OCR
Oxford Cambridge and RSA

AS Level Chemistry A

H032/02 Depth in Chemistry

Friday 9 June 2017 – Afternoon

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry A (sent with general stationery)

You may use:
- a scientific or graphical calculator

First name	
Last name	
Centre number	Candidate number

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional answer space is required, you should use the lined page(s) at the end of the booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **16** pages.

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Answer **all** the questions.

1 Barium combines with oxygen, chlorine and nitrogen to form ionic compounds.

(a) Barium oxide, BaO, has a giant ionic lattice structure.

(i) State what is meant by the term *ionic bond*.

.....

..... **[1]**

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in barium oxide.

Show outer electrons only.

[2]

(iii) Calculate the number of barium ions in 1.50 g of barium oxide.

Give your answer in standard form and to **three** significant figures.

number of barium ions = ... **[2]**

(b) Barium chloride, $BaCl_2$, is soluble in water.

(i) Compare the electrical conductivities of solid and aqueous barium chloride.

Explain your answer in terms of the particles involved.

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..... **[2]**

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(ii) Describe the use of aqueous barium chloride in qualitative analysis.

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..... **[2]**

(iii) Hydrated barium chloride can be crystallised from solution.

Hydrated barium chloride has the formula $BaCl_2 \cdot xH_2O$ and a molar mass of 244.3 g mol $^{-1}$.

Determine the value of ***x*** in the formula of $BaCl_2 \cdot xH_2O$.

Show your working.

x = ... **[2]**

(c) Barium nitride is formed when barium is heated with nitrogen.

(i) Complete the electron configuration of a nitride ion.

$1s^2$ ..... **[1]**

(ii) Solid barium nitride is reacted with water, forming an alkaline solution **A** and an alkaline gas **B**.

Identify **A** and **B**.

Write an equation, including state symbols, for the reaction.

A.....

B.....

.....

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..... **[4]**

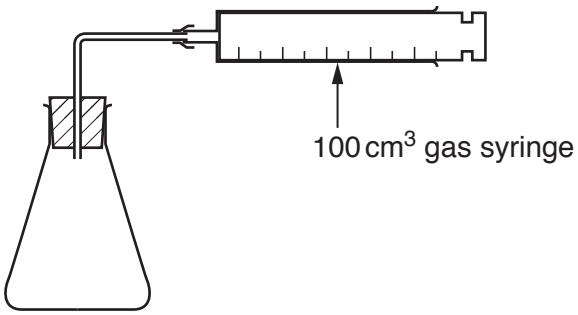
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2* A student was asked to carry out an experiment to determine the initial rate of reaction of zinc and hydrochloric acid.

The student plans to collect a total of about 72 cm^3 of hydrogen at RTP and to use an excess of zinc.

The student selects the following apparatus:

- the apparatus shown in the diagram
- 100 cm^3 measuring cylinder
- stop clock
- 2 decimal place balance



Outline how the student could carry out the experiment and explain how the results could be processed graphically.
Show all working in your calculations.

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..... **[6]**

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3 Alkanes are saturated hydrocarbons with the general formula C_nH_{2n+2}.

(a) A student carries out an experiment to measure the enthalpy change of combustion, $\Delta_c H$, of hexane.

The student finds that combustion of 1.29 g of hexane changes the temperature of 200 g of water from 20.5 °C to 65.5 °C.

(i) Calculate the enthalpy change of combustion, $\Delta_c H$, of hexane, in kJ mol^{-1}.

Give your final answer to an **appropriate** number of significant figures.

$\Delta_c H$ ..... kJ mol^{-1} **[4]**

(ii) The calculated value of $\Delta_c H$ for hexane from this experiment is different from the data book value.

Suggest **two** reasons for this difference.

1 .....

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2 .....

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[2]

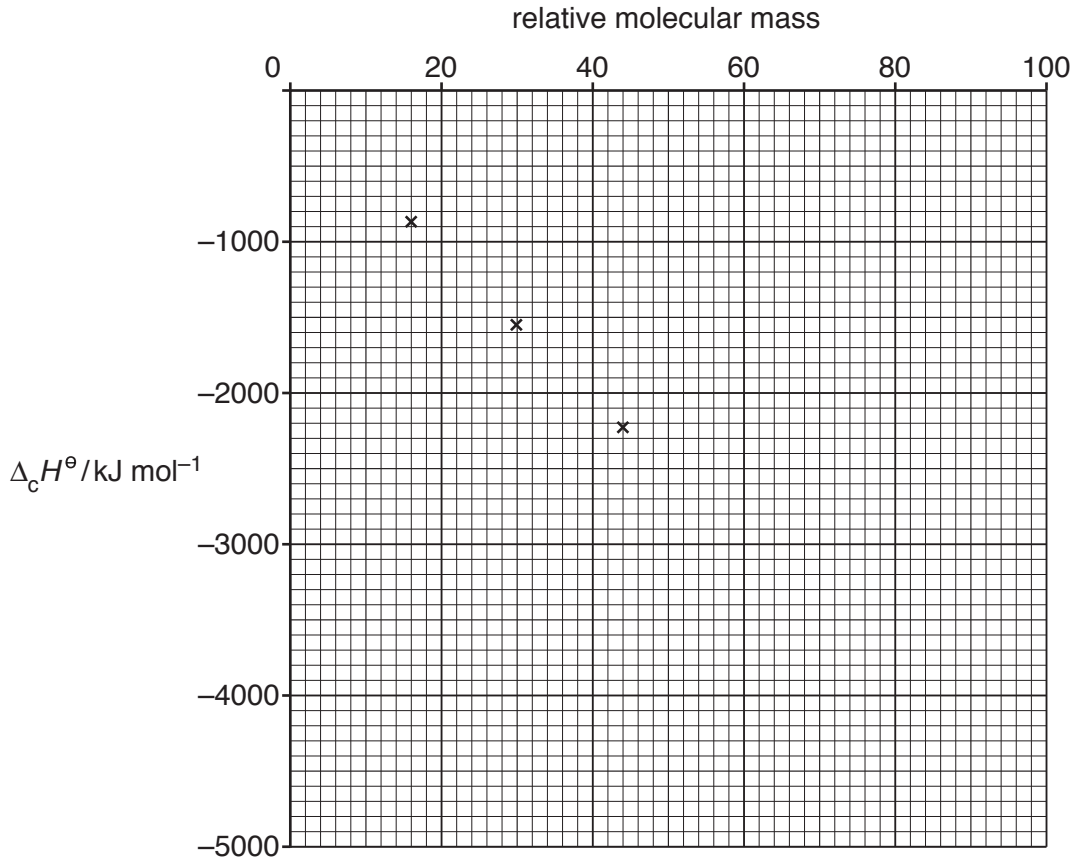
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(b) Data book values for the standard enthalpy changes of combustion, $\Delta_c H^\ominus$, of the first four alkanes are shown in the table.

Alkane	methane	ethane	propane	butane
$\Delta_c H^\ominus$ **/ kJ mol^{-1}**	–890	–1560	–2219	–2877

(i) The values for the first three alkanes are plotted on the graph below.

Plot the value for butane on the graph.



[1]

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(ii) Use the graph to estimate the energy released during complete combustion of 1.80 g of pentane.

Show relevant working below and on the graph.

energy released = ... kJ **[3]**

(c) The equation for the complete combustion of cyclohexane is shown below.

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

Standard enthalpy changes of formation, $\Delta_f H^\ominus$, are shown in the table.

Substance	$C_6H_{12}(l)$	$CO_2(g)$	$H_2O(l)$
$\Delta_f H^\ominus$ / kJ mol^{-1}	–156.3	–393.5	–285.8

Calculate the standard enthalpy change of combustion, $\Delta_c H^\ominus$, of cyclohexane.

$\Delta_c H^\ominus$ = ... kJ mol^{-1} **[3]**

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4 The hydroxyl group, –OH, is responsible for many properties of alcohols.

(a) Methanol, CH_3OH, is soluble in water because it has polar bonds.

Pauling electronegativity values for carbon, oxygen and hydrogen are shown below.

Element	Electronegativity
Carbon	2.5
Oxygen	3.5
Hydrogen	2.1

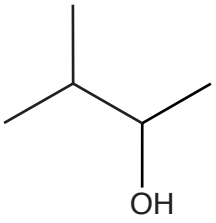
Use a labelled diagram to explain why methanol is soluble in water.

- Use displayed formulae showing one molecule of methanol and one molecule of water.
- Add partial charges $\delta+$ and $\delta-$ to show the **two** most polar bonds in a methanol molecule and the polar bonds in a water molecule.
- Show all lone pairs.
- Label the most important intermolecular bond between the molecules.

[2]

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(b) Alcohol **C** is analysed using mass spectrometry.



alcohol C

(i) Give the systematic name of alcohol **C**.

..... **[1]**

(ii) The mass spectrum of alcohol **C** is shown below.

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Write structural formulae for the ions responsible for peak **X** and peak **Y**.

X =

Y =

[2]

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(c)* Describe the oxidation reactions of butan-1-ol forming an aldehyde and a carboxylic acid.

Explain, using a diagram, how the aldehyde can be produced in the laboratory by controlling the reaction conditions.

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..... **[6]**

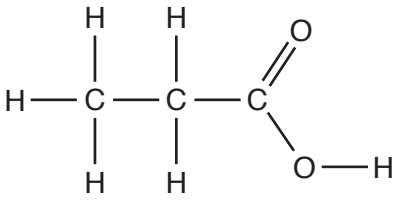
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5 Propanoic acid, CH_3CH_2COOH, is a member of the homologous series of carboxylic acids.

(a) Suggest the general formula for a carboxylic acid.

..... **[1]**

(b) The displayed formula for propanoic acid is shown below.



(i) State the shape and bond angle around a carbon atom in the alkyl group of propanoic acid. Explain the shape.

Shape .....

Bond angle .....

Explanation .....

.....

.....

..... **[2]**

(ii) Suggest a value for the C–O–H bond angle in propanoic acid.

..... **[1]**

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(c) Compound **D** is a neutral compound which is a structural isomer of propanoic acid, CH_3CH_2COOH.

The infrared spectrum of compound **D** is shown below.

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Suggest **two** possible structures of compound **D**.

Explain **all** your reasoning.

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..... **[4]**

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(d) 2-Chloropropanoic acid, $CH_3CHClCOOH$, can be made by reacting propanoic acid with chlorine in a radical substitution reaction.

(i) State the conditions for the reaction.

..... **[1]**

(ii) Write the overall equation for the reaction.

..... **[1]**

(iii) The first step in the reaction mechanism involves homolytic fission of a chlorine molecule to form two chlorine radicals.

Why is this step an example of *homolytic fission*?

.....

.....

..... **[1]**

(iv) Write **two** equations to show the propagation steps in the mechanism for this reaction.

Use dots,•, to show the unpaired electrons on radicals.

.....

..... **[2]**

(v) Draw the displayed formula of the radical formed in the first propagation step.

Use a dot,•, to show the position of the unpaired electron.

[1]

(vi) Further substitution forms a mixture of organic products.

Draw the structure of an organic product formed from 2-chloropropanoic acid by further substitution.

[1]

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6 Organic compounds can be prepared in the laboratory using synthetic routes with two or more stages.

(a) A student devises a two-stage synthesis of cyclohexene from bromocyclohexane.



bromocyclohexane **cyclohexene**

(i) Suggest the structure of **intermediate E** and the reagent(s) and conditions for **step 2**.

reagent(s) and conditions..... **[2]**

(ii) The student carries out this synthesis and obtains 1.23 g of pure cyclohexene from 5.50 g of bromocyclohexane.

Calculate the percentage yield of cyclohexene.

Give your final answer to an **appropriate** number of significant figures.

percentage yield = ... % **[3]**

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(b) Cyclohexene is reacted with bromine to prepare the organic compound **F**.

Give the structure of compound **F** and outline the mechanism for this reaction.

Include curly arrows, charges and relevant dipoles.

[4]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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