OCR
Oxford Cambridge and RSA

AS Level Chemistry A
H032/02 Depth in chemistry
Practice Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry A

You may use:
- a scientific calculator
- a ruler (cm/mm)

First name									
Last name									
Centre number						**Candidate number**				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- 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.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

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 **20** pages.

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Answer **all** the questions.

1 A student carries out a titration to determine the molar mass of an unknown acid, **A**.

- The student dissolves 2.24 g of acid **A** in distilled water and makes the solution up to 250.0 cm^3.
- The student titrates a 25.0 cm^3 portion of this solution with 0.120 mol dm^{-3} NaOH.
- 25.25 cm^3 of 0.120 mol dm^{-3} NaOH are required to reach the end point.

(a) Name the apparatus that the student should use to

- make up the acid solution to 250.0 cm^3
- measure the 25.0 cm^3 portion of acid solution.

make up the acid solution to 250 cm^3: .....

measure the 25.0 cm^3 portion: .....

[1]

(b) The acid reacts with NaOH in a 1 : 1 molar ratio.

Calculate the molar mass of acid **A**.

molar mass of acid **A =** ..... g mol^{-1} **[3]**

(c) The student is not confident that their titre is accurate.

Suggest what the student should do next to reduce the effect of any random error in the titration.

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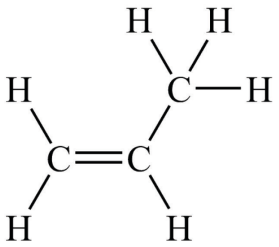
..... **[2]**

2 This question is about alkenes.

(a) Propene, drawn below, contains both σ- and π-bonds. The C–H and C–C single bonds are σ-bonds. The C=C double bond is made up of a σ-bond and a π-bond.



(i) Describe how a σ-bond forms.

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

(ii) State the bond angle and shape around each carbon atom of the C=C double bond in propene.

bond angle: .....

shape: .....

[1]

(b) Propene reacts with bromine, Br_2. In this reaction, bromine acts as an electrophile.

(i) Outline the mechanism of this reaction.

Include curly arrows, relevant dipoles and the structures of the intermediate and final product(s).

[4]

(ii) What does a curly arrow represent in a reaction mechanism?

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

(c) Pent-1-ene, $CH_3CH_2CH_2CH=CH_2$, is an alkene with molecular formula C_5H_{10}.

(i) Pent-1-ene does **not** show stereoisomerism.

Explain why.

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

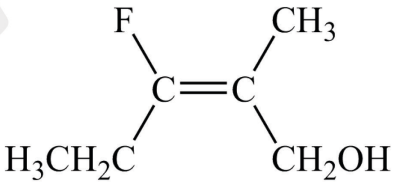
(ii) A structural isomer of pent-1-ene shows *cis–trans* stereoisomerism.

Draw structures for the *cis* and *trans* isomers of this structural isomer of pent-1-ene.

cis isomer	*trans* isomer

[2]

(d) The following molecule shows *E*/*Z* isomerism**.**



Use the Cahn–Ingold–Prelog priority rules to identify whether this alkene is an *E* or *Z* stereoisomer. Explain how you came to your decision.

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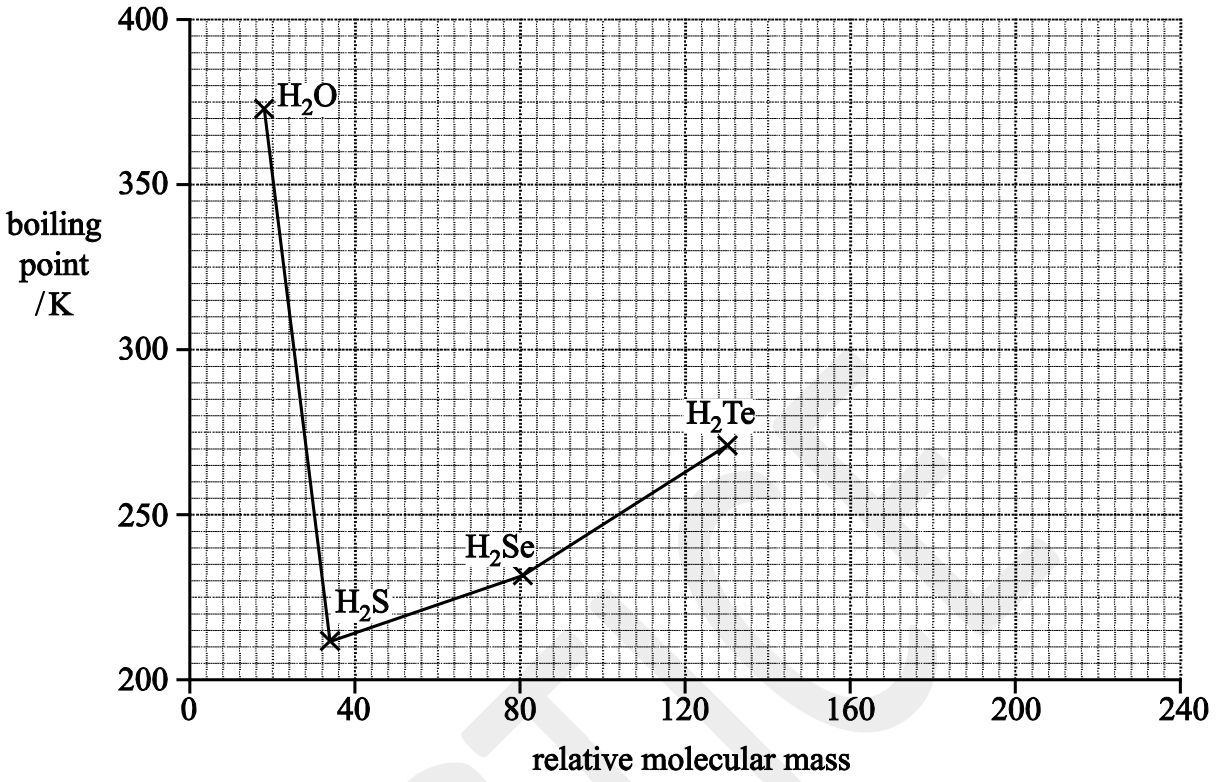
..... **[1]**

3 The graph below shows the variation in boiling points of the Group 16 hydrides.



(a) **(i)** The variation in boiling point can be explained by intermolecular bonding.

Explain why H_2S has a lower boiling point than H_2O and H_2Se.

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[4]

(ii) Polonium, Po, is at the bottom of Group 16. Its hydride has the formula H_2Po.

Estimate from the graph the boiling point of H_2Po.

The relative molecular mass of H_2Po is 211.

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

(b) The compounds SO_2 and MgO both contain oxygen.

The table below shows the melting point of both compounds:

Compound	**Melting point / K**
SO_2	200
MgO	3125

Predict the type of structure and bonding of SO_2 and MgO and explain the difference in their melting points.

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

4 This question looks at groups in the periodic table.

(a) Calcium and strontium are Group 2 metals. They both react with water.

A chemist reacts 0.200 g of strontium with 250 cm^3 water, leaving a colourless solution containing strontium ions. The volume remains at 250 cm^3.

(i) Write an equation for the reaction between strontium and water.

Include state symbols.

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

(ii) Calculate the concentration, in mol dm^{-3}, of strontium ions in the resulting solution.

concentration of strontium ions = ... mol dm^{-3} **[2]**

(iii) A student plans to carry out this experiment using 0.200 g of calcium instead of 0.200 g of strontium.

Predict the difference, if any, between the volume of gas produced by calcium and strontium.

Explain your reasoning and include a calculation in your answer.

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..... **[3]**

(b) Ionisation energies can provide evidence for electron structure.

Write an equation for the first ionisation energy of chlorine.

Include state symbols.

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

(c) The following data shows the first eight successive ionisation energies of an element.

Ionisation energy	1st	2nd	3rd	4th	5th	6th	7th	8th
Energy / kJ mol^{-1}	590	1145	4912	6474	8144	10 496	12 320	14 207

In which group of the periodic table would this element be found?

Use the data to justify your choice.

group: .....

justification: .....

.....

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

5 Butane, C_4H_{10}, is a highly flammable gas, used as a fuel for camping stoves. Butane reacts with oxygen as in the equation below:

$$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$$

(a) Explain why this equation represents the standard enthalpy change of combustion of butane.

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

(b) **(i)** The use of portable heaters in enclosed spaces can result in potential dangers if incomplete combustion takes place.

Explain the potential danger of incomplete combustion.

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

(ii) A portable heater is lit to heat a room.

The heater burns 600 g of butane and consumes 1.50 m^3 of O_2, measured at room temperature and pressure.

Determine whether this portable heater is safe to use.

Show **all** your working.

conclusion, with reason: .....

..... **[3]**

(c) Alkane **X** can also be used as a fuel.

Complete combustion of 0.0117 mol of **X** produces 2.00×10^{-3} m^3 of carbon dioxide gas, measured at 24.0 °C and 101 kPa.

Determine the molecular formula of **X**.

Show **all** your working.

molecular formula of **X** = ... **[4]**

(d) Butane can be produced from decane, $C_{10}H_{22}$, as shown in the equation below.

$$C_{10}H_{22}(l) \rightarrow C_4H_{10}(g) + 2C_3H_6(g)$$

Standard enthalpy changes of combustion, $\Delta_c H^{\ominus}$, are shown in the table below.

Substance	**$\Delta_c H^{\ominus}$ / kJ mol^{-1}**
$C_{10}H_{22}(l)$	–6778
$C_4H_{10}(g)$	–2877
$C_3H_6(g)$	–2058

Calculate the standard enthalpy change of reaction, $\Delta_r H^{\ominus}$, for the reaction. Include the sign.

$$C_{10}H_{22}(l) \rightarrow C_4H_{10}(g) + 2C_3H_6(g)$$

$\Delta_r H^{\ominus}$ = ... kJ mol^{-1} **[2]**

6 The following reaction is used in industry to make sulfur trioxide gas, SO_3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^{\circ} = -196 \text{ kJ mol}^{-1}$$

This preparation is carried out in the presence of a catalyst.

(a)* Explain the conditions of temperature and pressure that could be used to obtain the maximum equilibrium yield of sulfur trioxide.

Discuss the importance of a compromise between equilibrium yield and reaction rate when deciding the operational conditions for this process.

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.... **[6]**

(b) An experiment is carried out to find the rate of this reaction.

The equation is repeated below.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The results of the experiment are given in the table below:

Time / s	0	50	100	150	200	250	300	350
Concentration of SO_3 / mol dm^{-3}	0	0.024	0.034	0.038	0.039	0.040	0.041	0.041

(i) Plot a graph from the data provided.

Include a line of best fit.

[3]

(ii) Use the graph to determine the **initial** rate of this reaction.

Show your working below and on the graph.

initial rate = **.....** mol dm^{-3} s^{-1} **[2]**

(iii) This experiment is repeated in the presence of a catalyst.

Draw and label a line **on the graph** to show the results of the catalysed experiment over the same time period.

[1]

Question 6 continues on the next page

(c) A solid catalyst, vanadium(V) oxide, V_2O_5, is used in industry to increase the rate of the production of sulfur trioxide, SO_3, in this reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^{\ominus} = -196 \text{ kJ mol}^{-1}$$

(i) Explain, with a reason, whether V_2O_5 is a homogeneous or heterogeneous catalyst.

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

(ii) The use of catalysts in industrial processes can be beneficial to the environment.

State **one** reason for this.

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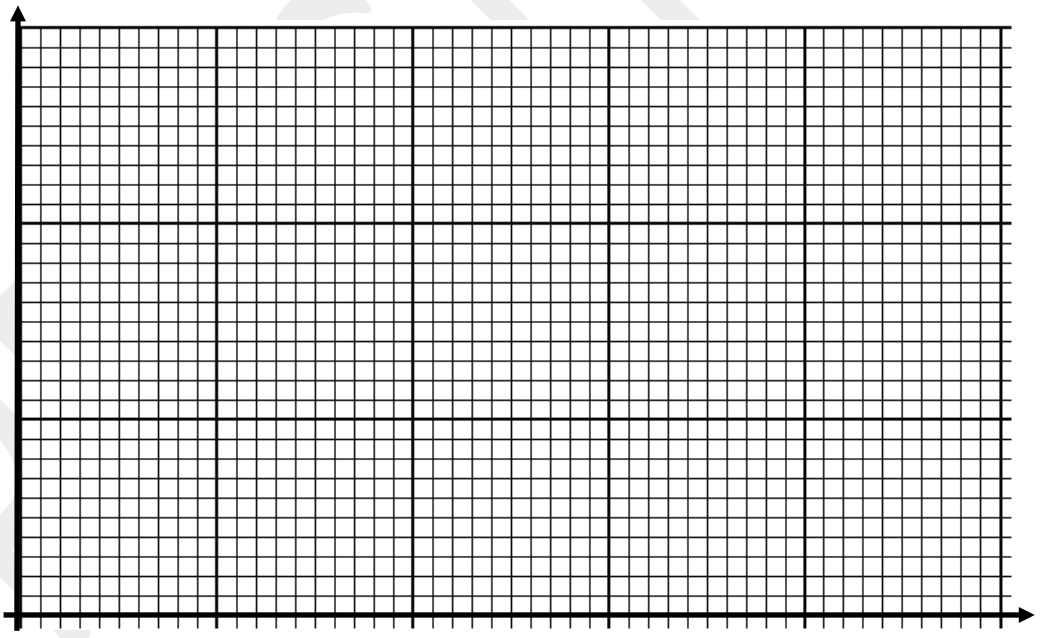
..... **[1]**

(iii) Using a fully labelled Boltzmann distribution on the grid below, explain why adding a catalyst increases the rate of a reaction.



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

7* You are provided with three alcohols that are structural isomers: $CH_3CH_2CH_2CH_2OH$, $CH_3CH_2CHOHCH_3$ and $(CH_3)_3COH$. You do not know which is which.

You have access to normal laboratory apparatus and chemicals, Quickfit apparatus, and an infrared spectrometer.

Describe a plan that would allow you to identify the three alcohols using the same experimental set up and method.

You should provide

- equations using structural formulae for any reactions
- a description of how you will identify the three alcohols from any observations and results.

[6]

END OF QUESTION PAPER

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