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3

91391



913910



NEW ZEALAND QUALIFICATIONS AUTHORITY
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SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2017

91391 Demonstrate understanding of the properties of organic compounds

2.00 p.m. Wednesday 15 November 2017
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the properties of organic compounds.	Demonstrate in-depth understanding of the properties of organic compounds.	Demonstrate comprehensive understanding of the properties of organic compounds.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L3-CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL

21

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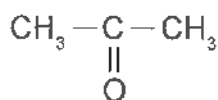
QUESTION ONE

- (a) Complete the table below to indicate the IUPAC name, functional group, and/or the structural formula for organic compounds that contain **only four carbon atoms**. The first row has been completed for you.

Functional group	Structural formula	IUPAC (systematic) name
Alkene	$\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$	but-1-ene
Amine	$ \begin{array}{ccccccc} & & \text{H} & & & & \\ & & & & \text{H} & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{N} & \begin{array}{l} \text{H} \\ \\ \text{H} \end{array} \\ & & & & & & & & & \\ & & \text{H} & & \text{H} & & \text{H} & & & \end{array} $	2-methylpropan-1-amine
Acyl chloride	$ \begin{array}{ccccccc} \text{H} & & \text{H} & \text{H} & & & \\ & & & & & & \\ \text{H} - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & \begin{array}{l} \text{O} \\ \\ \text{Cl} \end{array} \\ & & & & & & \\ \text{H} & & \text{H} & \text{H} & & & \end{array} $	butanoyl chloride
Ester	$ \begin{array}{ccccccc} & & \text{O} & & & & \\ & & & & & & \\ \text{H} - \text{C} & - & \text{O} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{H} \\ & & & & & & & & & & \\ & & & & \text{H} & & \text{H} & & \text{H} & & \\ & & & & & & & & & & \\ & & & & \text{H} & & \text{H} & & \text{H} & & \end{array} $	propyl methanoate
Ketone	$ \begin{array}{ccccccc} & & & & \text{O} & & \\ & & & & & & \\ \text{CH}_3 & \text{CH}_2 & - & \text{C} & - & \text{CH}_3 \\ & & & & & \\ & & & \text{O} & & \end{array} $	butan-2-one
Aldehyde	$ \begin{array}{ccccccc} \text{H} & \text{H} & \text{H} & & & & \\ & & & & & & \\ \text{H} - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & \begin{array}{l} \text{O} \\ \\ \text{H} \end{array} \\ & & & & & & \\ \text{H} & \text{H} & \text{H} & & & & \end{array} $	butanal
Amide	$ \begin{array}{ccccccc} \text{H} & \text{H} & \text{H} & & & & \\ & & & & & & \\ \text{H} - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & \begin{array}{l} \text{O} \\ \\ \text{NH}_2 \end{array} \\ & & & & & & \\ \text{H} & \text{H} & \text{H} & & & & \end{array} $	butanamide

- (b) Complete the following reaction scheme by drawing the structural formulae of both organic compounds **A** and **B**, as well as the major and minor products **C** and **D**.

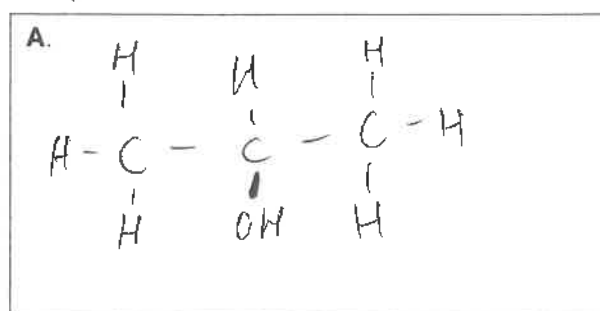
Identify both reagents 1 and 2, and indicate the type of reaction occurring at each step.



Propanone

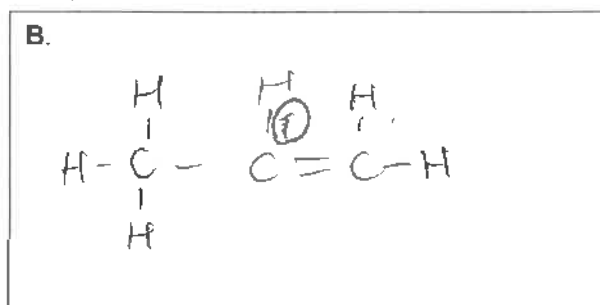
Type of reaction: Reduction

Reagent 1: NaBH_4



Type of reaction: elimination/dehydration

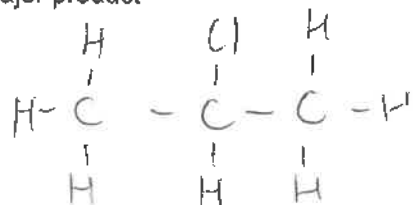
Reagent 2: conc H_2SO_4



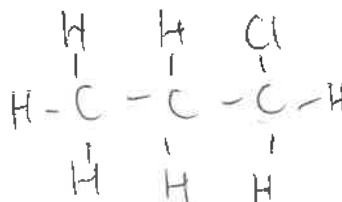
Type of reaction: addition

Reagent 3: HCl

C. Major product



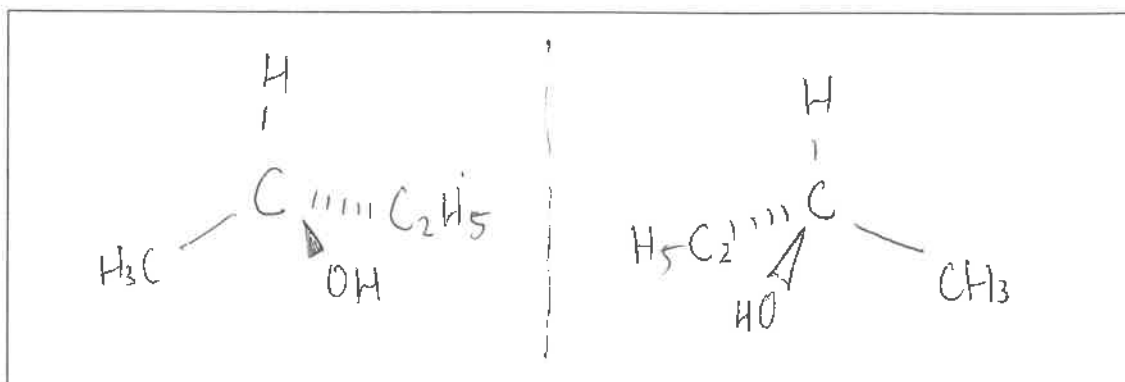
D. Minor product



(c) Some organic compounds can exist as enantiomers (optical isomers).

An example is a secondary alcohol with the molecular formula C_4H_9OH .

(i) Draw the enantiomers of C_4H_9OH in the box below.



(ii) Explain what is meant by the term enantiomers (optical isomers).

In your answer, you should:

- identify the structural requirement for a molecule, such as C_4H_9OH , to exist as enantiomers
- explain how enantiomers can be distinguished from each other.

In order to be an enantiomer the molecule must contain a chiral carbon atom. A chiral carbon atom is a carbon atom in which is bonded to 4 ~~other~~ ~~carbon~~ different groups of atoms. e.g. in C_4H_9OH the central C atom is bonded to a H atom, a CH_3 group, a C_2H_5 group and an OH group. To distinguish between the different enantiomers shine plane polarised light through the solutions and each enantiomer will ~~to~~ rotate the plane polarised light in opposite directions.

E7

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The examination continues on the following page.**

QUESTION TWO

- (a) Compound **P** and compound **Q** are straight-chain constitutional (structural) isomers with the molecular formula $C_5H_{12}O$. Compound **P** can form optical isomers, whereas compound **Q** cannot.

When reacted with concentrated sulfuric acid, compound **P** forms two products, compounds **R** and **S**; compound **Q** forms only one product, compound **S**.

When compound **Q** is reacted with *Reagent 1*, it forms a chloroalkane, compound **T**.

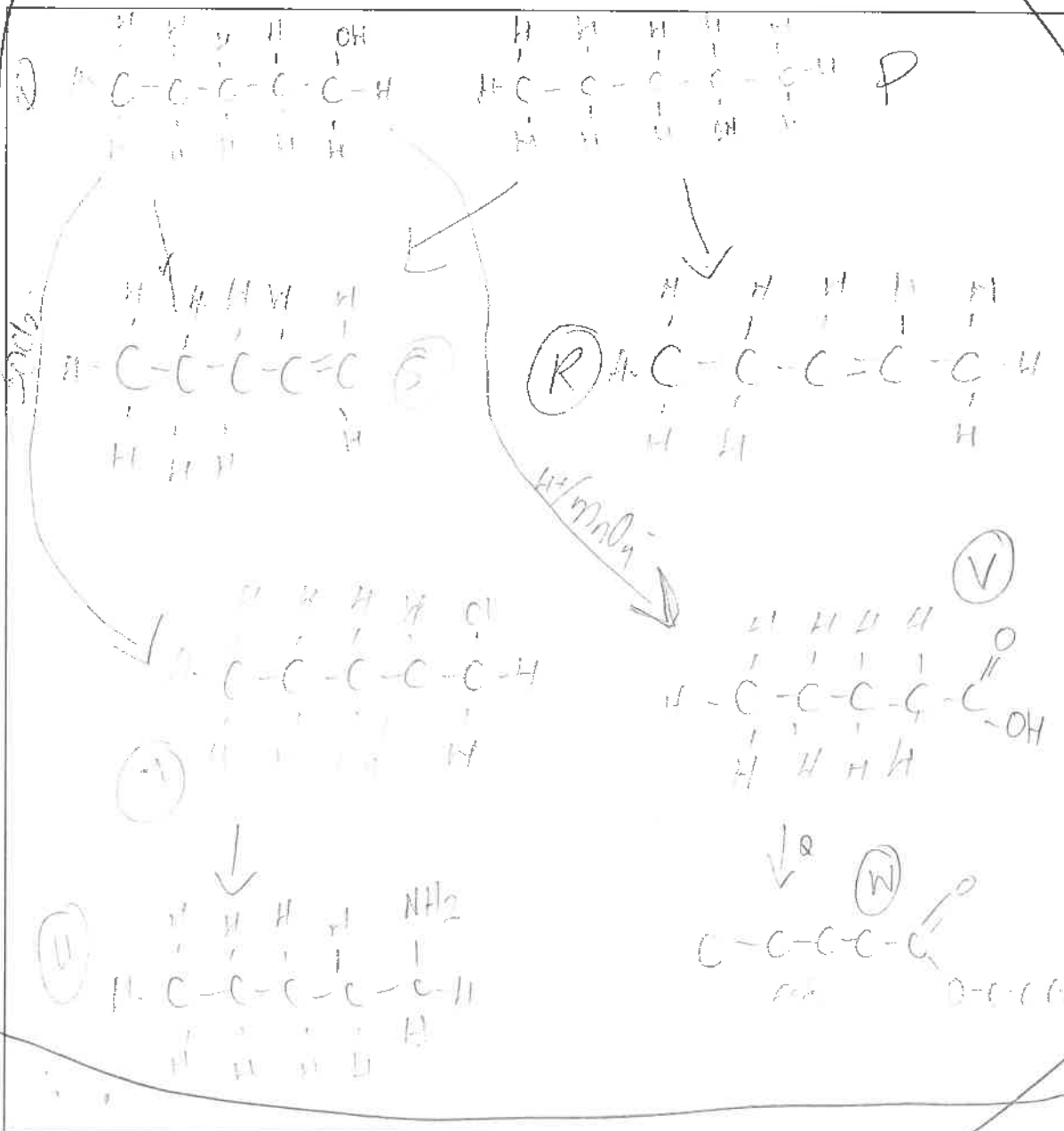
Compound **T** reacts with concentrated NH_3 to form compound **U**.

Compound **Q** can also be oxidised to form compound **V**, which will turn moist blue litmus paper red.

Compound **V** can also be reacted with compound **Q** and *Reagent 2*, to form a sweet-smelling liquid, compound **W**.

Use the information above to identify compounds **P** to **W**, and *reagents 1* and *2*.

Space for planning/working is provided in the box below.



Complete the following tables using the information found on the previous page.

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USE ONLY

Compound	Structure
P	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \text{H} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{OH} & \text{H} \end{array} $ pentan-2-ol
Q	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{OH} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \text{H} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $ pentan-1-ol
R	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} = \text{C} & - \text{C} & - \text{H} \\ & & & & & \\ & \text{H} & \text{H} & & \text{H} & \text{H} \end{array} $ pent-2-ene
S	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} = \text{C} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & & \text{H} \end{array} $ pent-1-ene
T	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{Cl} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \text{H} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $ 1-chloropentane
U	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{NH}_2 \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} - \text{H} \\ & & & & & \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $ pentan-1-amine
V	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{O} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} \\ & & & & & \backslash \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{OH} \end{array} $ pentanoic acid
W	$ \begin{array}{cccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{O} \\ & & & & & \\ \text{H} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{C} \\ & & & & & \backslash \\ & \text{H} & \text{H} & \text{H} & \text{H} & \text{O} - \text{C} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \\ & & & & & & & & & \\ & & & & & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array} $ pentanoic acid pentyl pentanoate

Reagent 1	SOCl_2
Reagent 2	conc H_2SO_4

- (b) (i) Adding an acidified potassium dichromate solution to propan-1-ol can produce either propanal or propanoic acid.

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Explain the laboratory procedure used to convert propan-1-ol to **propanal**.

In your answer, you should:

- outline the procedure for the conversion, and describe any colour changes linked to the species involved
- state the type of reaction occurring
- explain how the procedure ensures only **propanal** is collected.

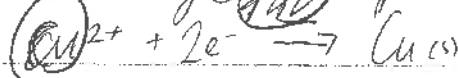
~~use distillation~~ when propan-1-ol is added to ~~the~~ acidified dichromate a oxidation reaction is taking place. This should be done using the process of distillation, where the solution is heated to speed up the rate of reaction. Since oxidation is taking place the colour of the solution will change from ~~orange~~ orange to green. Since propanal has the lowest boiling point once it is formed and the temperature has reached its BP the propanal will turn into gas while the propan-1-ol ~~and propanoic acid~~ ^{propanoic acid (if made)} still remain liquids. The vapour ~~of~~ of propanal will ~~enter a~~ ^{rise upward} and enter a condenser which has cold water running through it to cool the gas down back into a liquid which should only be propanal.

- (ii) Explain how Benedict's solution can be used to distinguish between propanone and propanal.

In your answer, you should include:

- any observations made linked to the organic compounds involved
- the type of reaction occurring
- relevant equations showing any organic reactants and products involved.

propanone is a ketone and is not further oxidised whereas propanal undergoes oxidation to form propanoic acid and will turn from blue and form an orange ~~precipitate~~ precipitate.



So the solution
will remain
blue

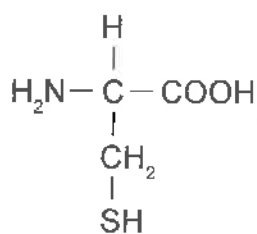
E7

QUESTION THREE

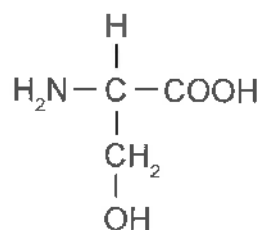
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Peptides are molecules that form when amino acids combine.

The following structures show the amino acids cysteine and serine.

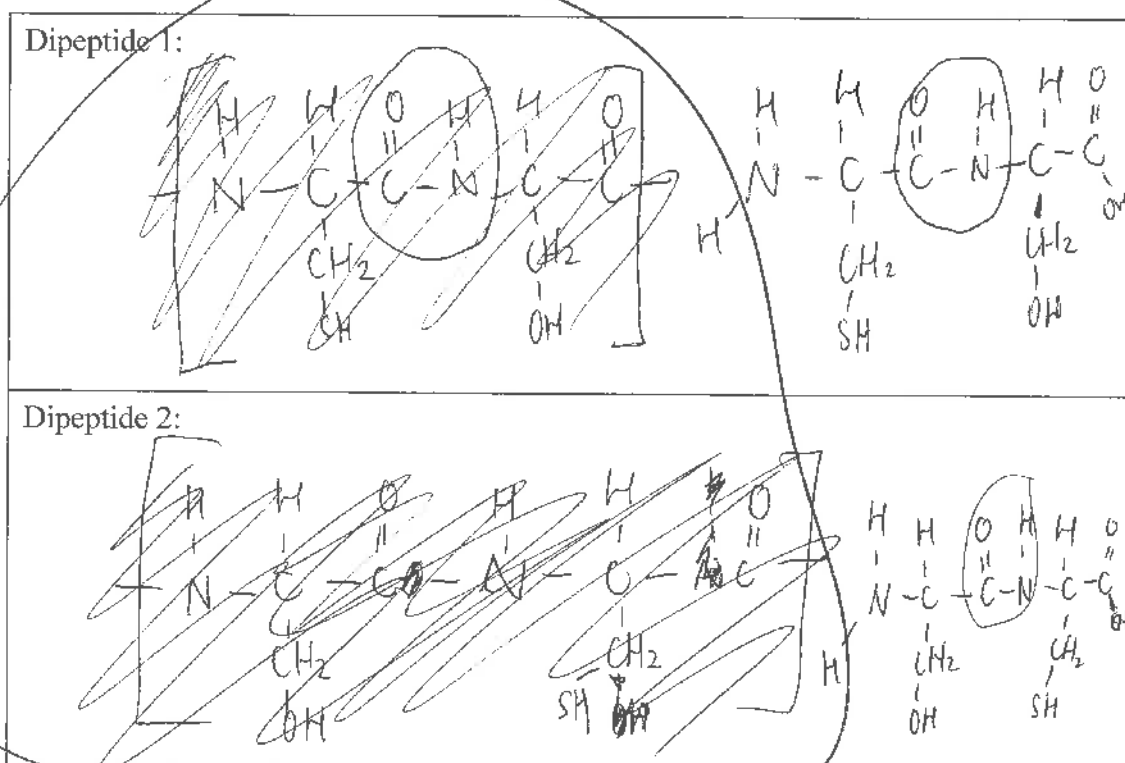


cysteine



serine

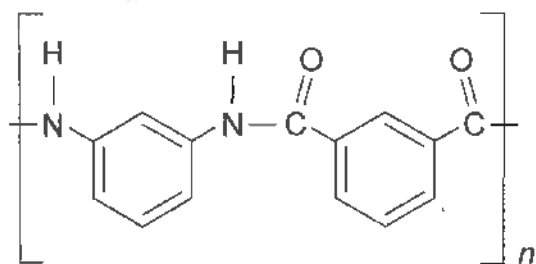
- (a) (i) In the boxes below, show two possible dipeptides that can be formed by combining the two amino acids shown above.

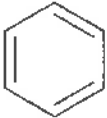


- (ii) Circle the amide functional group on ONE of the dipeptides drawn in part (i).

- (b) Nomex® is a polymer used in firefighters' suits. Nomex® is made up of two different monomers bonded together to form the polymer chain.

A small portion of the structure of Nomex® is shown below.

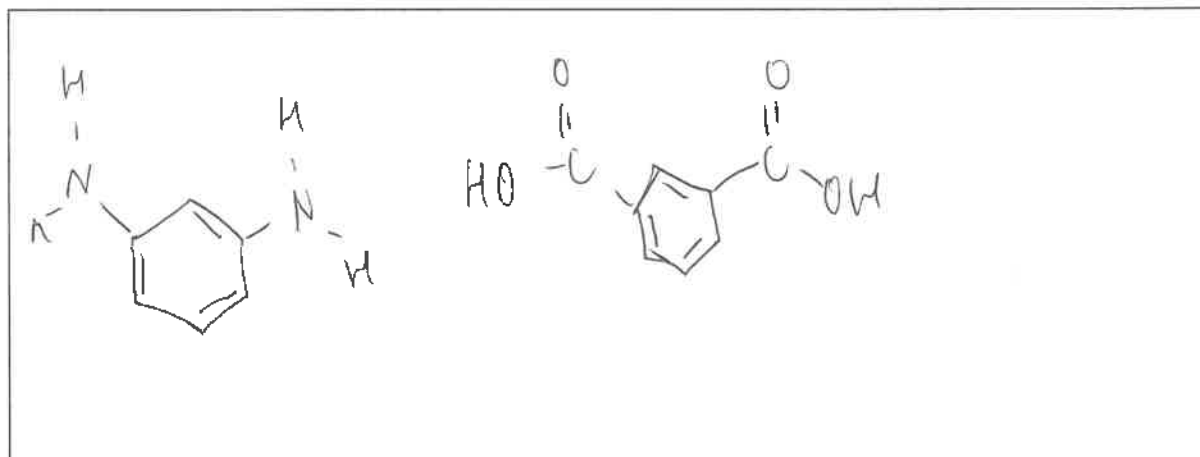


Note:  is a benzene ring and does not change when the monomers bond together to form the polymer.

Explain the structure of the polymer, Nomex®.

In your answer, you should include:

- the name of the functional group linking the monomers
- a drawing of both monomers
- a classification of the type of polymer formed, with an explanation to justify your choice.



The functional group linking the monomers is an amide linkage. This is because the 2 monomers undergo β condensation polymerisation, it is when the 2 monomers join together whilst a smaller molecule in this case H_2O is condensed out. As the OH from the carboxylic joins with an H off the amine group making H_2O and allowing a bond to form between the different monomers.

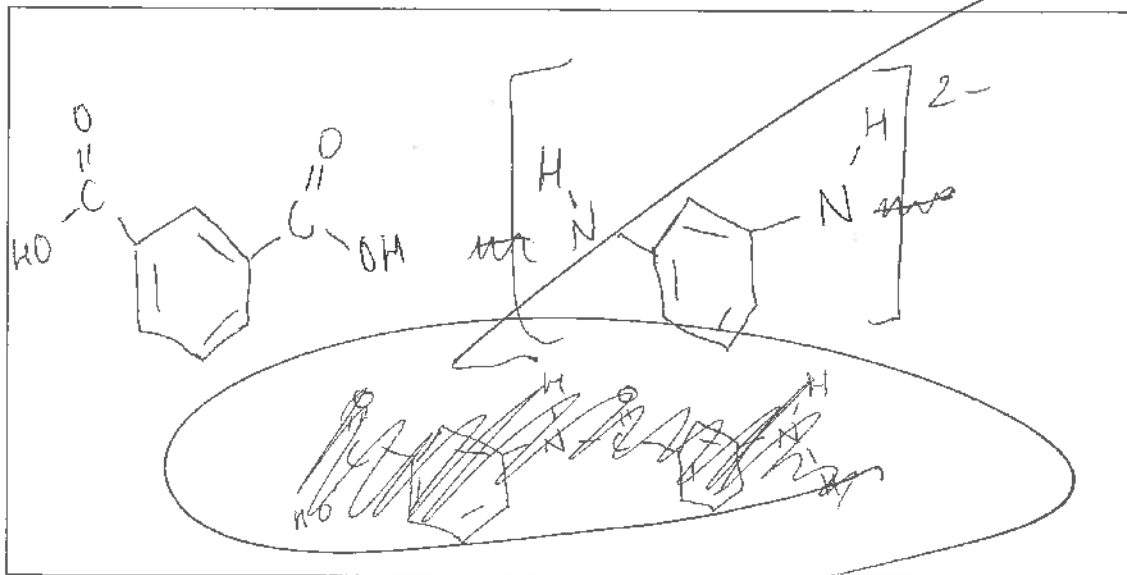
The polymer is an α polyamide due to the amide linkage.

(c) Polymers such as Nomex® can be hydrolysed by either aqueous acid or base.

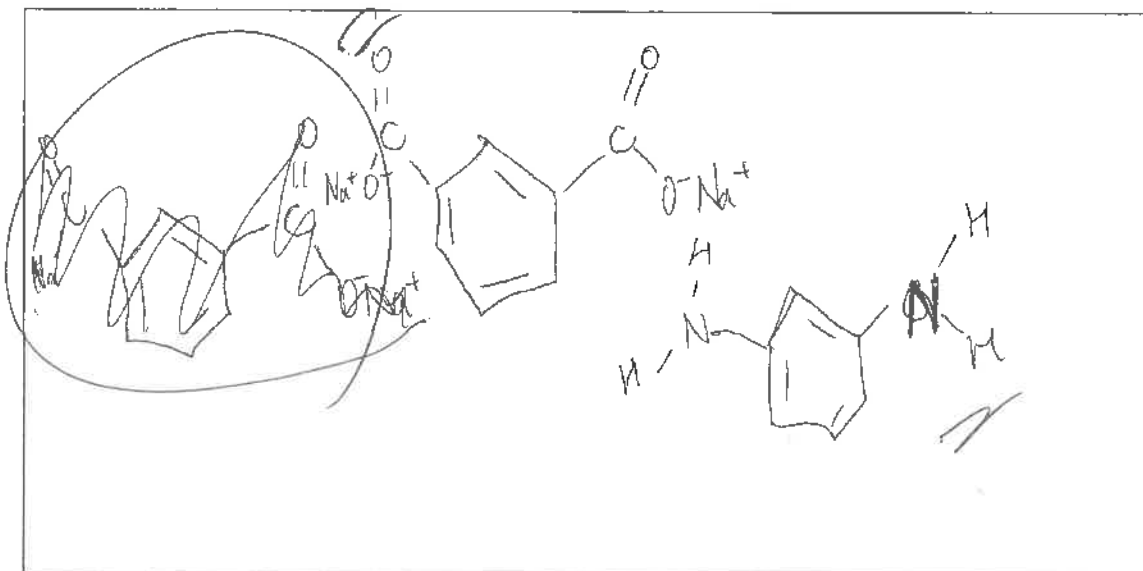
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Show the products of the hydrolysis of Nomex® using:

(i) aqueous acid



(ii) aqueous base.



E?

Subject:		Chemistry	Standard:		91391	Total score:		21
Q	Grade score	Annotation						
1	E7	This response gains E7, rather than E8 because the explanation of enantiomers is incomplete. Had the candidate also described the feature of being non-superimposable mirror images they would have gained an E8.						
2	E7	To gain an E8 the candidate would have needed to: Either in part (b)(i), have more clearly explained the need to remove propanal from the reaction mixture immediately to prevent further oxidation to propanoic acid, Or in part (b)(ii), included the need for warming the mixture.						
3	E7	To gain E8, the candidate needed to correctly draw the protonated diamine structure in part (c)(i).						