an equation for this reaction.

**[1 mark]**

_____

7

**Turn over for the next question**

*Do not write outside the box*

**0 2** This question is about some reactions of propene.

Propene reacts with hydrogen bromide to form two different products.

**0 2 . 1** Name the mechanism for this reaction.

**[1 mark]**

**0 2 . 2** Draw the skeletal formula of the major product formed in the reaction of propene with hydrogen bromide.

Explain why this is the major product.

**[3 marks]**

Skeletal formula

Explanation

**0 2 . 3** Propene can form poly(propene).

Explain why propene is reactive and poly(propene) is **not** reactive.

**[2 marks]**

**6**

*Do not write outside the box*

**0 3** In **acidic** conditions, epoxyethane reacts with water to form ethane-1,2-diol.

$$C_2H_4O + H_2O \rightarrow HOCH_2CH_2OH$$

**0 3 . 1** Outline the mechanism for this reaction.

Give **one** use of ethane-1,2-diol.

**[4 marks]**

Mechanism

Use _____

**0 3 . 2** A sample of 4.3 g of epoxyethane reacts with an excess of water to form 4.6 $cm^3$ of ethane-1,2-diol.

Calculate the percentage yield for the formation of ethane-1,2-diol.

The density of ethane-1,2-diol is 1.11 g $cm^{-3}$

**[4 marks]**

Percentage yield _____

**8**

*Do not write outside the box*

**0 4** This question is about halogenoalkanes.

The first step in the mechanism of the reaction between chlorine and methane to form chloromethane is shown.

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

**0 4 . 1** Name the mechanism of the reaction to form chloromethane from methane.

**[1 mark]**

**0 4 . 2** Give equations for two steps in this reaction that involve $Cl^{\bullet}$ as a reactant.

**[2 marks]**

1 _____

2 _____

**0 4 . 3** Chloromethane reacts with an excess of ammonia.

Outline a mechanism for this reaction.

**[4 marks]**

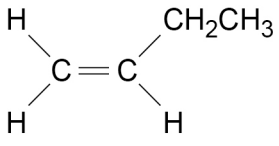
**0 4 . 4** Cyanide acts as a nucleophile in the reaction between potassium cyanide and chloromethane.

State why cyanide is able to act as a nucleophile in this reaction.

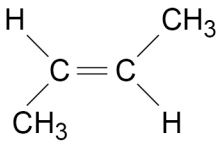
**[1 mark]**

*Do not write outside the box*

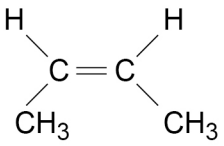
Hydroxide ions react with 2-chlorobutane to form the three isomers shown.



**P**



**Q**



**R**

**0 4 . 5** State the role of hydroxide ions in this reaction.

**[1 mark]**

**0 4 . 6** **P** and **Q** are isomers.

Name this type of isomerism.

**[1 mark]**

**0 4 . 7** **Q** and **R** are stereoisomers.

Define the term stereoisomers.

**[2 marks]**

**0 4 . 8** **R** is *Z*-but-2-ene.

State why **R** is the *Z* isomer.

**[1 mark]**

**13**

*Do not write outside the box*

**0 5** This question is about alcohols and their oxidation products.

**0 5 . 1** Some alcohols can be oxidised.

Identify a suitable oxidising agent.

State the colour change observed in the oxidation.

**[2 marks]**

Oxidising agent _____

Colour change _____

**0 5 . 2** Butan-1-ol is oxidised to form an aldehyde.

Write an equation for this reaction.
You should use [O] to represent the oxidising agent.

State how the aldehyde is obtained from the reaction mixture.

**[2 marks]**

Equation

_____

How aldehyde is obtained

_____

**0 5 . 3** Draw the structure of the carboxylic acid formed by the oxidation of butan-1-ol.

**[1 mark]**

*Do not write outside the box*

**0 5 . 4** Use IUPAC rules to name the organic compound formed when butan-2-ol is oxidised.

**[1 mark]**

---

**0 5 . 5** Compounds **S** and **T** are isomers with $M_r$ = 58.0
When heated with Tollens' reagent, **S** forms a silver mirror but **T** does not.

Draw the structures of **S** and **T**.

**[2 marks]**

**S** **T**

**0 5 . 6** Draw the structure of the alcohol with molecular formula $C_5H_{12}O$ that is **not** easily oxidised.

**[1 mark]**

**Question 5 continues on the next page**

*Do not write outside the box*

**0 5 . 7** Compound **U** has $M_r$ = 60.0
The infrared spectrum of **U** has absorptions in the ranges 2500–3000 $cm^{-1}$ and 1680–1750 $cm^{-1}$

Name compound **U**.

Identify a reagent that can be used in a simple test-tube reaction to confirm the presence of the functional group in **U**.

State what is observed.

**[3 marks]**

Name of **U** _____

Reagent _____

Observation _____

**0 5 . 8** Which compound is a secondary alcohol?

Tick (✓) **one** box.

**[1 mark]**

2,2-dimethylpropan-1-ol ☐

2,3-dimethylbutan-2-ol ☐

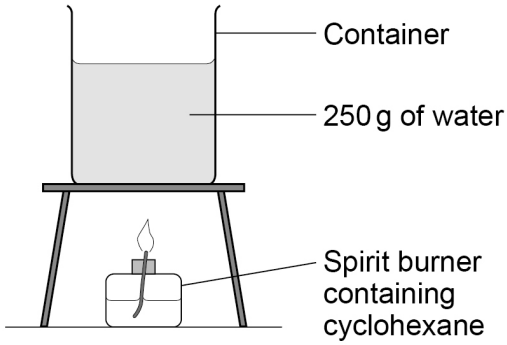
3,3-dimethylpentan-2-ol ☐

**13**

*Do not write outside the box*

**0 6** This question is about cyclohexane, $C_6H_{12}$

**0 6 . 1** A student collects data to calculate the enthalpy of combustion of liquid cyclohexane.




Method

- Weigh the spirit burner containing the cyclohexane and place it under the container of water.
- Measure the initial temperature of the water.
- Allow the cyclohexane to burn for five minutes.
- Measure the maximum temperature of the water.
- Reweigh the spirit burner containing the cyclohexane.

Results

| | |
|---|---|
| Initial temperature of water | 18.5 °C |
| Maximum temperature of water | 49.0 °C |
| Mass of cyclohexane burned | 1.51 g |

Calculate a value for the enthalpy of combustion, in kJ $mol^{-1}$, of cyclohexane.

The specific heat capacity of water, $c$ = 4.18 J $K^{-1}$ $g^{-1}$
You should ignore the heat capacity of the container.

**[4 marks]**

Enthalpy of combustion _____ kJ $mol^{-1}$

**Turn over ►**

*Do not write outside the box*

A value for the enthalpy of combustion of cyclohexane can be calculated from mean bond enthalpy data.

**0 6 . 2** Define the term mean bond enthalpy.

**[1 mark]**

**0 6 . 3** Cyclohexane ($C_6H_{12}$) burns in oxygen as shown.

$$C_6H_{12}(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$$

**Table 1** shows some mean bond enthalpy data.

**Table 1**

| | C—C | C—H | O=O | C=O | O—H |
|---|---|---|---|---|---|
| Mean bond enthalpy / kJ mol$^{-1}$ | 348 | 412 | 496 | 743 | 463 |

Use the equation and the data in **Table 1** to calculate a value for the enthalpy of combustion, in kJ mol$^{-1}$, of cyclohexane.

**[3 marks]**

Enthalpy of combustion _____ kJ mol$^{-1}$

*Do not write outside the box*

**0 6 . 4** The enthalpy of combustion value calculated using bond enthalpy data in **Question 06.3** is different from the value calculated in the experiment in **Question 06.1**.

Give **two** reasons why these values are different.

**[2 marks]**

Reason 1 _____

_____

Reason 2 _____

_____

**10**

**Turn over for the next question**

*Do not write outside the box*

**0 7** Compound **Y** was analysed in a combustion experiment.

**0 7 . 1** Complete combustion of 0.220 g of **Y** formed 0.524 g of carbon dioxide and 0.267 g of water.

Calculate the percentage by mass of carbon and of hydrogen in **Y**.

**[3 marks]**

C _____ %

H _____ %

**0 7 . 2** Compound **Y** contains carbon, hydrogen and oxygen only.

Use your answers to **Question 07.1** to calculate the empirical formula of **Y**.

(If you were unable to answer **Question 07.1** you should use the values 68.1% carbon and 13.7% hydrogen. These are **not** the correct values.)

**[3 marks]**

Empirical formula _____

*Do not write outside the box*

**0 7 . 3** Compound **Y** and compound **Z** both have an absorption at 3330 $cm^{-1}$ in their infrared spectra.

**Z** is a symmetrical molecule with molecular formula $C_3H_8O$

Draw the displayed formula of **Z**

**[1 mark]**

7

**Turn over for the next question**

*Do not write outside the box*

**0 8** The polymer poly(tetrafluoroethene) is made from the monomer $C_2F_4$

**0 8 . 1** Draw the repeating unit of poly(tetrafluoroethene).

**[1 mark]**

**0 8 . 2** Define the term standard enthalpy of formation.

**[2 marks]**

*Do not write outside the box*

**0 8 . 3** The monomer $C_2F_4$ can be made as shown in the equation.

$$2\,CHClF_2(g) \rightarrow C_2F_4(g) + 2\,HCl(g) \quad \Delta H = +127\ kJ\ mol^{-1}$$

Some standard enthalpies of formation are shown.

| Substance | $C_2F_4(g)$ | $HCl(g)$ |
|---|---|---|
| $\Delta_f H^{\ominus}$ / kJ mol$^{-1}$ | –658 | –92.3 |

Calculate the standard enthalpy of formation, in kJ mol$^{-1}$, of $CHClF_2$

Give your answer to 3 significant figures.

**[3 marks]**

Enthalpy of formation _____ kJ mol$^{-1}$

6

**END OF QUESTIONS**

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**ANSWER IN THE SPACES PROVIDED**

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| Question number | **Additional page, if required.**<br>**Write the question numbers in the left-hand margin.** |
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