

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Thursday 9 January 2020

Morning (Time: 1 hour 30 minutes)

Paper Reference **WCH11/01****Chemistry****International Advanced Subsidiary/Advanced Level****Unit 1: Structure, Bonding and Introduction to
Organic Chemistry****Candidates must have: Scientific calculator
Ruler**

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- There is a Periodic Table printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ►

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SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box ☐. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☐.

- 1 How many protons, neutrons and electrons are in a $^{37}\text{Cl}^-$ ion?

	Protons	Neutrons	Electrons
☐ A	17	20	16
☐ B	17	20	17
☐ C	17	20	18
☐ D	20	17	21

(Total for Question 1 = 1 mark)

- 2 A sample of an element X contains only the isotopes shown.

Isotope	Percentage abundance
^{58}X	68.077
^{60}X	26.223
^{61}X	1.140
^{62}X	3.634
^{64}X	0.926

What is the relative atomic mass of element X to **three** decimal places in this sample?

- ☐ A 58.760
☐ B 58.8
☐ C 59.4
☐ D 59.440

(Total for Question 2 = 1 mark)

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3 How many **orbitals** are there, in total, in the first three quantum shells of an atom?

- ☐ A 3
- ☐ B 6
- ☐ C 9
- ☐ D 14

(Total for Question 3 = 1 mark)

4 Which element is in the **p-block** and has atoms containing **two** unpaired electrons in the ground state?

- ☐ A lithium
- ☐ B carbon
- ☐ C fluorine
- ☐ D titanium

(Total for Question 4 = 1 mark)

5 The first five ionisation energies of an element, in kJ mol^{-1} , are

578 1817 2745 11 578 14 831

This element could be

- ☐ A sodium
- ☐ B magnesium
- ☐ C aluminium
- ☐ D silicon

(Total for Question 5 = 1 mark)

6 What is the relative formula mass of hydrated barium hydroxide, $\text{Ba(OH)}_2 \cdot 8\text{H}_2\text{O}$?

[A_r values: Ba = 137.3, O = 16.0, H = 1.0]

- ☐ A 171.3
- ☐ B 203.3
- ☐ C 299.3
- ☐ D 315.3

(Total for Question 6 = 1 mark)



- 7 An 11.0 g sample of anhydrous sodium sulfate, Na_2SO_4 , is dissolved in deionised water to form 70 cm^3 of solution.

What is the concentration, in mol dm^{-3} , of Na_2SO_4 in the aqueous solution formed?

[M_r value: $\text{Na}_2\text{SO}_4 = 142.1$]

- ☐ A 0.0011
- ☐ B 0.90
- ☐ C 1.1
- ☐ D 900

(Total for Question 7 = 1 mark)

- 8 Which of these ionic compounds would be expected to have the **highest** melting temperature?

- ☐ A NaF
- ☐ B MgO
- ☐ C KCl
- ☐ D CaS

(Total for Question 8 = 1 mark)

- 9 Which of these compounds has the **greatest** covalent character?

- ☐ A MgF_2
- ☐ B MgI_2
- ☐ C BaF_2
- ☐ D BaI_2

(Total for Question 9 = 1 mark)

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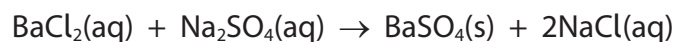
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10 Barium chloride reacts with sodium sulfate:



[M_r values: $\text{BaCl}_2 = 208.3$, $\text{Na}_2\text{SO}_4 = 142.1$, $\text{BaSO}_4 = 233.4$, $\text{NaCl} = 58.5$]

(a) What would you **see** when this reaction is carried out?

(1)

- ☐ A blue solution turns colourless
- ☐ B effervescence
- ☐ C no visible change
- ☐ D white precipitate

(b) What is the ionic equation for this reaction?

(1)

- ☐ A $\text{Ba}^+(\text{aq}) + \text{SO}_4^-(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
- ☐ B $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{NaCl}(\text{aq})$
- ☐ C $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
- ☐ D $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + \text{NaCl}(\text{aq})$

(c) What is the maximum mass of BaSO_4 that could be produced from 0.500 g of BaCl_2 in this reaction?

(1)

- ☐ A 0.446 g
- ☐ B 0.500 g
- ☐ C 0.560 g
- ☐ D 0.821 g

(d) What is the atom economy (by mass) for the formation of BaSO_4 in this reaction?

(1)

- ☐ A 33.3%
- ☐ B 62.2%
- ☐ C 66.6%
- ☐ D 80.0%

(Total for Question 10 = 4 marks)



11 Which of these forms of carbon does **not** contain delocalised electrons?

- ☐ A diamond
- ☐ B C₆₀ fullerene
- ☐ C graphene
- ☐ D graphite

(Total for Question 11 = 1 mark)

12 Which of these molecules is polar?

- ☐ A OF₂
- ☐ B BF₃
- ☐ C CF₄
- ☐ D PF₅

(Total for Question 12 = 1 mark)

13 Which species has its correct shape and bond angle shown?

	Species	Shape	Bond angle
☐ A	CH ₃ ⁺	trigonal planar	120°
☐ B	NH ₃	pyramidal	109.5°
☐ C	NH ₄ ⁺	square planar	90°
☐ D	H ₂ O	linear	180°

(Total for Question 13 = 1 mark)

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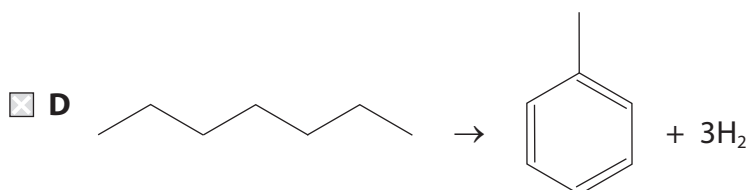
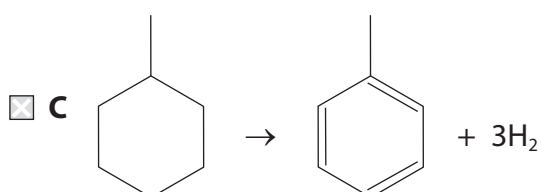
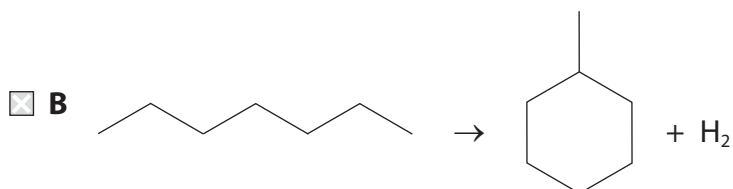
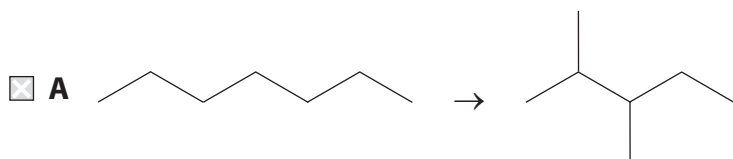
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14 Some equations for reactions used in reforming crude oil fractions are shown.

Which equation is **not** balanced?



(Total for Question 14 = 1 mark)

15 A pure alkane fuel is burned in air.

Which substance is **not** a possible combustion product?

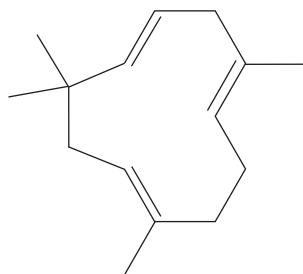


(Total for Question 15 = 1 mark)

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16 What is the number of σ bonds and π bonds in one molecule of this compound?



- ☐ A
- ☐ B
- ☐ C
- ☐ D

σ bonds	π bonds
15	3
39	3
15	6
39	6

(Total for Question 16 = 1 mark)

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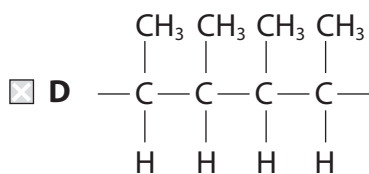
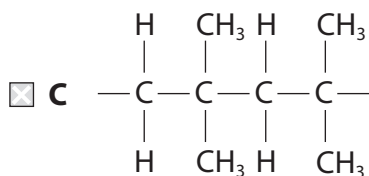
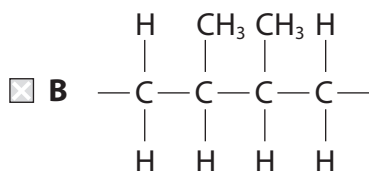
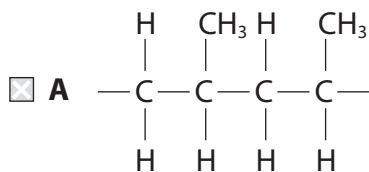
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17 The polymers shown are all made from single monomers.

Which polymer is made from a monomer that has geometric isomers?



(Total for Question 17 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS



SECTION B

Answer ALL the questions.

Write your answers in the spaces provided.

18 This question is about the element chlorine.

- (a) Give the electronic configuration, using the s, p, d notation, for a chlorine atom in the ground state.

(1)

- (b) Write an equation for the **first** ionisation energy of chlorine. Include state symbols.

(2)

- (c) Explain the difference in the **first** ionisation energies of chlorine and bromine.

(3)

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(d) Chlorine occurs naturally as a diatomic molecule.

Draw a dot-and-cross diagram to show the bonding in a molecule of chlorine.
Show outer shell electrons only.

(1)

(e) Chlorine is a gas at room temperature and pressure.

Explain why chlorine has a low boiling temperature.

(2)

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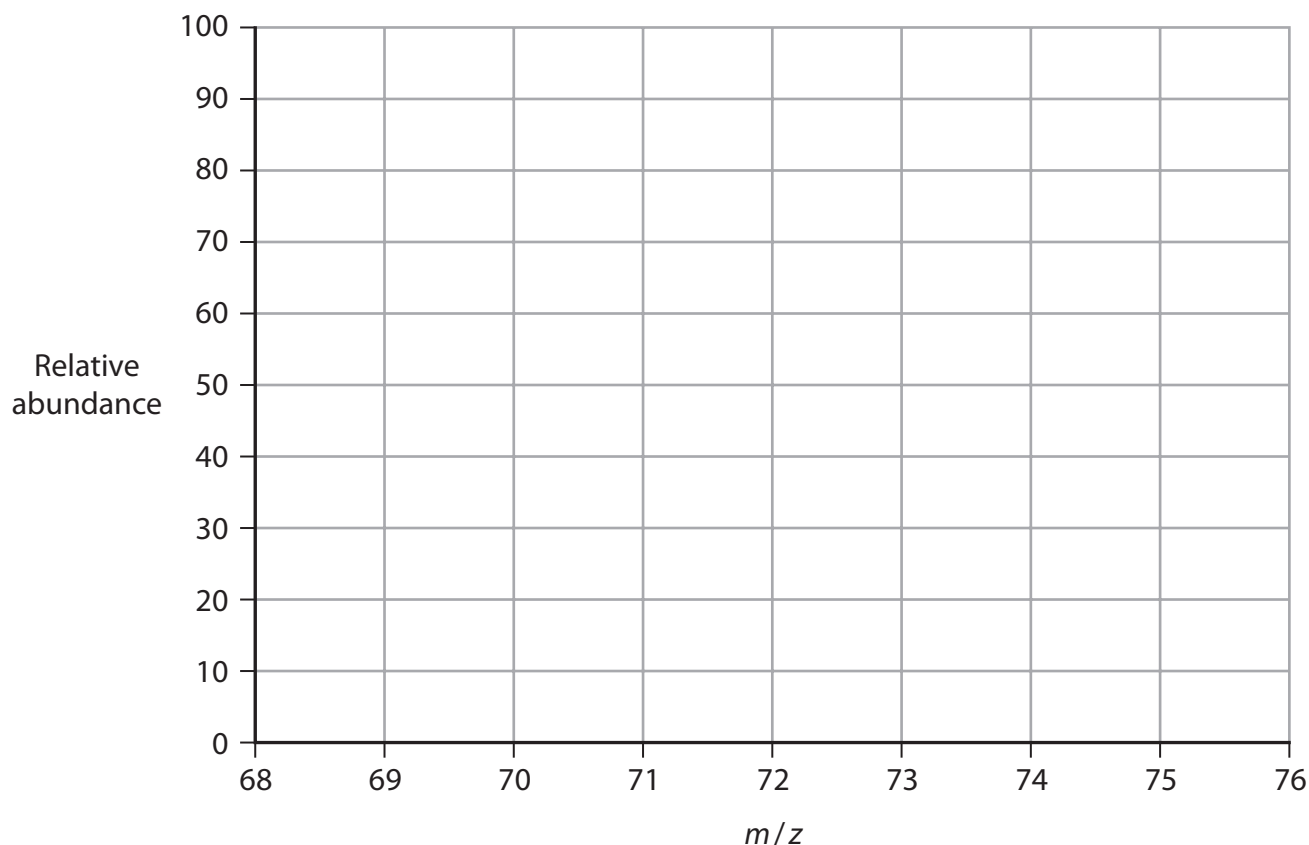
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(f) Chlorine has two stable isotopes. The isotopes have mass numbers 35 and 37, with relative abundance in the ratio 3:1.

(i) Complete the mass spectrum for a sample of chlorine gas to show the expected molecular ion peaks due to Cl_2^+ .

(2)



(ii) Suggest why there could be a small peak at $m/z = 36$ in the mass spectrum of chlorine gas.

(2)

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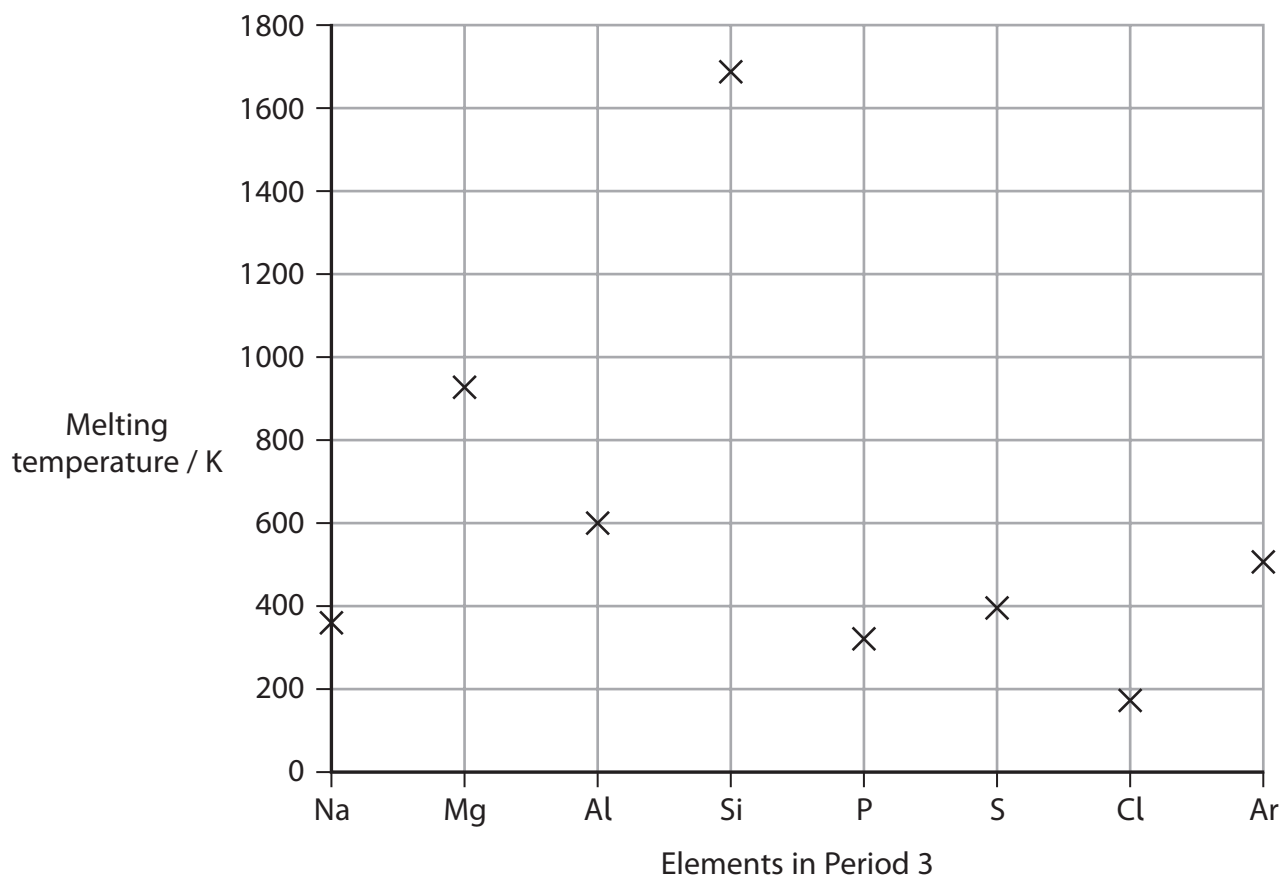
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(Total for Question 18 = 13 marks)



19 This question is about the bonding, structure and properties of the elements in Period 3 of the Periodic Table and their compounds.

(a) A student plotted a graph to show the melting temperatures of the elements in Period 3.



(i) The student incorrectly plotted **two** values: one for a metal and one for a non-metal.

Identify these elements, by name or formula.

(2)

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- (ii) Explain, with reference to structure and bonding, why silicon has a very high melting temperature.

(3)

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- (b) Aluminium has the greatest electrical conductivity of the Period 3 elements.

- (i) Describe how metals conduct electricity.

(2)

- (ii) Give a possible reason why aluminium has a higher electrical conductivity than sodium.

(1)



(c) Aluminium is extracted by the electrolysis of aluminium oxide in the liquid state.

- (i) Draw a dot-and-cross diagram to show the bonding in aluminium oxide.
Show outer shell electrons only.

(3)

- (ii) Give a reason why aluminium oxide must be in the liquid state before electrolysis can occur.

(1)

(Total for Question 19 = 12 marks)



20 This question is about hexane, C_6H_{14} .

(a) The skeletal formula of hexane is



Draw the four structural isomers of hexane in the boxes.

(4)

Isomer 1	Isomer 2
Isomer 3	Isomer 4

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(b) Hexane reacts with bromine in the presence of ultraviolet radiation to form a mixture of bromoalkanes.

(i) Draw the initiation step of this reaction, using curly half-arrows.

(2)

(ii) Write equations for two propagation steps to show how $C_6H_{13}Br$ is formed. Curly arrows are **not** required.

(2)

(iii) Give the **molecular** formula of an alkane formed in a termination step in this reaction.

(1)

(iv) Calculate the percentage by mass of bromine in the heaviest molecule containing **six** carbon atoms that could form when hexane reacts with a **large excess** of bromine.

[A_r values: C = 12.0, Br = 79.9]

(3)

(Total for Question 20 = 12 marks)



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21 This question is about ethene, C_2H_4 .

- (a) The global production of ethene is about 150 million tonnes per year.

Calculate the number of **molecules** in 150 million tonnes of ethene.

[1 tonne = 1000 kg Avogadro constant = $6.02 \times 10^{23} \text{ mol}^{-1}$]

(2)

- (b) Ethene is used commercially to speed up the ripening of bananas.
Ethene levels of 100 parts per million (ppm) are used in ripening rooms.

Calculate the amount, in **moles**, of ethene in a ripening room of volume 220 m^3 at a temperature of 21°C and pressure of $1.01 \times 10^5 \text{ Pa}$.

Give your answer to an appropriate number of significant figures.

[$pV = nRT$ $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$]

(5)



(c) Ethene and chlorine react to form 1,2-dichloroethane.

- (i) Draw the mechanism for the reaction between ethene and chlorine to form 1,2-dichloroethane.

Include curly arrows, and relevant lone pairs and dipoles.

(4)

- (ii) One hazard symbol for 1,2-dichloroethane is shown.



By identifying this hazard, give **one** way of minimising the risk when working with 1,2-dichloroethane in a laboratory.

Assume the use of safety goggles and a laboratory coat.

(2)

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(d) Ethene reacts with oxygen, O_2 , in the presence of a silver catalyst, to form compound **Y** as the only product.

- (i) When 10.0 g of ethene reacts completely with oxygen, the mass of compound **Y** formed is 15.7 g.

Calculate the empirical formula of **Y**.

You **must** show your working.

[A_r values: H = 1.0, C = 12.0, O = 16.0]

(2)

- (ii) Compound **Y** reacts with water to form compound **Z**.
Compound **Z** is also produced in the reaction between ethene and acidified potassium manganate(VII).

Give the **displayed** formula of compound **Z**.

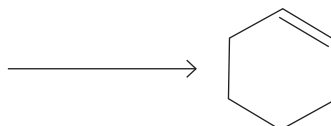
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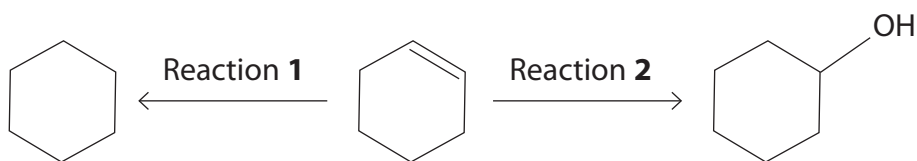
- (e) Ethene reacts with buta-1,3-diene to form cyclohexene as the only product.

Complete the equation for the formation of cyclohexene from ethene and buta-1,3-diene using **skeletal** formulae.

(1)



- (f) Two reactions of cyclohexene are shown.



- (i) Classify the type of reaction occurring in Reaction 1.

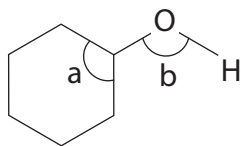
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- (ii) Give the reagents and conditions needed for Reaction 2.

(2)



(iii) Cyclohexanol is the product of Reaction 2.



Bond angle $a = 109.5^\circ$

Explain why bond angle b is smaller than bond angle a .
Include the expected value for bond angle b in your answer.

(3)

(Total for Question 21 = 23 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 MARKS



