

Tuesday 12 May 2026 – Morning

AS Level Chemistry A

H032/01 Breadth in chemistry

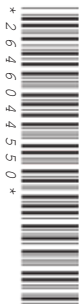
Time allowed: 1 hour 30 minutes

You must have:

- the DataSheet for Chemistry A

You can use:

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- This document has **24** pages.

ADVICE

- Read each question carefully before you start your answer.

Section A

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

Write your answer to each question in the box provided.

- 1 Sodium, aluminium, sulfur and chlorine are elements in Period 3 which form ionic compounds.

Predict the ionic charges from the position of the elements in the periodic table.

	~~Na~~	~~Al~~ ¹ ₃₋	~~S~~ ₂₋	~~Cl~~ ¹ ₁₋
A				
B	1+	3+	6+	7+
C	1+	3+	2-	1-
D	1-	5+	2+	1+

Your answer

[1]

- 2 What is the number of nitrogen atoms in 0.5000 mol of NH_4NO_3 ?

- A 3.010×10^{23}
 B 6.020×10^{23}
 C 1.204×10^{24}
 D 2.709×10^{24}

Your answer

[1]

- 3 What is the formula of iron(II) chlorate(V)?

- A $\text{Fe}(\text{Cl O}_3)_2$
 B $\text{Fe}_2\text{Cl O}_5$
 C $\text{Fe}(\text{Cl O}_5)_2$
 D $\text{Fe}_2(\text{Cl O}_3)_3$

Your answer

[1]

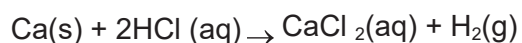
- 4 Which row shows the atomic structure of $^{65}\text{Cu}^+$?

	Protons 29	Neutrons 36	Electrons 27
A			
B	29	36	28
C	30	35	29
D	36	29	35

Your answer

[1]

- 5 An excess of calcium metal reacts with 100 cm^3 of 0.400 mol dm^{-3} hydrochloric acid, HCl (aq) as shown below.



What is the volume of hydrogen gas produced at RTP?

- A 240 cm^3
 B 480 cm^3
 C 960 cm^3
 D 1200 cm^3

Your answer

[1]

- 6 Hydrated zinc sulfate, $\text{ZnSO}_4 \cdot x\text{H}_2\text{O}$, contains 43.8% water by mass.

What is the value of x ?

- A 3
 B 5
 C 7
 D 10

Your answer

[1]

- 7 Predict which row describes properties of a compound formed between a Group 1 element and a halogen.

	Bonding Covalent	Structure Simple molecular	Electrical conductivity Does not conduct
A			
B	Metallic	Giant lattice	Conducts when solid or molten
C	Ionic	Giant lattice	Conducts when molten or in solution
D	Ionic	Simple molecular	Conducts when molten or in solution

Your answer

[1]

- 8 Which row shows the correct units for the terms p (pressure), V (volume) and T (temperature) in the ideal gas equation to calculate the amount of gas in mol?

	p	V	T
A	kPa	m ³	°C
B	Pa	m ³	K
C	kPa	dm ³	°C
D	Pa	dm ³	K

Your answer

[1]

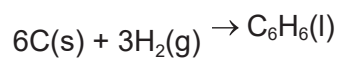
- 9 Which molecule contains the smallest bond angle?

- A** CH₄
B H₂O
C NH₃
D SF₆

Your answer

[1]

- 10 The equation for the formation of benzene, $\text{C}_6\text{H}_6(\text{l})$, from its elements in their standard states is shown below.



The table shows standard enthalpy changes of combustion, $\Delta_c H^\ominus$.

Substance	C(s)	H ₂ (g)	C ₆ H ₆ (l)
$\Delta_c H^\ominus / \text{kJ mol}^{-1}$	-393.5	-285.8	-3267.6

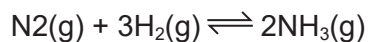
What is the enthalpy change of formation, $\Delta_f H^\ominus$, in kJ mol^{-1} , for benzene, $\text{C}_6\text{H}_6(\text{l})$?

- A -2588.3
 B -49.2
 C +49.2
 D +2588.3

Your answer

[1]

- 11 The reversible reaction below is in equilibrium.



The equilibrium concentrations are shown in the table.

Substance	$\text{N}_2(\text{g})$	$\text{H}_2(\text{g})$	$\text{NH}_3(\text{g})$
Equilibrium concentration / mol dm^{-3}	5.00×10^{-1}	2.00×10^{-1}	3.00×10^{-4}

What is the numerical value of K_c ?

- A 2.25×10^{-5}
 B 7.50×10^{-5}
 C 9.00×10^{-4}
 D 4.40×10^{-3}

Your answer

[1]

- 12 Which change in pressure and change in temperature would **always** shift the position of the equilibrium below to the right towards the products?



	Change in pressure	Change in temperature
A	Decrease	Decrease
B	Increase	Increase
C	Decrease	Increase
D	Increase	Decrease

Your answer

[1]

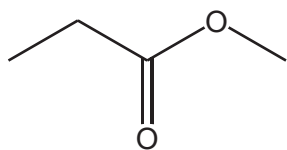
- 13 Which equation does **not** represent a disproportionation reaction?

- A $2\text{KMnO}_4 + 16\text{HCl} \rightarrow 5\text{Cl}_2 + 2\text{MnCl}_2 + 2\text{KCl} + 8\text{H}_2\text{O}$
 B $\text{H}_2\text{O} + \text{Cl}_2 \rightarrow \text{HClO} + \text{HCl}$
 C $3\text{HClO} \rightarrow 2\text{HCl} + \text{HClO}_3$
 D $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaClO} + \text{NaCl} + \text{H}_2\text{O}$

Your answer

[1]

14 What is the empirical formula of the compound shown?



- A $C_4H_8O_2$
 B C_2H_4O
 C $CH_3CH_2COOCH_3$
 D $C_nH_{2n}O_2$

Your answer ☐

[1]

15 Which compound is aromatic and contains an alkyl group?

A	
B	
C	
D	

Your answer ☐

[1]

16 What are the numbers of σ -bonds and π -bonds in the molecule below?



	σ -bonds	π -bonds
A	10	
B		2
C	9	4
D	8	4

7

Your answer

[1]

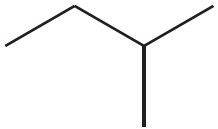
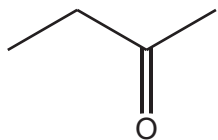
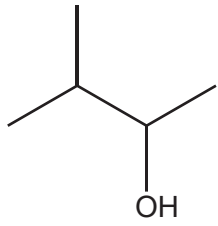
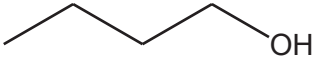
17 Which of the following does **not** improve the sustainability of polymers?

- A Burying waste polymers in landfill.
- B Combustion of waste polymers for energy production.
- C Developing biodegradable polymers.
- D Developing photodegradable polymers.

Your answer

[1]

18 Which compound is most likely to produce a mass spectrum with a fragment ion at $m/z = 31$?

A	
B	
C	
D	

Your answer

[1]

19 Which compound does **not** have a suspected link to global warming?

A CH₄

B CO₂

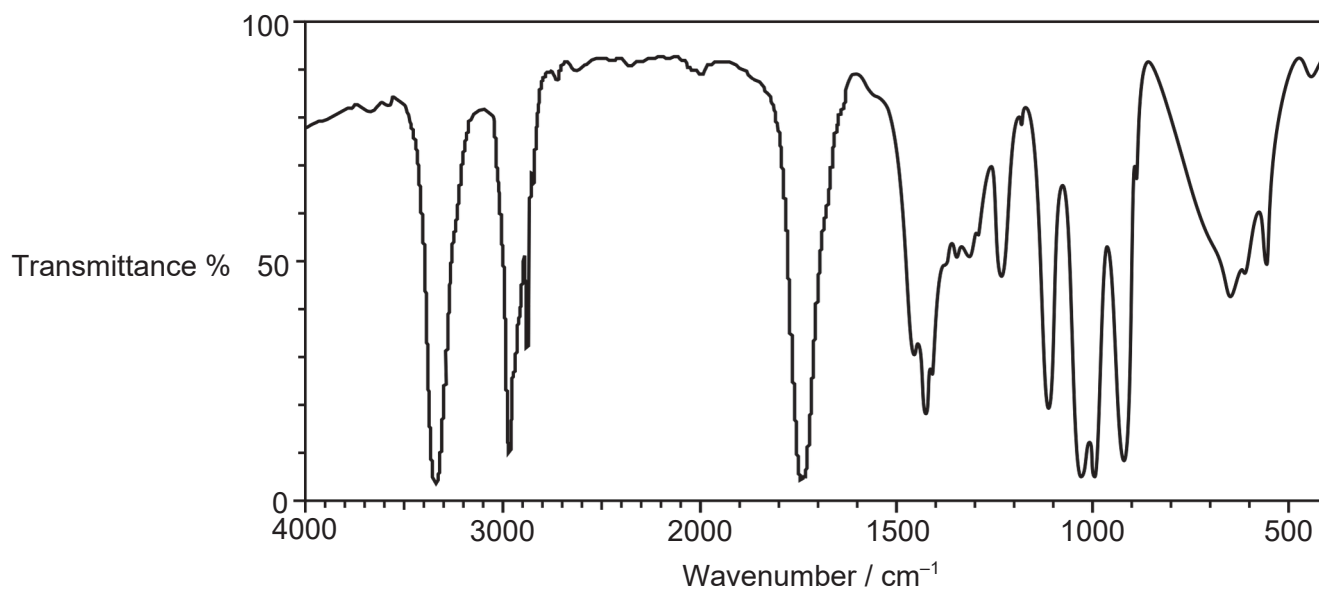
C H₂O

D O₂

Your answer

[1]

20 Which compound could have produced the IR spectrum below?



- A $\text{H}_2\text{C}=\text{CHCH}_2\text{OH}$
- B $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$
- C $\text{CH}_3\text{COCH}_2\text{OH}$
- D $\text{CH}_3\text{CH}_2\text{COOH}$

Your answer

[1]

11
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DO NOT WRITE ON THIS PAGE
Turn over for Section B

12
Section B

21 This question is about the Periodic table.

(a) Complete the electron configurations of the following.

An atom of Ni: $1s^2$

An ion of Ca^{2+} : $1s^2$

[2]

(b) Complete the table to show the number of electron **orbitals** found in each of the first four shells.

Shell	1st	2nd	3rd	4th
Number of electron orbitals				

[1]

(c) Arsenic is a Period 4 element.

(i) Which group and block does arsenic belong to?

Group	Block

[1]

(ii) Sodium arsenide, NaAs, reacts with hydrochloric acid to form a gas with a molar mass of 77.9 g mol^{-1} . A second product is also formed.

Write the equation for this reaction.

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

(d) Hydrogen bromide, HBr, has a boiling point of -67°C .

Hydrogen iodide, HI, has a boiling point of -35°C .

Explain the difference in boiling points.

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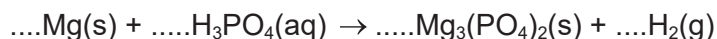
 **[2]**

22 This question is about Group 2 elements and their compounds.

- (a) Magnesium reacts with phosphoric acid, H_3PO_4 , to produce magnesium phosphate, $\text{Mg}_3(\text{PO}_4)_2$, and hydrogen.

This is a redox reaction.

- (i) Balance the equation.



[1]

- (ii) Using oxidation numbers, explain which element has been oxidised and which element has been reduced.

Element oxidised

.....

Element reduced

.....

[2]

- (b) The trend in reactivity of the Group 2 elements can be linked to their first and second ionisation energies.

- Write the equation, including state symbols, to represent the **second** ionisation energy of magnesium.
- Explain why the second ionisation energy of magnesium is greater than the second ionisation energy of calcium.

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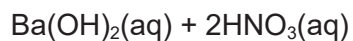
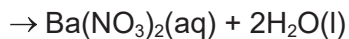
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.....[4]

23 This question is about acids.

- (a) A student carries out a titration to find the concentration of $\text{HNO}_3(\text{aq})$ using barium hydroxide, $\text{Ba}(\text{OH})_2(\text{aq})$.

The equation is shown below.



The student uses a pipette to transfer 15.0 cm^3 of $0.120 \text{ mol dm}^{-3}$ $\text{Ba}(\text{OH})_2(\text{aq})$ into a conical flask.

The results are shown below.

Titration	~~Trial~~	~~32.50~~	~~41.60~~	~~32.10~~	~~36.50~~
Final reading / cm^3					
Initial reading / cm^3					
Titre / cm^3					

- (i) Complete the table. [1]
- (ii) Calculate the mean titre that the student should use for analysing the results.

Mean titre = ... cm^3 [1]

- (iii) Calculate the concentration of the $\text{HNO}_3(\text{aq})$ in mol dm^{-3} .

Give your answer to **3** significant figures and in **standard form**.

Concentration = ... mol dm^{-3} [3]

- (b) A student reacts magnesium carbonate, MgCO_3 , with an excess of 1.00 mol dm^{-3} nitric acid, $\text{HNO}_3(\text{aq})$.

A second student reacts the same mass of MgCO_3 with an excess of 1.00 mol dm^{-3} ethanoic acid, $\text{CH}_3\text{COOH}(\text{aq})$.

The students collect the CO_2 gas until each reaction is complete.

The results are shown below.

	$\text{HNO}_3(\text{aq})$	$\text{CH}_3\text{COOH}(\text{aq})$
Volume of CO_2 gas collected	600 cm^3	600 cm^3
Time for MgCO_3 to completely react	120 s	200 s

Explain the results.

Volume of CO_2 gas collected

.....

.....

Time for MgCO_3 to completely react

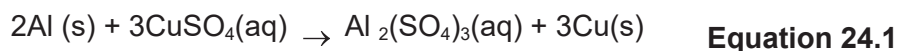
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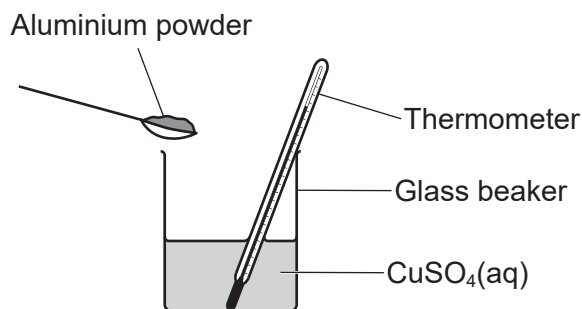
[3]

24 This question is about enthalpy changes.

(a) Aluminium reacts with aqueous copper(II) sulfate, $\text{CuSO}_4(\text{aq})$, as shown in **Equation 24.1**.



A student wants to find the enthalpy change of reaction, $\Delta_r H$, for the reaction shown in **Equation 24.1**, using the apparatus below.



The student uses 50.0 cm^3 of 1.00 mol dm^{-3} $\text{CuSO}_4(\text{aq})$ and obtains a temperature increase of 40.5°C . The aluminium is added until it is in excess.

(i) Calculate $\Delta_r H$ for the reaction shown in **Equation 24.1**, in kJ mol^{-1} .

Give your answer to **3** significant figures.

Assume that the densities of all solutions and the specific heat capacity, c , of the reaction mixture are the same as for water.

$\Delta_r H = \dots\dots\dots \text{kJ mol}^{-1}$ **[4]**

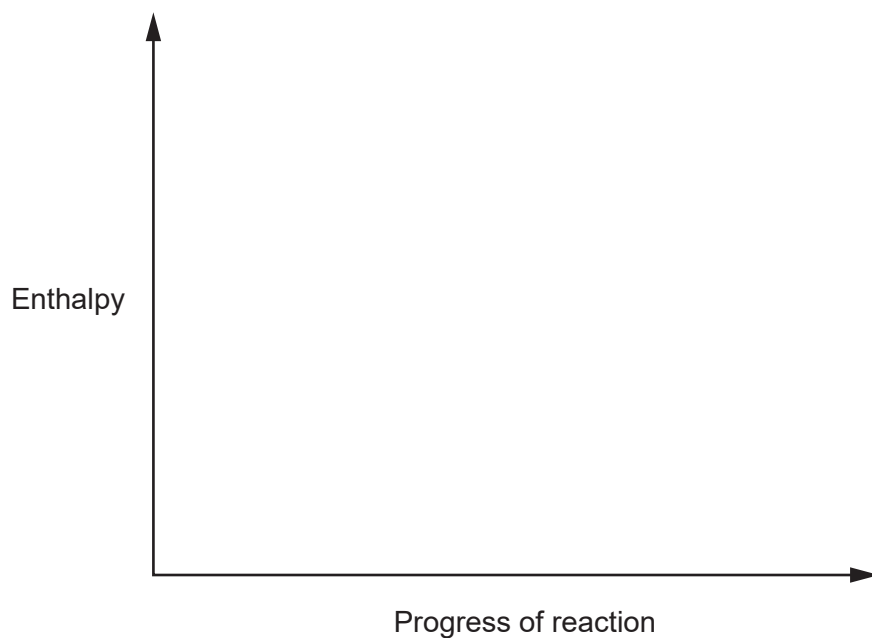
(ii) Suggest how the student's experiment could be modified to obtain a more accurate result.

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

(b) Complete the enthalpy profile diagram for the reaction in **Equation 24.1**.

On your diagram:

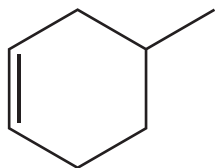
- Label the enthalpy change of reaction, ΔH .
- Include the formulae of the reactants and products.
- Label the activation energy, E_a .



[2]

25 This question is about organic synthesis.

(a) Compound **L**, shown below, is used in organic synthesis.

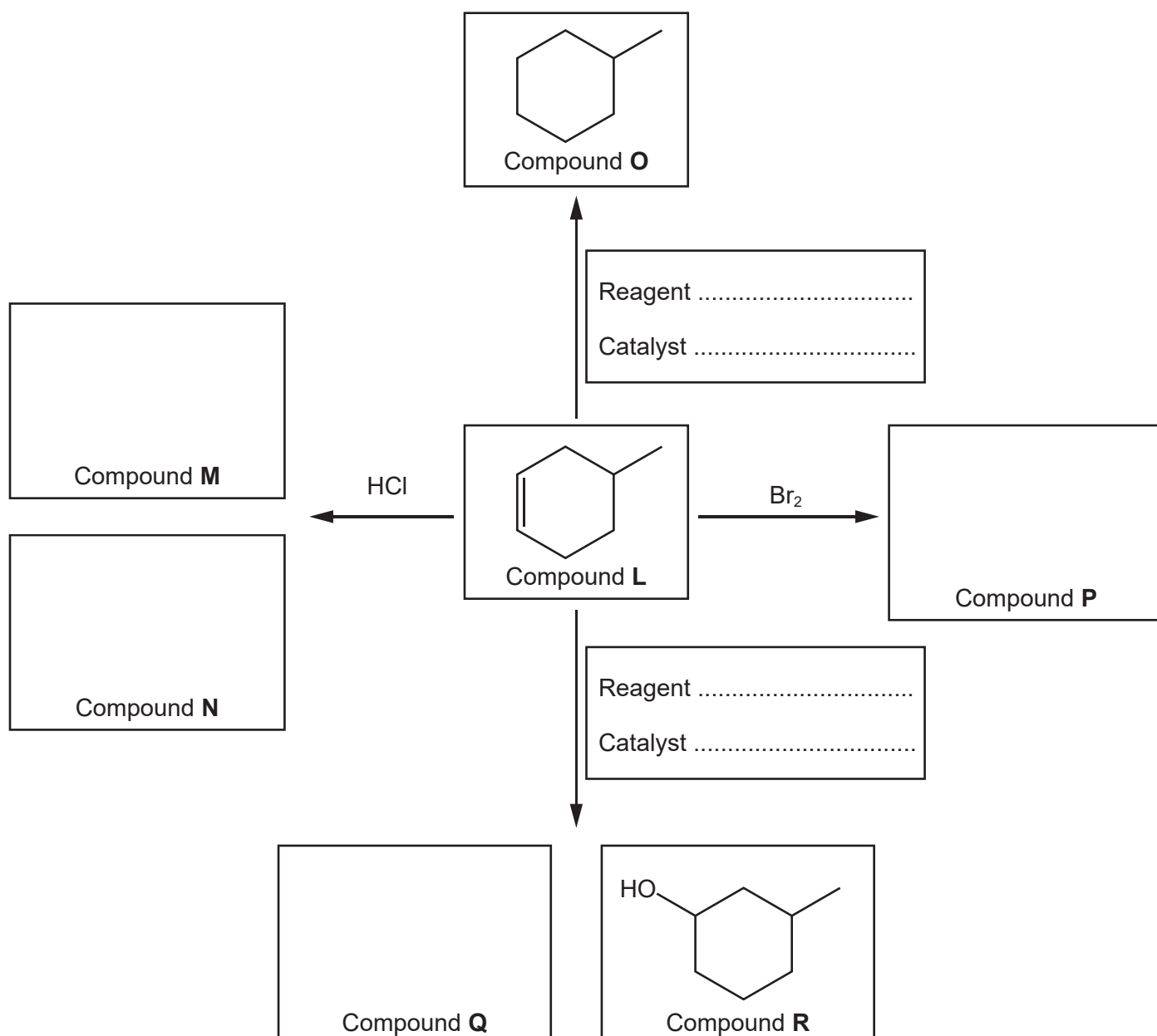


(i) What is the systematic name of compound **L**?

..... [1]

(ii) Complete the flowchart for the reactions of compound **L**.

Show the missing reagents, catalysts and the structures of organic products.



[6]

- (iii) HCl is the reagent in the formation of compounds **M** and **N**.

Name the reaction mechanism and the type of bond fission that occurs when compounds **M** and **N** are formed.

Mechanism

Bond fission

[2]

- (iv) Describe what would be observed when compound **L** is converted to compound **P**.

What functional group does this reaction test for?

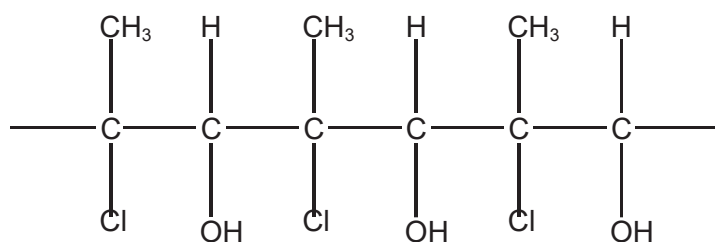
Observation

Functional group

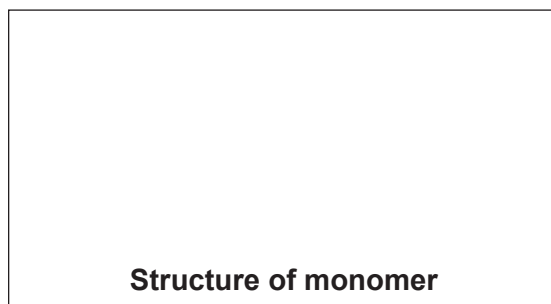
[1]

- (b) Compound **S** is a polymer of an alkene.

Three repeat units are shown.



Draw the structure of the monomer used to make compound **S**.



[1]

26 This question is about haloalkanes.

(a) 2-Bromopropane can be hydrolysed with aqueous sodium hydroxide, NaOH(aq).

(i) The OH⁻ ion in NaOH(aq) acts as a nucleophile.

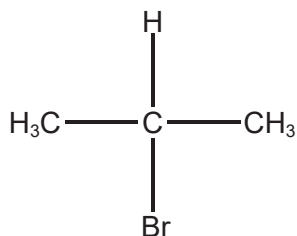
Define the term nucleophile.

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

(ii) Outline the mechanism for the hydrolysis of 2-bromopropane with OH⁻ ions.

The structure of 2-bromopropane has been included.

Show curly arrows, relevant dipoles and lone pairs, and product(s).



[3]

- (b) A student wants to compare the rates of hydrolysis of the haloalkanes 2-chloropropane, 2-bromopropane and 2-iodopropane. Aqueous hydroxides are **not** available.

- Identify the reagents that the student could use and the observations that they would make.
- Predict and explain the rates of hydrolysis of the three haloalkanes.

[5]

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

The page contains 25 horizontal dotted lines for writing answers. A vertical solid line is positioned on the left side of the page, creating a margin for writing question numbers. The dotted lines extend from the vertical line across the width of the page.



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