AQA

AS
Chemistry (7404/2)

Paper 2: Organic and Physical Chemistry

Specimen 2014 Session 1 hour 30 minutes

Materials
For this paper you must have:
- the Data Booklet, provided as an insert
- a ruler
- a calculator.

Instructions
- Answer **all** questions.
- Show **all** your working.

Information
- The maximum mark for this paper is 80.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature _____

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Section A

Answer **all** questions in this section.

1 Compound **J**, known as leaf alcohol, has the structural formula $CH_3CH_2CH{=}CHCH_2CH_2OH$ and is produced in small quantities by many green plants. The geometric *E* isomer of **J** is responsible for the smell of freshly cut grass.

0 1 . 1 Give the structure of the *E* isomer of **J**.

[1 mark]

0 1 . 2 Give the IUPAC name of a chain isomer of **J** that does **not** exhibit geometric isomerism.

[1 mark]

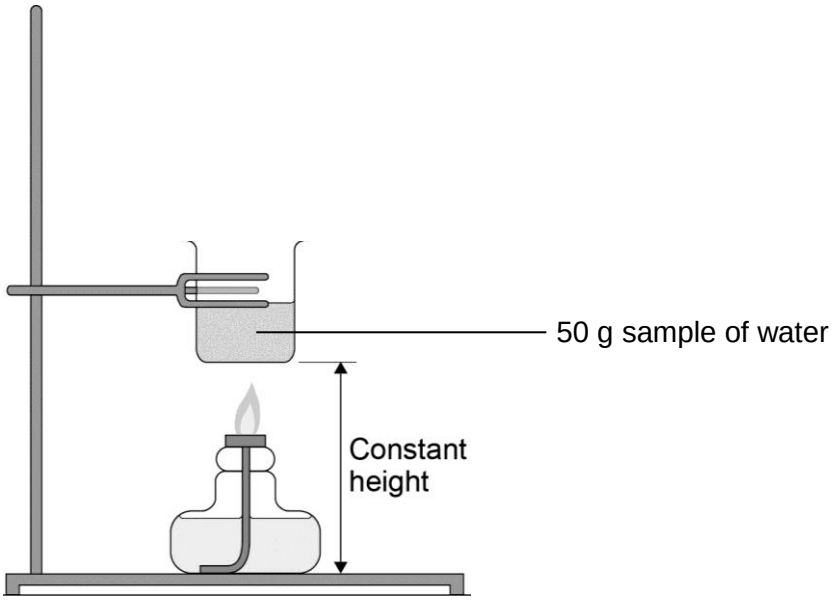
0 1 . 3 Give the **skeletal formula** of the organic product formed when **J** is dehydrated using concentrated sulfuric acid.

[1 mark]

Turn over for the next question

2 **Figure 1** shows apparatus used in an experiment to determine the enthalpy of combustion of leaf alcohol.

Figure 1



The alcohol is placed in a spirit burner and weighed. The burner is lit and the alcohol allowed to burn for a few minutes. The flame is extinguished and the burner is re-weighed. The temperature of the water is recorded before and after heating.

Table 1 shows the results obtained.

Table 1

Mass of spirit burner and alcohol before heating / g	56.34
Mass of spirit burner and alcohol after heating / g	55.84
Mass of alcohol burned / g	
Temperature of water before heating / °C	20.7
Temperature of water after heating / °C	40.8
Temperature rise / °C	

0 2 . 1 Complete **Table 1** by calculating the mass of alcohol burned and the temperature rise of the water.

[1 mark]

0 2 . 2 Calculate the heat energy gained by the water during the experiment.
(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

[2 marks]

Heat energy gained = _____ J

0 2 . 3 Use the results from **Table 1** and your answer from Question **2.2** to calculate a value for the enthalpy of combustion of leaf alcohol (M_r = 100.0). Give units in your answer.

[3 marks]

Enthalpy of combustion = _____ Units = _____

0 2 . 4 State how your answer to Question **2.3** will be different from the value quoted in reference sources.
Give **one** reason for your answer.

[2 marks]

_____

_____

_____

_____

_____

Question 2 continues on the next page

0 2 . 5 A 50 g sample of water was used in this experiment.

Explain how you could measure out this mass of water without using a balance.

[2 marks]

3 2-bromo-2-methylpentane is heated with potassium hydroxide dissolved in ethanol. Two structural isomers are formed.

0 3 . 1 State the meaning of the term **structural isomers**.

[1 mark]

0 3 . 2 Identify the **two** structural isomers.

[2 marks]

Isomer 1

Isomer 2

0 3 . 3 Name and draw the mechanism for the formation of **one** of the isomers.

[4 marks]

Name of mechanism

Mechanism

Turn over for the next question

4 Glucose can decompose in the presence of microorganisms to form a range of products. In the mouth, glucose forms a carboxylic acid (M_r = 90.0) containing 40% carbon and 6.7% hydrogen by mass.

0 4 . 1 Deduce the empirical and molecular formulas of the carboxylic acid formed.

[4 marks]

Empirical formula = _____ Molecular formula = _____

0 4 . 2 Fermentation of glucose produces ethanol.

Write an equation for the reaction occurring during fermentation.
Give **three** essential conditions for the fermentation reaction to occur.

[4 marks]

Equation

_____

Condition 1 _____

Condition 2 _____

Condition 3 _____

0 4 . 3 Give **two** differences between the infrared spectrum of a carboxylic acid and that of an alcohol.
Use **Table A** on the Data Sheet.

[2 marks]

Difference 1 _____

_____

Difference 2 _____

_____

5 $CBrClF_2$ is an effective fire extinguisher but it is no longer used. In the upper atmosphere, a bond in $CBrClF_2$ breaks and reactive species are formed.

0 5 . 1 Identify the condition that causes the weakest bond in $CBrClF_2$ to break. Deduce an equation for the formation of the reactive species.

[3 marks]

Condition _____

Equation

_____

0 5 . 2 One of the reactive species formed from $CBrClF_2$ acts as a catalyst in the decomposition of ozone.

Write **two** equations to show how this species acts as a catalyst.

[2 marks]

Equation 1

_____

Equation 2

_____

Turn over for the next question

6 Dodecane ($C_{12}H_{26}$) is a hydrocarbon found in the naphtha fraction of crude oil. Dodecane can be used as a starting material to produce a wide variety of useful products. The scheme in **Figure 2** shows how one such product, polymer **Y**, can be produced from dodecane.

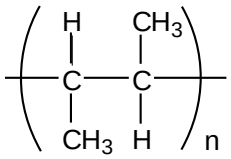
Figure 2

Reaction **1**

$$C_{12}H_{26} \longrightarrow C_2H_4 + C_4H_8 + \mathbf{X}$$

Reaction **2**

$$nC_4H_8 \rightleftharpoons$$



Polymer **Y**

0 6 . 1 Identify compound **X**.

[1 mark]

0 6 . 2 State the method that could be used to separate **X** from the products of reaction **1**.

[1 mark]

0 6 . 3 Give the IUPAC name of the compound C_4H_8 that is polymerised in reaction **2**.

[1 mark]

0 6 . 4 Reaction **1** is an example of thermal cracking.

State **two** reaction conditions needed in reaction **1**.

[2 marks]

1 _____

2 _____

0 6 . 5 In reaction **2**, C_4H_8 is a gas and polymer **Y** is a solid. A typical pressure for this reaction is 100 MPa.

Explain how an increase in the pressure would affect the rate of reaction and the yield of product.

[5 marks]

0 6 . 6 Reaction **2** is exothermic. A typical temperature for this reaction is 200 °C.

Explain how an increase in the temperature would affect the rate of reaction and the yield of product.

[5 marks]

7 A student carried out an experiment to determine the number of C=C double bonds in a molecule of a cooking oil by measuring the volume of bromine water decolourised.

The student followed these instructions:

- Use a dropping pipette to add 5 drops of oil to 5.0 cm^3 of inert organic solvent in a conical flask.
- Add bromine water from a burette to the solution in the conical flask and swirl the flask after each addition to measure the volume of bromine water that is decolourised.

The student's results are shown in **Table 2**.

Table 2

Experiment	Volume of bromine water / cm^3
1	39.40
2	43.50
3	41.20

0 7 . 1 State **two** practical steps that the student should follow to ensure that the burette measures an accurate volume of bromine water.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 2 Suggest a reason for the inconsistency in the student's results.

[1 mark]

_____

0 7 . 3 Suggest an alternative method the student could use to make up the oil solution in order to give more consistent results.

[3 marks]

0 7 . 4 The oil had a density of 0.92 g cm^{-3}.
Assume that the M_r of the oil is 885 and a drop of oil has a volume of 0.05 cm^3.

Calculate the approximate mass of oil used in each experiment and the approximate amount, in moles, of oil used.

[4 marks]

Mass of oil = _____ g Amount of oil = _____ moles

Question 7 continues on the next page

0 7 . 5 The concentration of bromine in the bromine water was 0.020 mol dm^{-3}.
The volume of bromine water used in experiment 1 was 39.40 cm^3.

Calculate the amount, in moles, of bromine used in experiment 1.
Give your answer to the appropriate level of precision.

[3 marks]

Amount of bromine = _____ moles

0 7 . 6 Use your answers to Questions **7.4** and **7.5** to determine the whole number mole ratio of oil to bromine.
Use this ratio to deduce the number of C=C double bonds in a molecule of the oil.

[2 marks]

Whole number mole ratio = _____

Number of C=C double bonds = _____

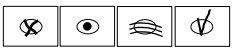
Section B

Answer **all** questions in this section.

Only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD 

WRONG METHODS 

If you want to change your answer you must cross out your original answer as shown. 

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. 

0 8 How many of these compounds are position isomers of butan-1-ol?

$CH_3CH(OH)CH_2CH_3$ $CH_2(OH)CH_2CH_2CH_3$ $CH_3CH_2OCH_2CH_3$

[1 mark]

A 0

B 1

C 2

D 3

0 9 Which of these substances has permanent dipole-dipole attractions between molecules?

[1 mark]

A CCl_4

B C_2F_4

C $(CH_3)_2CO$

D CO_2

1 0 What is the total volume of gas remaining after 20 cm^3 ethane are burned completely in 100 cm^3 oxygen at a constant temperature above 100 °C?

[1 mark]

$$C_2H_6 + 3\tfrac{1}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

A 40 cm^3 ⬭

B 100 cm^3 ⬭

C 120 cm^3 ⬭

D 130 cm^3 ⬭

1 1 Consider the reaction between propene and hydrogen bromide to form the major product.

Which species is formed in the mechanism of this reaction?

[1 mark]

A $CH_3–C^+H–CH_2Br$ ⬭

B $CH_3–CHBr–C^+H_2$ ⬭

C $CH_3–C^+H–CH_3$ ⬭

D $CH_3–CH_2–C^+H_2$ ⬭

1 2 Which of these substances reacts most rapidly to produce a silver halide precipitate with acidified silver nitrate?

[1 mark]

A CH_3Br ⬭

B CH_3Cl ⬭

C CH_3F ⬭

D CH_3I ⬭

1 3 Which statement about *E*-1,2-dichloroethene is correct?

[1 mark]

A It has the same boiling point as *Z*-1,2-dichloroethene. ⬭

B It forms a polymer with the same repeating unit as *Z*-1,2-dichloroethene. ⬭

C It has the same IR spectrum as *Z*-1,2-dichloroethene in the range 400–1500 cm^{-1}. ⬭

D It has a molecular ion peak different from that of *Z*-1,2-dichloroethene in its mass spectrum. ⬭

1 4 Which statement about ethene is correct?

[1 mark]

A It has no geometric isomers because there is free rotation around the C=C bond. ⬭

B It reacts with HBr in a nucleophilic addition reaction. ⬭

C It burns in excess oxygen to produce carbon dioxide and water. ⬭

D The C=C bond is twice as strong as the C–C bond in ethane. ⬭

1 5 Which statement about ethanal is correct?

[1 mark]

A It reacts with Tollens' reagent to form silver. ⬭

B It has a higher boiling point than ethanol. ⬭

C Its empirical and molecular formulas are different. ⬭

D It belongs to a homologous series with general formula $C_nH_{2n+1}O$ ⬭

1 6 Which of these substances does **not** contribute to the greenhouse effect?

[1 mark]

A Unburned hydrocarbons. ⬭

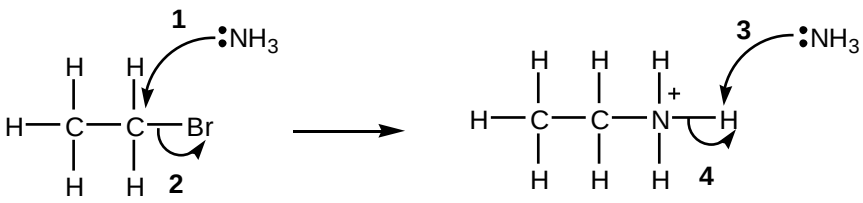
B Carbon dioxide. ⬭

C Water vapour. ⬭

D Nitrogen. ⬭

Questions **17** and **18** are about a method that can be used to prepare ethylamine.

$$CH_3CH_2Br + 2NH_3 \longrightarrow CH_3CH_2NH_2 + NH_4Br$$



1 7 Which of the curly arrows in the mechanism is **not** correct?

[1 mark]

A 1 ⬭

B 2 ⬭

C 3 ⬭

D 4 ⬭

1 8 Which statement about the reaction is **not** correct?

[1 mark]

A Ethylamine is a primary amine. ⬭

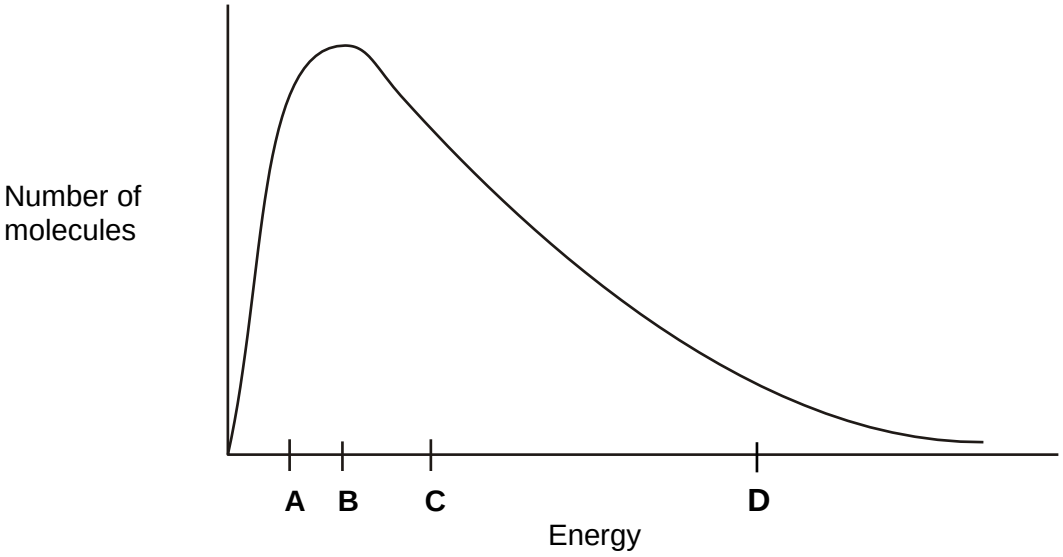
B The mechanism is a nucleophilic substitution. ⬭

C Using an excess of bromoethane will prevent further reaction to form a mixture of amine products. ⬭

D Ammonium bromide is an ionic compound. ⬭

Questions **19** and **20** are about the Maxwell–Boltzmann distribution of molecular energies in a sample of a gas shown in **Figure 3**.

Figure 3



1 9 Which letter best represents the mean energy of the molecules?

[1 mark]

A ⬭

B ⬭

C ⬭

D ⬭

2 0 What does the area under the curve represent?

[1 mark]

A The total energy of the particles. ⬭

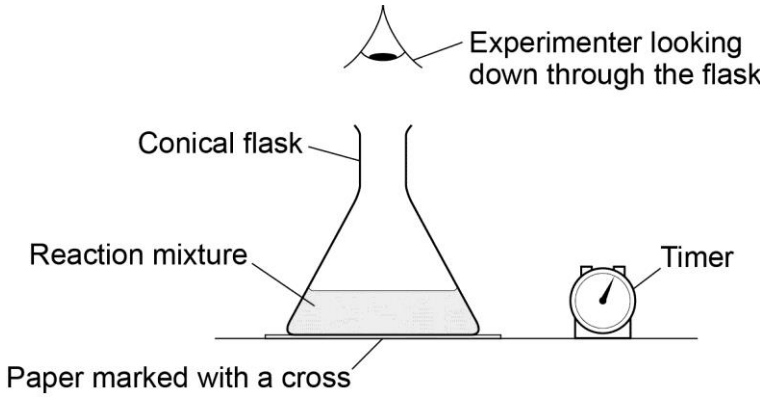
B The total number of particles. ⬭

C The number of particles that can react with each other. ⬭

D The total number of particles that have activation energy. ⬭

The apparatus in **Figure 4** was set up to measure the time taken for 20.0 cm^3 of sodium thiosulfate solution to react with 5.0 cm^3 of hydrochloric acid in a conical flask at 20 °C. The timer was started when the sodium thiosulfate was added to the acid in the flask. The timer was stopped when it was no longer possible to see the cross on the paper. The experiment was repeated with acid at different temperatures.

Figure 4



2 1 What is likely to reduce the accuracy of the experiment?

[1 mark]

A Rinsing the flask with acid before each new experiment. ⬭

B Stirring the solution throughout each experiment. ⬭

C Using the same piece of paper for each experiment. ⬭

D Using different measuring cylinders to measure the volumes of acid and sodium thiosulfate. ⬭

2 2 The experiment was repeated at 20 °C using a larger conical flask.

Which statement is correct about the time taken for the cross to disappear when using a larger conical flask?

[1 mark]

A The time taken will **not** be affected by using a larger conical flask. ⬭

B The time taken will be decreased by using a larger conical flask. ⬭

C The time taken will be increased by using a larger conical flask. ⬭

D It is impossible to predict how the time taken will be affected by using a larger conical flask. ⬭

END OF QUESTIONS