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AS Level Chemistry A
H032/01 Breadth in chemistry
Sample Question Paper

Date – Morning/Afternoon
Version 2.0

Time allowed: 1 hour 30 minutes

You must have:
- the Data Sheet for Chemistry A

You may use:
- a scientific or graphical calculator

First name	
Last name	

Centre number						**Candidate number**				

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INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- 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 **[ ]**.
- This document consists of **28** pages.

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

1 How many electrons are in a $^{24}_{12}Mg^{2+}$ ion?

A 10

B 12

C 14

D 22

Your answer ☐

[1]

2 What is the formula of chromium(III) sulfate?

A Cr_3SO_4

B $Cr(SO_4)_3$

C $Cr_2(SO_4)_3$

D Cr_3SO_3

Your answer ☐

[1]

3 Which molecule is non-polar?

A SF_6

B H_2S

C PF_3

D NH_3

Your answer ☐

[1]

SPECIMEN

4 Which row is correct?

	Highest pH when added to water	Most reactive halogen
A	MgO	F_2
B	MgO	I_2
C	BaO	F_2
D	BaO	I_2

Your answer ☐

[1]

5 Which equation represents a redox reaction?

A $Mg + 2HCl \rightarrow MgCl_2 + H_2$

B $MgO + 2HCl \rightarrow H_2O + MgCl_2$

C $MgCO_3 + 2HCl \rightarrow CO_2 + H_2O + MgCl_2$

D $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

Your answer ☐

[1]

6 This question is about trends in the periodic table.

Which trend is correct?

A melting point decreases from lithium to carbon

B boiling point decreases from fluorine to iodine

C first ionisation energy decreases from lithium to caesium

D first ionisation energy increases from nitrogen to oxygen

Your answer ☐

[1]

SPECIMEN

7 A sample of a compound **M** contains 1.46 g of carbon, 0.482 g of hydrogen and 1.69 g of nitrogen.

What is the empirical formula of **M**?

A CH_2N

B C_4HN_4

C CH_4N

D C_2H_4N

Your answer ☐

[1]

8 A student mixes 100 cm^3 of 0.200 mol dm^{-3} NaCl(aq) with 100 cm^3 of 0.200 mol dm^{-3} Na_2CO_3(aq).

What is the total concentration of Na^+ ions in the mixture formed?

A 0.100 mol dm^{-3}

B 0.200 mol dm^{-3}

C 0.300 mol dm^{-3}

D 0.400 mol dm^{-3}

Your answer ☐

[1]

9 Which mass of substance contains the greatest number of atoms?

A 3.00 g of ammonia, NH_3

B 3.00 g of chloromethane, $CHCl_3$

C 4.00 g of hydrogen sulfide, H_2S

D 4.00 g of hydrogen chloride, HCl

Your answer ☐

[1]

SPECIMEN

10 Which reagent would exactly neutralise 100 cm^3 of 1.00 mol dm^{-3} $H_2SO_4(aq)$?

A 0.100 mol $Al(OH)_3$

B 0.100 mol NH_3

C 0.100 mol $Ba(OH)_2$

D 0.100 mol NaOH

Your answer ☐

[1]

11 The table below shows standard enthalpy changes of formation, $\Delta_f H$.

Compound	$NH_4NO_3(s)$	$H_2O(g)$	$CO_2(g)$
$\Delta_f H$ / kJ mol^{-1}	–366	–242	–394

What is the enthalpy change for the following reaction?

$$2NH_4NO_3(s) + C(s) \rightarrow 2N_2(g) + 4H_2O(g) + CO_2(g)$$

A –630 kJ mol^{-1}

B –540 kJ mol^{-1}

C +540 kJ mol^{-1}

D +630 kJ mol^{-1}

Your answer ☐

[1]

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12 Carbon monoxide reacts with steam in the following reaction equation:

$$CO(g) + H_2O\ (g) \rightleftharpoons CO_2(g) + H_2(g) \qquad \Delta H = -40\ \text{kJ mol}^{-1}$$

Which change will shift the position of equilibrium to the right hand side of the equation?

A decrease in pressure

B increase in pressure

C decrease in temperature

D increase in temperature

Your answer ☐

[1]

13 Which substance contains hydrogen bonding in the liquid state?

A $CH_3(CH_2)_4CH_3$

B $CH_3(CH_2)_3CHFCH_3$

C $CH_3(CH_2)_3COCH_3$

D $CH_3(CH_2)_3CH(OH)CH_3$

Your answer ☐

[1]

14 Which volume of oxygen gas, at room temperature and pressure, is required for complete combustion of 1.25×10^{-3} mol of propan-1-ol?

A 105 cm^3

B 120 cm^3

C 135 cm^3

D 120 cm^3

Your answer ☐

[1]

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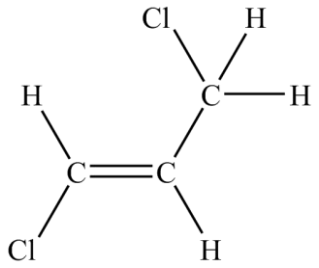
15 Three of the following displayed formulae represent the same isomer of $C_3H_4Cl_2$ but one structure represents a different isomer, **X**.

Which displayed formula represents **X**?

A



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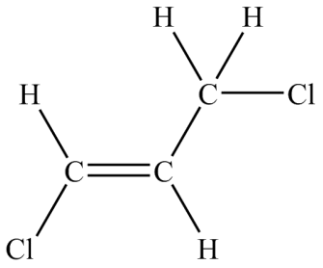

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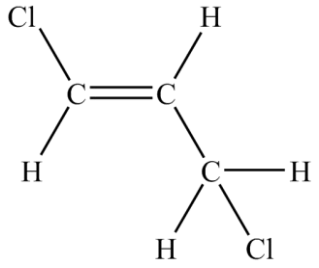

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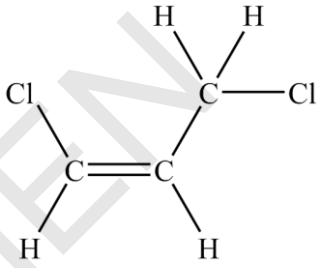

Your answer ☐

[1]

16 Which alcohol will **not** react with potassium dichromate(VI) in sulfuric acid?

A $CH_3CH_2CH(OH)CH_2CH_3$

B $CH_3CH_2CH(CH_3)CH_2OH$

C $(CH_3)_2CHCH(CH_3)OH$

D $(CH_3CH_2)_2C(CH_3)OH$

Your answer ☐

[1]

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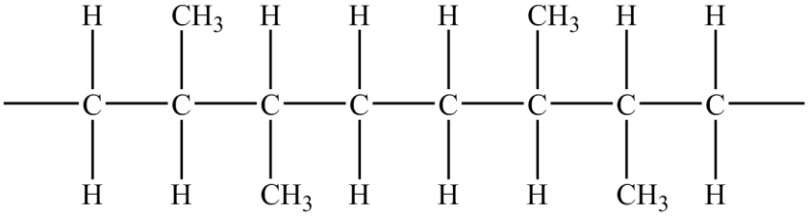
17 A section of a polymer chain is shown below.



Identify the monomer that would give rise to this section of addition polymer.

A *E*-But-2-ene

B *Z*-But-2-ene

C Methylpropene

D Propene

Your answer ☐

[1]

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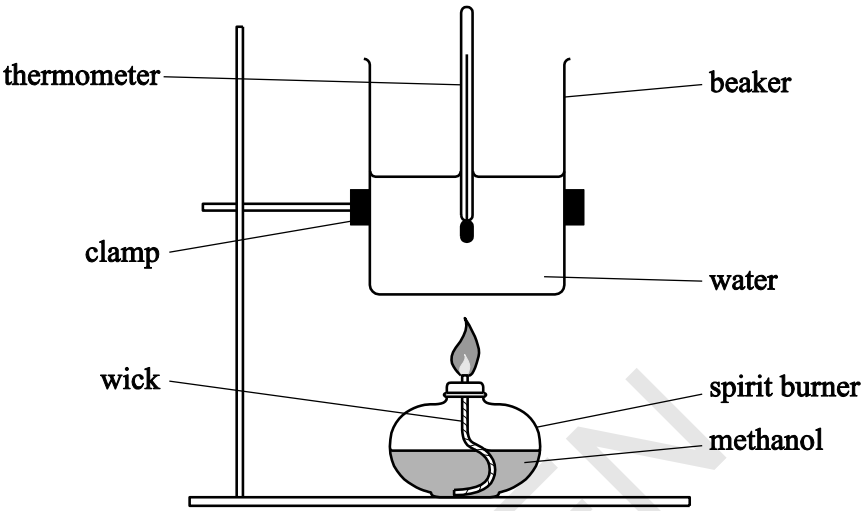
18 **(a)** A student used the apparatus below in an experiment to determine the enthalpy change of combustion of methanol.

The student measured 100 cm^3 and poured it into the beaker.



The student measured a temperature rise of 10.5 °C.

The student calculated the amount of energy transferred to the water.

Which of the following uses the appropriate number of significant figures and correct standard form to represent the result of the calculation?

A 4.389×10^3 J

B 4.39×10^3 J

C 43.9×10^2 J

D 44.0×10^2 J

Your answer ☐

[1]

SPECIMEN

18 **(b)** The student's calculated enthalpy change was less exothermic than the value in data books.

Which of the following errors could have contributed to this result?

Error 1: After the final temperature was recorded, the student removed the burner from under the beaker. The flame burnt for a further 5 minutes before weighing the spirit burner.

Error 2: The student recorded the final temperature 5 minutes after removing the burner.

Error 3: The student spilt some water on the bench when pouring the water from the measuring cylinder into the beaker.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐

[1]

19 A student prepares a standard solution and carries out a titration.
The standard solution is placed in the burette.

Which of the following would result in a titre that is larger than it should be?

1: Water is added to completely fill the volumetric flask, rather than to the graduation line.

2: The conical flask is washed out with water before carrying out each titration.

3: The pipette is washed out with water before carrying out each titration.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐

[1]

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SECTION B

Answer **all** the questions.

20 Bromine and mercury are the only two naturally occurring elements that are liquids at room temperature and pressure. Some physical properties of these two elements are given below.

	Appearance at room temperature	**Melting point / °C**	**Boiling point / °C**	**Electrical conductivity of the liquid**
Bromine	dark orange liquid	–7.2	58.8	very low
Mercury	shiny silver liquid	–38.8	356.7	good

(a) Complete the full electron configuration of a bromine atom.

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

(b) Bromine and mercury react with many elements and compounds.

Predict the formula of the compound formed when bromine reacts with aluminium.

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

(c) Explain how the structure and bonding in bromine account for its relatively low melting point.

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.....

.....

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

SPECIMEN

(d) Mercury and bromine react together to form mercury(II) bromide, $HgBr_2$.

Describe and explain how electrical conductivity occurs in mercury(II) bromide and mercury, in both solid and molten states.

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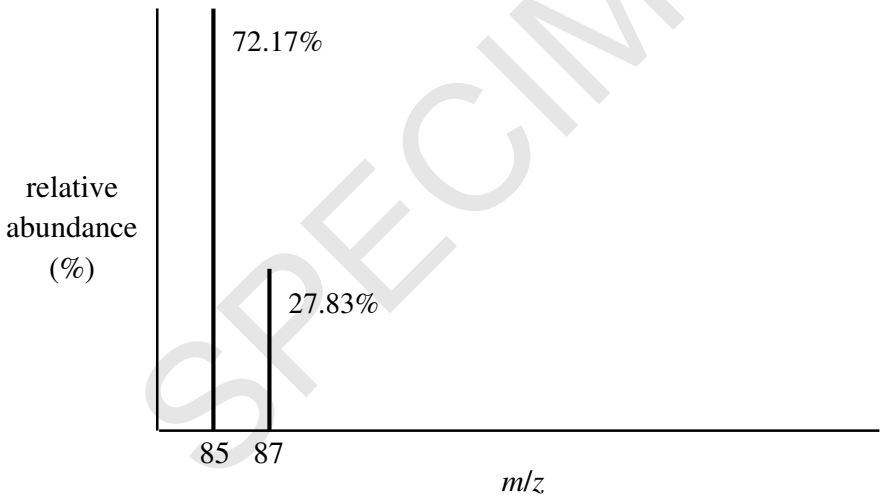
..... **[5]**

(e) Element **X** melts at temperatures reached on very hot summer days.

A sample of element **X** was analysed by mass spectrometry. The mass spectrum is shown below.



(i) Calculate the relative atomic mass of element **X**.

Give your answer to **two** decimal places.

relative atomic mass = ... **[2]**

(ii) Suggest the identity of element **X**.

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

SPECIMEN

21 Carbon monoxide can be made in the laboratory by heating a mixture of zinc metal and calcium carbonate. An equation for this reaction is shown below.

$$Zn(s) + CaCO_3(s) \rightarrow ZnO(s) + CaO(s) + CO(g)$$

(a) This reaction is a redox reaction.

Deduce which element has been oxidised and which has been reduced, and state the change in oxidation number in each case.

element oxidised **……** oxidation number change: from **……** to **……**

element reduced **……** oxidation number change: from **……** to **……**

[2]

(b) Carbon monoxide contains a triple bond, and includes a dative covalent bond.

Construct a '*dot-and-cross*' diagram to show the outer electron pairs in a molecule of carbon monoxide.

[2]

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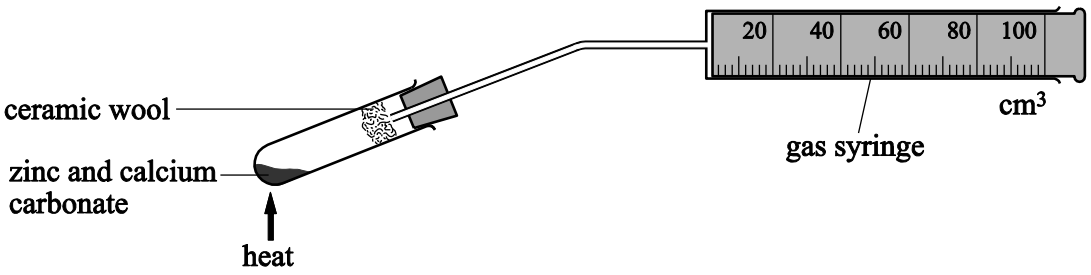
(c) A student carried out the reaction of zinc (Zn) and calcium carbonate ($CaCO_3$) in a fume cupboard. The student measured the volume of gas produced.



A mixture containing 0.27 g of powdered zinc and 0.38 g of powdered $CaCO_3$ was heated strongly for two minutes. The volume of gas collected in the 100 cm^3 syringe was then measured. The experiment was then repeated.

(i) Calculate the maximum volume of carbon monoxide, measured at room temperature and pressure, that could be produced by heating this mixture of Zn and $CaCO_3$.

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volume of carbon monoxide = ... cm^3 **[2]**

(ii) The student did **not** obtain the volume of gas predicted in **(i)** using this procedure.

Apart from further repeats, suggest **two** improvements to the practical procedure that would allow the student to obtain a more accurate result.

.....

.....

.....

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

(d) The student repeated the experiment in **(c)** using different quantities of zinc and calcium carbonate.

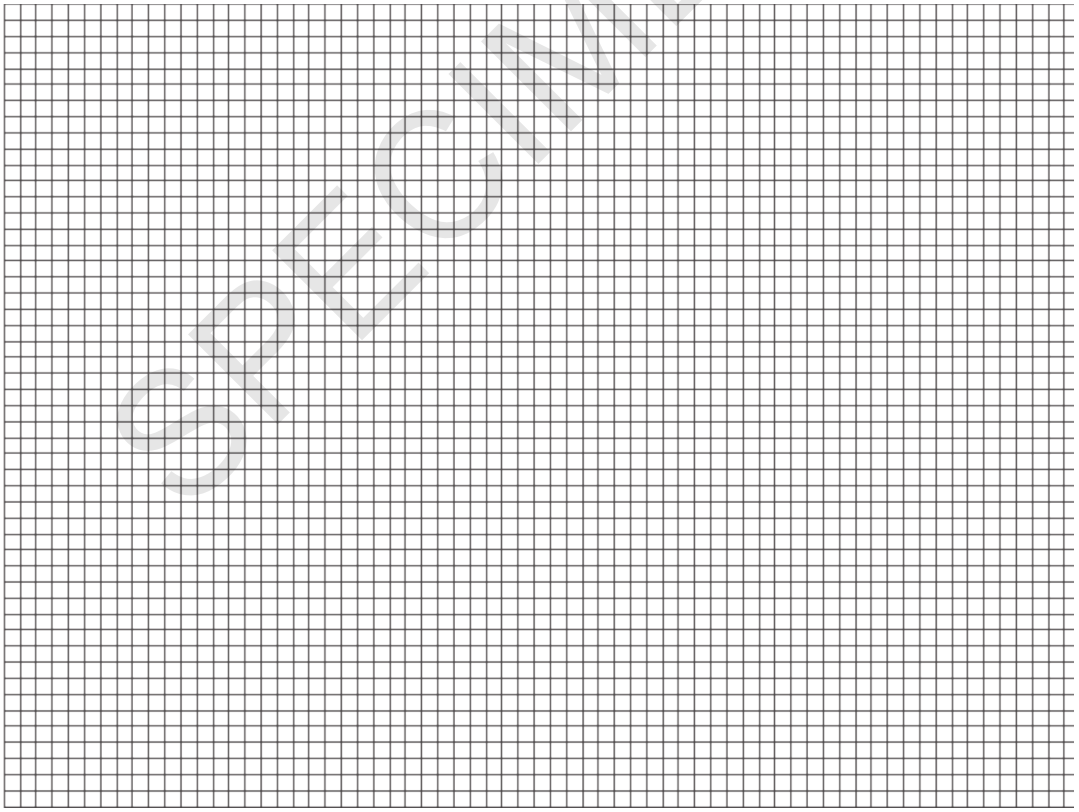
The student measured the total volume of gas collected over time.

The student's results are shown below.

Time / s	**Total volume of gas collected / cm^3**
0	0
20	13
40	42
60	56
80	65
100	72
120	72

(i) Plot a graph from the data provided.

Include a line of best fit.



[3]

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(ii) Using the graph, determine the rate of reaction, in $cm^3\ s^{-1}$, after 50 s.

Show your working on your graph.

rate after 50 s = ... $cm^3\ s^{-1}$ **[2]**

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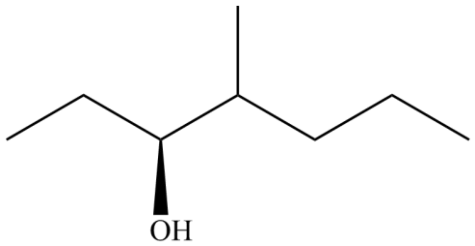
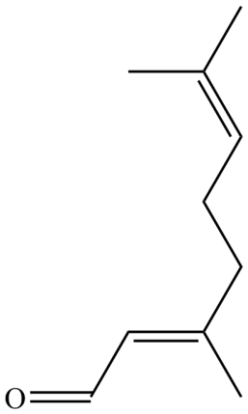
22 The organic compounds labelled **A** to **E** below are all produced by living organisms.



A



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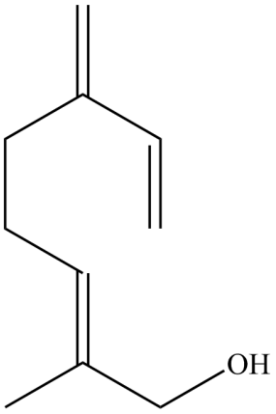

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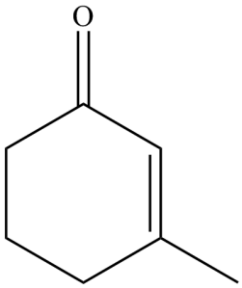
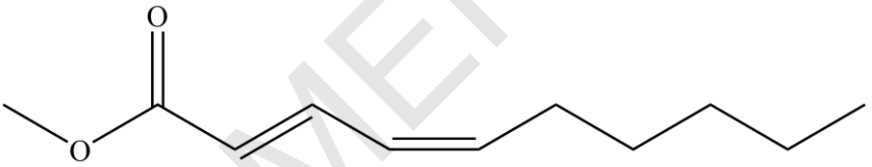


D



E

SPECIMEN

(a) State the systematic name of compound **A**.

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

(b) Compound **D** reacts readily with hydrogen chloride in an addition reaction. Two products are formed in this reaction, but one of the products is formed in much greater amounts than the other.

(i) Draw the structure of **both** possible addition products of this reaction.

product 1	**product 2**

[2]

(ii) State and explain which of the two possible products will be formed in greater amounts. Include a diagram of the intermediate in the mechanism of this reaction in your answer.

.....

.....

.....

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

(iii) 4.125 g of compound **D** is reacted with an excess of hydrogen chloride. The mixture of products contains 95% by mass of one product and 5% by mass of the other product.

Calculate the mass of each product formed.

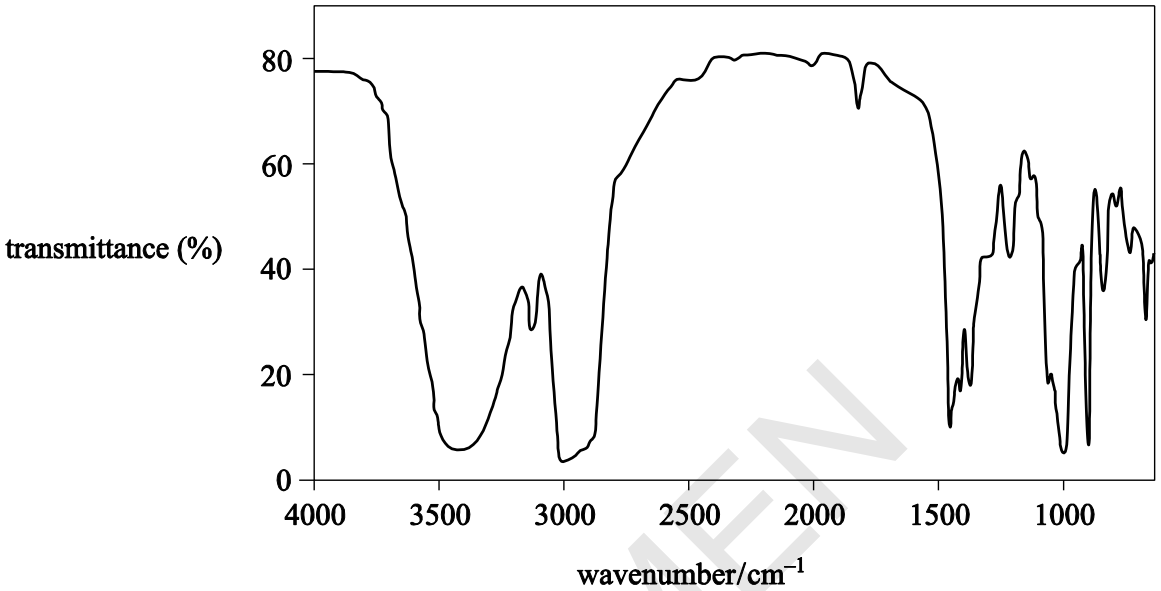
[2]

SPECIMEN

(c) Analysis of one of the compounds **A** to **E** is shown below.

Percentage composition by mass: C, 78.94%; H, 10.53%; O 10.53%

Infrared spectrum:



Use this information to identify the compound.

Explain your reasoning, referring to **all** the evidence provided.

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

SPECIMEN

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SPECIMEN

23 A student carries out the following experiment to investigate the reaction between hexane and chlorine. The chlorine is made by reaction of aqueous sodium chlorate(I) with dilute hydrochloric acid.

Procedure	**Observations**
1 cm^3 of hexane is mixed with 1 cm^3 dilute aqueous sodium chlorate(I) in a test-tube.	The mixture forms two colourless layers.
1 cm^3 dilute hydrochloric acid is slowly added to the mixture.	The acid mixes with the lower layer, which turns a pale green colour.
The tube is then stoppered and shaken.	The pale green colour moves to the upper layer, leaving the lower layer colourless.
The tube is placed under a bright light and shaken at regular intervals for about 10 minutes. The stopper is loosened regularly to release any pressure.	The pale green colour slowly disappears leaving two colourless layers after about 10 minutes.

(a) **(i)** The reaction between aqueous sodium chlorate(I) and dilute hydrochloric acid produces aqueous sodium chloride as well as chlorine.

Suggest an equation for this reaction.

…… **[2]**

(ii) Outline a simple practical test that would confirm the presence of chloride ions in the lower layer, and give the expected result.

test: ……

result: ……..

……

[2]

(iii) Name the apparatus that could be used to separate the two liquid layers present at the end of the experiment.

…… **[1]**

SPECIMEN

(b) The reaction of hexane with chlorine took place when the bright light was switched on.

(i) Give the skeletal formula of **one** possible organic product of this reaction.

[1]

(ii) Explain why this type of mechanism is likely to produce a mixture of organic products.

.....

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

SPECIMEN

24 Every year, two million tonnes of ethanol are produced worldwide by hydration of ethene obtained from crude oil.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45 \text{ kJ mol}^{-1}$$

This reaction is typically carried out using a catalyst at 300 °C and 6000 kPa.

(a) The catalyst allows the reaction to reach equilibrium more quickly at the given temperature and pressure.

(i) State the catalyst used in this reaction.

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

(ii) Outline how a catalyst increases the rate of a chemical reaction.

.....

.....

.....

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

SPECIMEN

(b) An increasing amount of ethanol is made by the fermentation of glucose from plants, rather than by the hydration of ethene. Fermentation is catalysed by enzymes from yeast at a temperature of 40 °C and a pressure of 100 kPa.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Compare the sustainability of each process for the manufacture of ethanol, by considering their:

- atom economies
- raw materials
- reaction conditions.

Suggest which process is the more sustainable.

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

END OF QUESTION PAPER

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