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A' Level Chemistry

Year 1

Unit 5: Halogenoalkanes & Alkenes

Summer Examination Revision Pack

The questions in this pack should be attempted **AFTER** completing all other revision.

Grade Accelerator

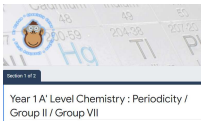
Recall Definitions
Drawing Diagrams
Using Equations
Drawing Graphs

Quizlet Classes

Flashcard Based
Games
Tests & Quizzes
Keyword Spell Checker

Condensed Notes

Keywords & Definitions
Key Concepts
Application
Key Skills



Online Forms

Take Time to Answer
Use Paper & Calculator
Work It Out
Review Missed Marks

Use the 3 Wave Process when completing these revision packs.

1. Complete the questions without assistance
(Can't answer a question? Leave it and move on)
2. Use your notes to fill any gaps after step 1
3. Use the mark scheme to fill in any remaining gaps.

1. Having gaps after step 1 is normal, that's why we are doing revision!
2. If your notes don't help during step 2, they are not good enough!
(Change your note taking method and try to understand the problem)
3. If you don't understand why the mark scheme answer is correct, **see Andy.**

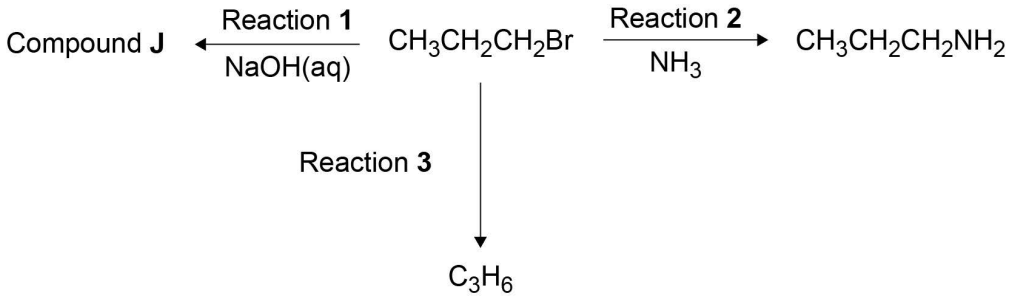
If you struggle with the questions in the pack, **STOP!** and complete some more revision.

If you come to a complete dead-end, **STOP!** and speak to **Andy** asap.

Answer **all** questions in the spaces provided

0 1 **Figure 1** shows some compounds made from a halogenoalkane.

Figure 1



0 1 . 1 Draw the displayed formula of compound **J**.

[1 mark]

0 1 . 2 Name the mechanism for Reaction **2** and give an essential condition used to ensure that $CH_3CH_2CH_2NH_2$ is the major product.

[2 marks]

Name of mechanism _____

Condition _____

0 1 . 3 Calculate the mass, in grams, of $CH_3CH_2CH_2NH_2$ produced from 25.2 g of $CH_3CH_2CH_2Br$ in Reaction **2** assuming a 75.0% yield.

Give your answer to the appropriate number of significant figures.

[3 marks]

Mass _____ g

0 1 . 4 When Reaction **2** is carried out under different conditions, a compound with molecular formula $C_9H_{21}N$ is produced.

Draw the skeletal formula of the compound.

Identify the functional group in the compound including its classification.

[2 marks]

Skeletal formula

Functional group including classification _____

0 1 . 5 Identify the reagent and conditions used in Reaction **3**.

[1 mark]

_____

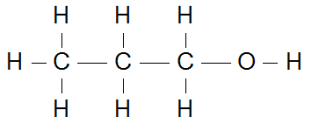
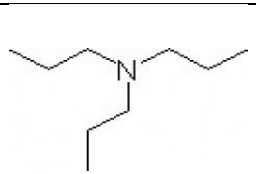
0 1 . 6 Name and outline a mechanism for Reaction **3**.

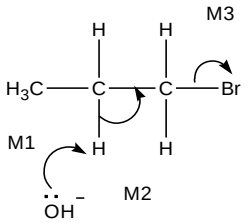
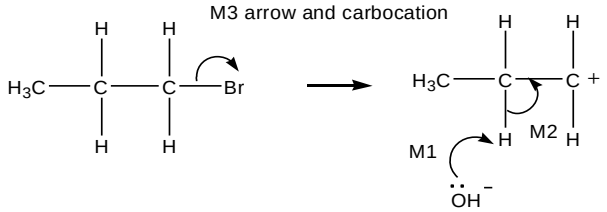
[4 marks]

Name of mechanism _____

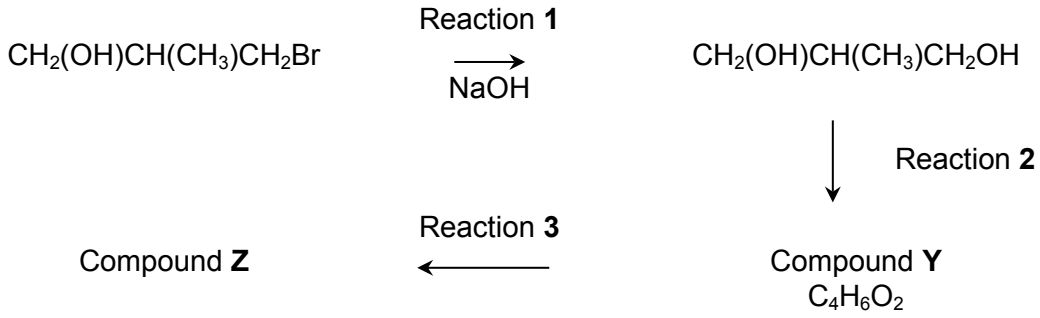
Mechanism

13

Question	Answers	Mark	Additional Comments/Guidance
01.1		1	Must be displayed
01.2	Nucleophilic substitution Excess NH_3	1 1	 Ignore aqueous, alcoholic, conc, dil, temp, heat, pressure
01.3	Amount of $CH_3CH_2CH_2Br$ 25.2/122.9 (=0.205) (mol) Amount of $CH_3CH_2CH_2NH_2$ M1 x 0.75 (= 0.154) (mol) Mass $CH_3CH_2CH_2NH_2$ M2 x 59.0 = 9.07g Must be 3sf	M1 M2 M3	If either Mr incorrect or used incorrectly then only award 1 mark for 75% yield calculation (ignore rounding to 123 for $CH_3CH_2CH_2Br$) OR Max mass amine = M1 x 59.0 (= 12.1) (g) Actual mass = M2 x 0.75 = 9.07g Must be 3sf Allow 9.09 but if 9.08 check for AE 18.9 scores 1 for 75%
01.4	 tertiary amine or 3° amine (only award if a tertiary amine shown)	1 1	Must be skeletal Ignore lone pair

Question	Answers	Mark	Additional Comments/Guidance
01.5	NaOH/ ethanol or KOH / ethanol (both required)	1	**Not** aqueous Ignore heat, temp, conc., dil, Accept alcoholic for ethanol
01.6	(Basic) Elimination  M1 arrow from <u>lone pair on O</u> of hydroxide to correct H (or to space mid way between hydroxide O and H) M2 arrow from C-H bond to C-C bond following attack by OH^{-} on the correct H M3 arrow from C-Br bond to Br If nucleophilic substitution shown then allow M3 only in mechanism If wrong haloalkane used then Max 2 for mechanism	1 3	Also credit E1 mechanism  M3 curly arrow for loss of Br^{-} & structure of carbocation M1 arrow from <u>lone pair on O</u> of hydroxide to H (or to space mid way between hydroxide O and H) (same as E2) M2 arrow from C-H bond to C-C bond (same as E2)
Total		**13**	

0 2 Halogenoalkanes are useful compounds in synthesis. A reaction pathway is shown.



0 2 . 1 Give the IUPAC name for $CH_2(OH)CH(CH_3)CH_2Br$

[1 mark]

0 2 . 2 Reaction **1** occurs via a nucleophilic substitution mechanism.

Explain why the halogenoalkane is attacked by the nucleophile in this reaction.

[3 marks]

0 2 . 3 The infrared spectrum of Compound **Y** shows a significant absorption in the range 1680–1750 cm^{-1}

Draw the displayed formula of Compound **Y**.

[1 mark]

0 2 . 4 Compound **Z** has the empirical formula C_3H_4NO

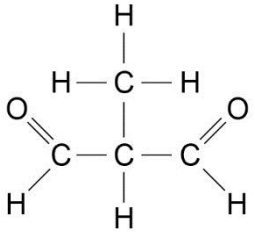
Give the structure of Compound **Z**.
Suggest the reagent for Reaction **3**.

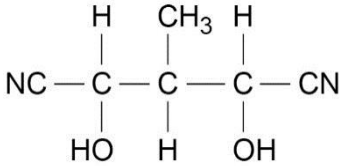
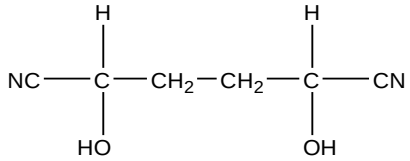
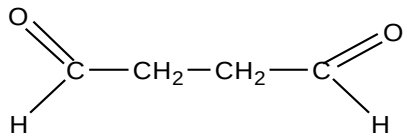
[2 marks]

Structure

Reagent for Reaction **3** _____

7

Question	Answers	Mark	Additional Comments/Guidance
02.1	3-bromo-(2)-methylpropan-1-ol ONLY	1	3 and 1 are essential, 2 may be omitted, but any other number here is wrong Ignore hyphens and commas
02.2	Bromine is more electronegative than carbon C is partially positive / electron deficient Lone/electron pair (on the nucleophile) donated to the partially positive carbon	M1 M2 M3	Allow difference in electronegativity if polarity of bond shown M2 and M3 can be awarded from diagram that shows nucleophilic attack Allow lone pair attracted to / attacks the partially positive carbon
02.3		1	Must be displayed with all bonds shown

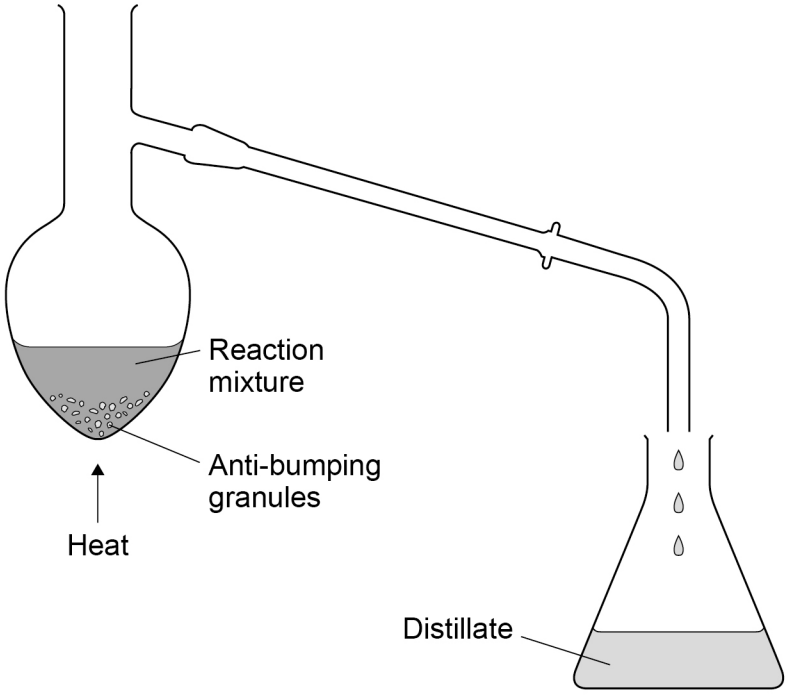
Question	Answers	Mark	Additional Comments/Guidance
02.4	 KCN & (dil) acid Allow  from  	1 1	Not need be displayed See General Marking instructions section 3.12 for penalties for incorrectly drawn bonds such as C–HO or C–NC etc. Allow HCN Ignore alcoholic solvents Penalise conc. HCl, H_2SO_4 or any HNO_3
Total		7	

Do not write outside the box

0 2 A student prepared cyclohexene by heating cyclohexanol with concentrated phosphoric acid. The cyclohexene produced was distilled off from the reaction mixture.

0 2 . 1 Complete the diagram of the apparatus used to distil the cyclohexene from the reaction mixture at 83 °C.

[2 marks]



0 2 . 2 The distillate was shaken with saturated sodium chloride solution. The cyclohexene was separated from the aqueous solution using a separating funnel.

State why cyclohexene can be separated from the aqueous solution using the separating funnel.

[1 mark]

Do not write outside the box

0 2 . 3 The cyclohexene separated in Question **02.2** was obtained as a cloudy liquid.
The student dried this cyclohexene by adding a few lumps of anhydrous calcium chloride and allowing the mixture to stand.

Give **one** observation that the student made to confirm that the cyclohexene was dry.

[1 mark]

0 2 . 4 In this preparation, the student added an excess of concentrated phosphoric acid to 14.4 g of cyclohexanol (M_r = 100.0).
The student obtained 4.15 cm^3 of cyclohexene (M_r = 82.0).
Density of cyclohexene = 0.810 g cm^{-3}

Calculate the percentage yield of cyclohexene obtained.
Give your answer to the appropriate number of significant figures.

[5 marks]

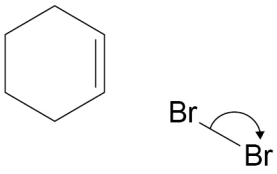
% yield _____

Question 2 continues on the next page

0 2 . 5 Cyclohexene reacts with bromine.

Complete the mechanism for this reaction.

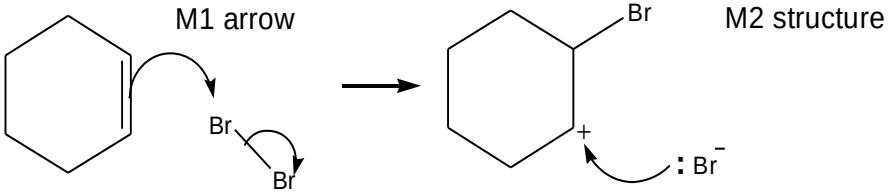
[3 marks]



12

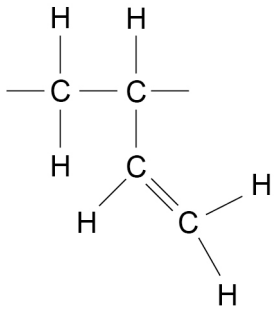
Question	Answers	Additional Comments/Guidelines	Mark
02.1	Thermometer and bung in flask with bulb level with side arm. Condenser jacket with water in at bottom and out at top.	Must be cross section diagram with no gaps at joints	1 1
02.2	Liquids are immiscible	Allow don't mix, forms two layers (stated or implied) Allow it is insoluble Ignore density or reference to solutions	1
02.3	Liquid goes clear / not cloudy	Ignore colourless	1

02.4	*Via moles* Amount cyclohexanol (= 14.4/100) = 0.144 mol	*Via mass* Amount cyclohexanol (= 14.4/100) = 0.144 mol	*Via volume* Amount cyclohexanol (= 14.4/100) = 0.144 mol	M1
	Mass cyclohexene formed = 4.15 x 0.81 = 3.36 g	Mass cyclohexene formed = 4.15 x 0.81 = 3.36 g	Mass of cyclohexene expected (= 0.144 × 82.0 = 11.808 g) OR M1 × 82	M2
	amount cyclohexene obtained (= 3.36/82.0 = 0.0410 mol) OR M2/82.0	mass of cyclohexene expected (= 0.144 × 82.0 = 11.808 g) OR = M1 × 82.0	volume of cyclohexene expected (= 11.808/0.810 = 14.577cm^3) OR M2/0.810	M3
	%Yield = $\frac{0.0410}{0.144}$ x 100 OR $\frac{M3}{M1}$ x 100	%Yield = $\frac{3.36}{11.808}$ x 100 OR $\frac{M2}{M3}$ x 100	%Yield = $\frac{4.15}{14.577}$ x 100 OR $\frac{4.15}{M3}$ x 100	M4
	= 28.5% (must be 3 sf)	= 28.5% (must be 3 sf)	= 28.5% (must be 3 sf)	M5
	Only award M5 if answer is to 3sf and follows some attempt at % yield calculation in M4			

02.5	 M3 arrow & lone pair on bromide		Lose M1 if Full charges on Br–Br OR Wrong partial charges on Br–Br OR Arrow is to Br^+ ion (formed in a preliminary step) Any C shown in the ring must have the correct number of hydrogens attached to score M2	3

Do not write outside the box

0 3 . 2 The insides of some golf balls are made from a mixture of three other polymers. The repeating unit for one of these polymers is shown.



Draw the skeletal formula of the monomer used to make this polymer.

Give the IUPAC name of the monomer.

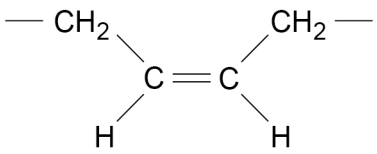
[2 marks]

Skeletal formula of monomer

IUPAC name _____

Do not write outside the box

0 3 . 3 A second polymer in the mixture has a repeating unit with the structure shown.



The third polymer in the mixture is a stereoisomer of this polymer.

Draw the structure of the repeating unit of the third polymer.

Give a reason why this type of stereoisomerism arises.

[2 marks]

Repeating unit

Reason _____

_____

_____

0 3 . 4 Golf balls recovered from lakes and ponds can be used again even after being in water for several years.

Explain why these golf balls do not biodegrade.

[1 mark]

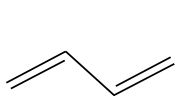
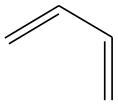
_____

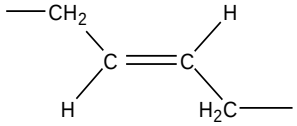
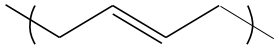
_____

_____

9

Turn over for the next question

Question	Answers	Additional Comments/Guidelines	Mark
03.2	 **OR**  <u>Buta-1,3-diene</u>	**Must be skeletal** M2 can only be this and is independent of M1	1 1

03.3	 Mark independently Restricted rotation about the C=C or double bond	Must show trailing bonds Ignore brackets and *n* Allow skeletal – with brackets  Must be E 'trans' Allow lack of rotation/no rotation/limited rotation about the C=C or double bond Ignore different groups on each carbon of the C=C double bond	1 1

03.4	<u>Carbon Carbon bonds</u> are non polar or (too) strong or not attacked by nucleophiles Or <u>Carbon Carbon bonds</u> cannot be hydrolysed	Allow carbon chains ….. OR Bonds between repeating units …… Ignore C–H bonds	1

Do not write outside the box

0 5 This question is about 2-bromopropane.

0 5 . 1 Define the term electronegativity.

Explain the polarity of the C–Br bond in 2-bromopropane.

[3 marks]

Electronegativity _____

_____

_____

Explanation _____

_____

_____

0 5 . 2 Outline the mechanism for the reaction of 2-bromopropane with an **excess of ammonia**.

[4 marks]

Do not write outside the box

0 5 . 3 Draw the skeletal formula of the main organic species formed in the reaction between a **large excess of 2-bromopropane** and ammonia.

Give a use for the organic product.

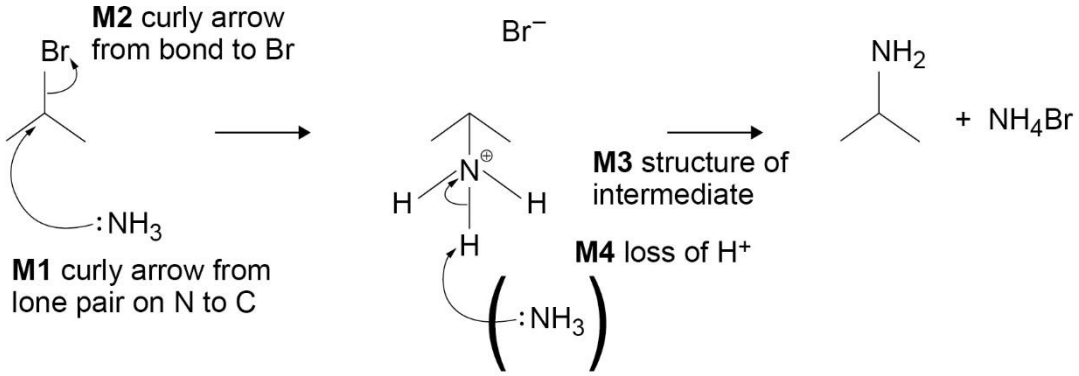
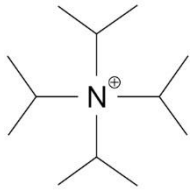
[2 marks]

Skeletal formula

Use _____

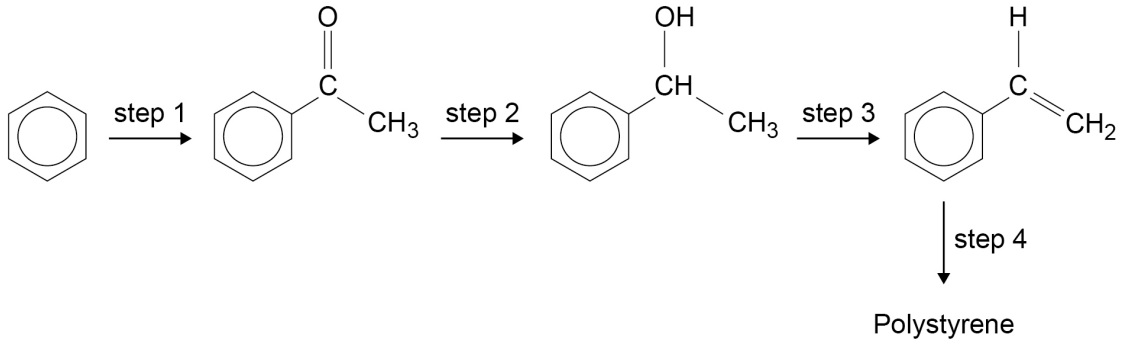
9

Turn over for the next question

Question	Answers	Additional comments/Guidelines	Mark
05.1	**M1** The (relative) tendency of an atom to attract a pair of electrons/ the electrons/ electron density in a covalent bond **M2** Br is more electronegative than C (or vice versa) **M3** So Br is δ- and C is δ+		1 1 1
05.2		**M4** Penalise loss of H^+ using Br^- Allow S_n1	4
05.3	 **M1** **M2** Use: (Hair) conditioner / (Cationic) surfactant / disinfectant	Allow + outside square brackets Allow fabric softener	1 1

Do not write outside the box

0 6 Polystyrene can be made from benzene in the series of steps shown.



0 6 . 1 State the type of reaction in step **1**.

Identify the reagent(s) and conditions needed for step **1**.

[3 marks]

Type of reaction _____

Reagent(s) _____

Conditions _____

0 6 . 2 State the name of the mechanism for the reaction in step **2**.

Identify the inorganic reagent needed for step **2**.

Name the organic product of step **2**.

[3 marks]

Name of mechanism _____

Inorganic reagent _____

Name of organic product _____

Do not write outside the box

0 6 . 3 The organic product of step **2** is reacted with concentrated sulfuric acid in step **3**.

Outline the mechanism for step **3**.

[3 marks]

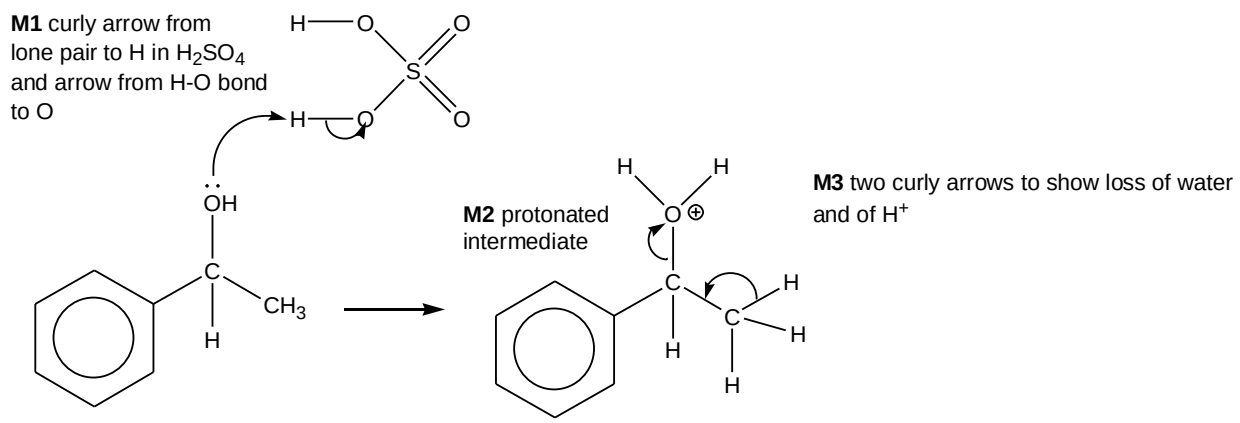
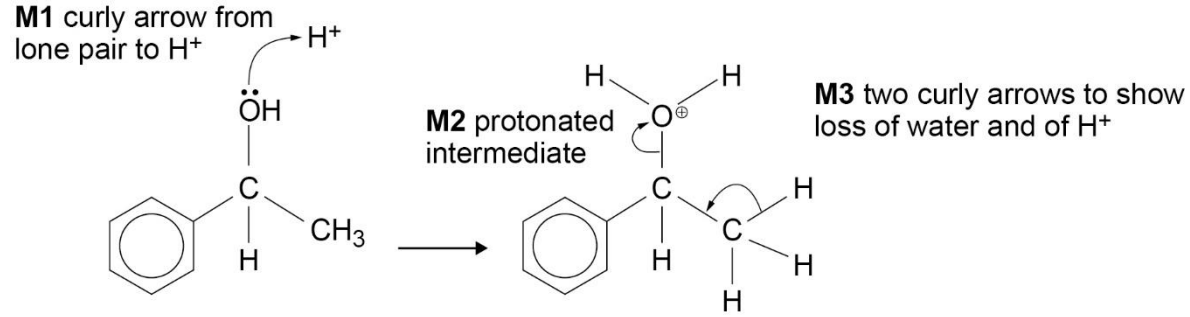
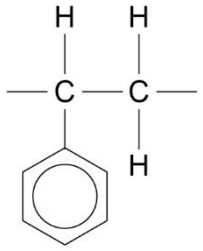
0 6 . 4 Draw the repeating unit of polystyrene.

[1 mark]

10

Turn over for the next question

Question	Answers	Additional comments/Guidelines	Mark
06.1	**M1** Acylation **M2** CH_3COCl OR Ethanoyl chloride **M3** $AlCl_3$ OR Aluminium chloride (mark could be awarded in space for M2)	Allow electrophilic substitution Allow ethanoic anhydride for M2 M3 dependent on M2 Allow Dry/anhydrous for M3 Apply list principle to extra incorrect conditions	1 1 1
06.2	**M1** Nucleophilic addition **M2** $NaBH_4$ **M3** 1-phenyl ethan(-1-)ol	Allow $LiAlH_4$ for M2 If H_2/Ni stated allow M2 and M3 but to score a matching M1 it would have to be Catalytic addition	1 1 1

06.3	 	Penalise **M1** for mistakes on structure of H_2SO_4 Allow H^+ attacked in **M1** Allow **M3** as two steps Allow displayed formulae	3
06.4		Must show trailing bonds Ignore brackets and any use of n Allow C_6H_5 for phenyl group	1

Do not write outside the box

0 3 This question is about 2-methylbut-1-ene.

0 3 . 1 Name the mechanism for the reaction of 2-methylbut-1-ene with concentrated sulfuric acid.

Outline the mechanism for this reaction to form the major product.

[5 marks]

Name of mechanism _____

Outline of mechanism to form major product

0 3 . 2 Draw the structure of the minor product formed in the reaction in Question **03.1**

Explain why this is the minor product.

[3 marks]

Structure of minor product

Explanation _____

_____

_____

_____

Turn over ►

Do not write outside the box

0 3 . 3 Draw the skeletal formula of a functional group isomer of 2-methylbut-1-ene.

[1 mark]

0 3 . 4 2-methylbut-1-ene can form a polymer.

State the type of polymerisation.

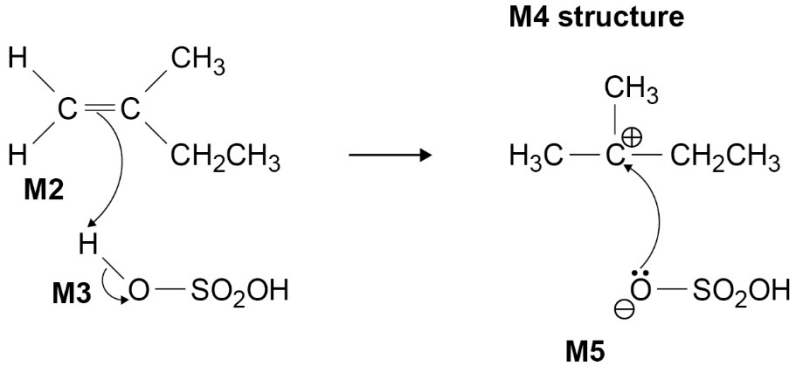
Draw the repeating unit for the polymer formed.

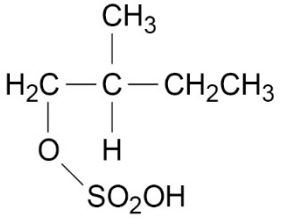
[2 marks]

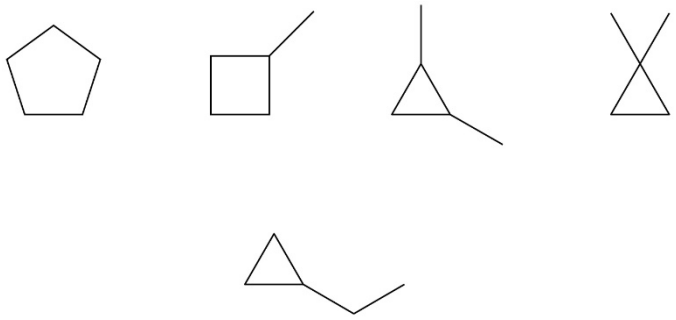
Type of polymerisation _____

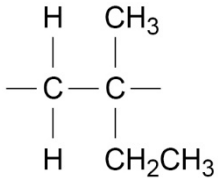
Repeating unit

11

Question	Answers	Additional Comments/Guidelines	Mark
03.1	Electrophilic addition  **M2**: must show an arrow from = of C=C towards the H atom of the H–O bond or HO that is part of H–O–S–… on a compound with molecular formula H_2SO_4 **M2** could have arrow to H^+ in which case M3 would be for an independent H–O bond break on a compound with formula H_2SO_4 **M3**: must use an arrow to show the breaking of the H–O bond **M4**: is for the correct carbocation structure **M5**: must show an arrow from a lone pair of electrons on the correct oxygen of the negatively charged ion towards the positively charged carbon atom **NB: The arrows are double-headed**	NB Allow fully displayed or other structural formulae if H_2O used as electrophile – max 4 ONLY M3 ignore partial charges unless wrong NOT M4 if primary carbocation shown. M5 NOT HSO_4 credit as shown or as $:OSO_3H$ – in which case negative charge can be shown anywhere ECF from H_2SO_3 in M2 **IGNORE** subsequent use of water to hydrolyse hydrogensulfate	M1 M2 M3 M4 M5 (1 x AO1, 4 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
03.2		If tertiary shown here allow as ECF for M1 if primary shown in 03.1	M1
	(major) product formed via more stable carbocation OR tertiary carbocation more stable (than primary)	Must be clear refers to intermediate and not product	M2
	Due to electron-releasing character / (positive) inductive effect of three alkyl groups (as opposed to one)	Primary has one e^- donating alkyl group	M3 (3 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
03.3	Skeletal formula of cycloalkane	 ignore structure of 2-methylbut-1-ene	1 (AO1)

Question	Answers	Additional Comments/Guidelines	Mark
03.4	Addition (polymerisation) 	Not additional Penalise incorrect attachment of ethyl group Must have trailing bonds Ignore n and brackets Ignore structure of 2-methylbut-1-ene	M1 M2 (1 x AO1, 1 x AO2)

Do not write outside the box

0 5 This question is about the preparation of hexan-2-ol.
Hexan-2-ol does not mix with water and has a boiling point of 140 °C

Hexan-2-ol can be prepared from hex-1-ene using this method.

a Measure out 11.0 cm^3 of hex-1-ene into a boiling tube in an ice bath.

b Carefully add 5 cm^3 of concentrated phosphoric acid to the hex-1-ene.

c After 5 minutes add 10 cm^3 of distilled water to the mixture and transfer the boiling tube contents to a separating funnel.

d Shake the mixture and allow it to settle.

e Discard the lower (aqueous) layer.

f Add a fresh 10 cm^3 sample of distilled water and repeat steps **d** and **e**.

g Transfer the remaining liquid to a beaker.

h Add 2 g of anhydrous magnesium sulfate and allow to stand for 5 minutes.

i Filter the mixture under reduced pressure.

j Distil the filtrate and collect the distillate that boils in the range 130–160 °C

0 5 . 1 It is important to wear eye protection and a lab coat when completing this experiment.

Suggest, with a reason, **one** other appropriate safety precaution for this experiment.

[2 marks]

Precaution _____

Reason _____

_____

0 5 . 2 Give a reason for adding the distilled water in steps **c** and **f**.

[1 mark]

_____

_____

0 5 . 3 Give a reason for adding anhydrous magnesium sulfate in step **h**.

[1 mark]

_____

_____

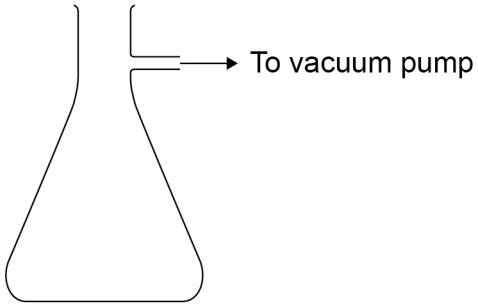
Question 5 continues on the next page

Turn over ►

Do not write outside the box

0 5 . 4 Complete and label the diagram of the apparatus used to filter the mixture under reduced pressure in step **i**.

[2 marks]



0 5 . 5 Identify the most likely organic impurity, other than hex-1-ene, in the distillate collected in step **j**.

Suggest **one** reason why it could be difficult to remove this impurity.

[2 marks]

Impurity _____

Reason _____

_____

Do not write outside the box

0 5 . 6 Calculate the mass, in g, of hexan-2-ol formed from 11.0 cm^3 of hex-1-ene if the yield is 31.0%

Give your answer to 1 decimal place.

Density of hex-1-ene = 0.678 g cm^{-3}

[4 marks]

Mass _____ g

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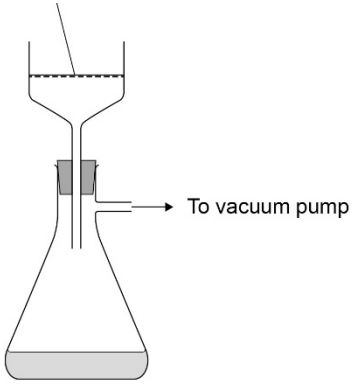
Question	Answers	Additional Comments/Guidelines	Mark
05.1	Wear gloves Conc phosphoric acid is corrosive OR Use a fume cupboard Volatile organic compounds are harmful / toxic OR Keep away from naked flames Organic compounds are flammable OR Periodically release pressure inside separating funnel Prevent build-up of pressure	Allow wash spillages with lots of water Allow work in a well-ventilated lab space Other valid suggestions eg heating mantle or electric heater Not water bath	1 1 (2 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
05.2	To remove (water) soluble impurities	Allow to remove (excess) acid	1 (AO2)

Question	Answers	Additional Comments/Guidelines	Mark
05.3	To remove water / absorb water / dry the liquid	Allow drying agent	1 (AO2)

Question	Answers	Additional Comments/Guidelines	Mark
05.4		Deduct a mark(s) for error(s) / omission(s) Minimum • Cross sectional (ie funnel top and end shown open) • Bung or collar drawn • (Buchner) Funnel – approximate shape WITH label • Filter paper – WITH label	2 (2 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
05.5	Impurity: hexan-1-ol Reason: It is likely to have a similar boiling point	If hexan-3-ol allow ecf for M2	M1 M2 (2 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
05.6	Mass hex-1-ene = 11.0 × 0.678 (or = 7.46 g) n hex-1-ene = $\frac{7.46}{84.0}$ (or = 0.0888) Mass of product = 0.0888 × 0.31 x 102 Mass product = 2.8 g	Allow consequential marks for M2,M3,M4 Allow answers 2.8 or 2.9 only	M1 M2 M3 M4 (4 x AO2)

Do not write outside the box

0 3 Under suitable conditions, 2-bromobutane reacts with sodium hydroxide to produce a mixture of five products, **A**, **B**, **C**, **D** and **E**.

Products **A**, **B** and **C** are alkenes.

A is a structural isomer of **B** and **C**.

A does not exhibit stereoisomerism.

B and **C** are a pair of stereoisomers.

Products **D** and **E** are alcohols.

D and **E** are a pair of enantiomers.

0 3 . 1 Give the names of the **two** concurrent mechanisms responsible for the formation of the alkenes and the alcohols.

[2 marks]

Mechanism to form alkenes _____

Mechanism to form alcohols _____

0 3 . 2 Define the term stereoisomers.

[2 marks]

_____

_____

_____

0 3 . 3 Deduce the name of isomer **A**.

Explain why **A** does **not** exhibit stereoisomerism.

[2 marks]

Name _____

Explanation _____

_____

_____

Do not write outside the box

0 3 . 4 Outline the mechanism for the reaction of 2-bromobutane with sodium hydroxide to form alkene **A**.

[3 marks]

0 3 . 5 Deduce the name of isomer **B** and the name of isomer **C**.

Explain the origin of the stereoisomerism in **B** and **C**.

[2 marks]

Names _____

_____

Explanation _____

_____

_____

0 3 . 6 Draw 3D representations of enantiomers **D** and **E** to show how their structures are related.

[2 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 7 A student compares the rates of hydrolysis of 1-chlorobutane, 1-bromobutane and 1-iodobutane.

The suggested method is:

- add equal volumes of the three halogenoalkanes to separate test tubes
- add equal volumes of aqueous silver nitrate to each test tube
- record the time taken for a precipitate to appear in each test tube.

State and explain the order in which precipitates appear.

[2 marks]

Order in which precipitates appear _____

_____

_____

Explanation _____

_____

_____

_____

_____

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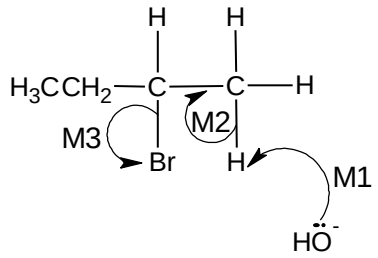
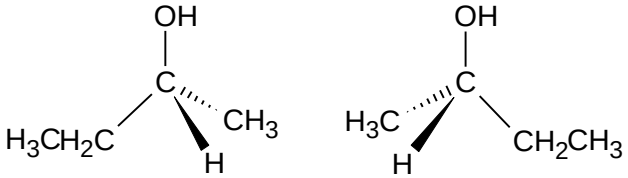
Question	Answers	Additional Comments/Guidelines	Mark
03.1	(for alkenes) elimination (for alcohols) nucleophilic substitution	**Allow** base elimination **Not** nucleophilic elimination	1 1 (2 x AO1)

Question	Answers	Additional Comments/Guidelines	Mark
03.2	(Different molecules/compounds with the) same (molecular and) structural formula Different spatial arrangement of atoms	 **Allow** different spatial arrangement of bonds/groups	1 1 (2 x AO1)

Question	Answers	Additional Comments/Guidelines	Mark
03.3	**A** = but-1-ene two groups/atoms/Hs the same on one of the C=C carbons	**Not** butene **Allow** two groups/atoms/Hs the same on first C **Not** two groups the same on one <u>side</u> of C=C **Ignore** references to no chiral carbon **Ignore '**priority' i.e. 2 groups with the same priority… gets M2 for '2 groups the same…'	1 1 (1 x AO1, 1 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
03.4		If wrong halogenoalkane used then max 2/3 **M1** lone pair on O, negative charge (anywhere) and curly arrow from lone pair to H on carbon 1 **Not** if (covalent) NaOH / additional arrows to or from NaOH / additional arrows to or from Na^+ **M2** curly arrow from C(1)–H to C(1)–C(2) **M2** is standalone from **M1** **Allow** ecf if H on carbon 3 attacked in **M1** for curly arrow from C(3)-H to C(2)–C(3) **Not** as ecf if H on carbon 2 attacked in **M1** for curly arrow from C(2)-H **M3** Curly arrow from C–Br to Br (mark is independent) **Not** if any additional arrows / incorrect polarity or formal charges on C–Br **Allow** ecf for mechanism to form but-2-ene from 03.3 **Allow** E1 mechanism M1 curly arrow from C–Br bond to the Br M2 curly arrow from lone pair on O of OH^- to a correct H on the correct C adjacent to C+ on the carbocation M3 curly arrow from a correct C–H bond to a correct C–C bond penalise M1 for any additional arrow(s) to/from the Br to/from anything else penalise M2 for any additional arrow(s) on NaOH	1 1 1 (3 x AO2)

Question	Answers	Additional Comments/Guidelines	Mark
03.5	*Z*-but-2-ene **AND** *E*-but-2-ene lack of/restricted/no (free) rotation around C=C/double bond	**allow** 'cis'/'trans' and **B** and **C** either way round **Allow** *E*/*Z* but-2-ene, cis/trans but-2-ene **Allow** C=C/double bond cannot rotate	1 1 (1 x AO1, 1 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
03.6		**M1** any correct 2D or 3D structure of butan-2-ol **Allow** C_2H_5 **M2** must show at least one wedge bond and one dash bond in each structure from the chiral C and any bonds **in the plane cannot** be at 180º to each other second structure could be drawn as mirror image of first **or** with same orientation of bonds and two groups swapped round **Allow** ECF for second structure from incorrect first structure, providing molecule is chiral	1 1 (1 x AO2, 1 x AO3)

Question	Answers	Additional Comments/Guidelines	Mark
03.7	Silver iodide then silver bromide then silver chloride bond strength C–I < C–Br < C–Cl	**Allow** yellow then cream then white **Allow** iodide/AgI then bromide/AgBr then chloride/AgCl **Allow** iodo(butane) then bromo(butane) then chloro(butane) **Ignore** iodine then bromine then chlorine **Ignore** incorrect formulae **Allow** carbon-halogen bond strength decreases down the group / from Cl to I	1 1 (2 x AO3)