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3

91391



913910



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
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SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2015

91391 Demonstrate understanding of the properties of organic compounds

2.00 p.m. Wednesday 11 November 2015
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.

Achievement

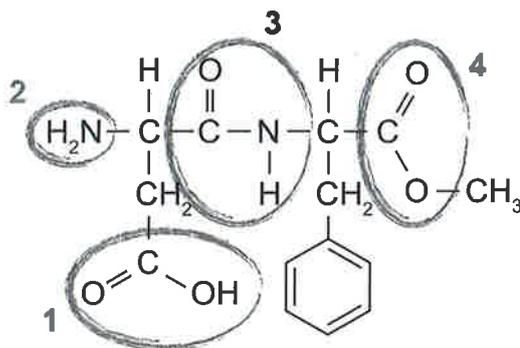
TOTAL

10

ASSESSOR'S USE ONLY

QUESTION ONE

- (a) The structure of aspartame is given below. Aspartame is often used as an artificial sweetener in drinks.



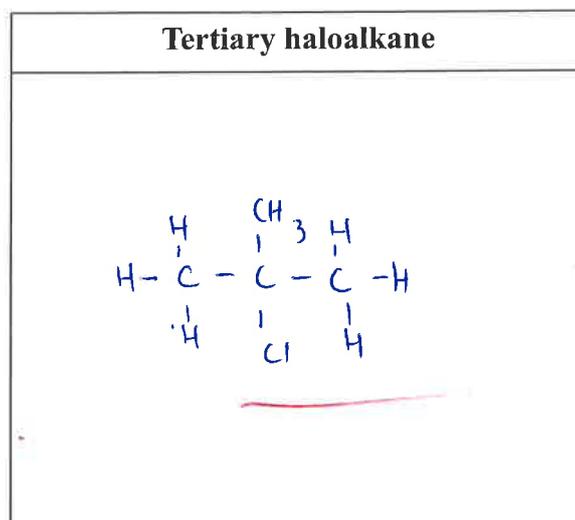
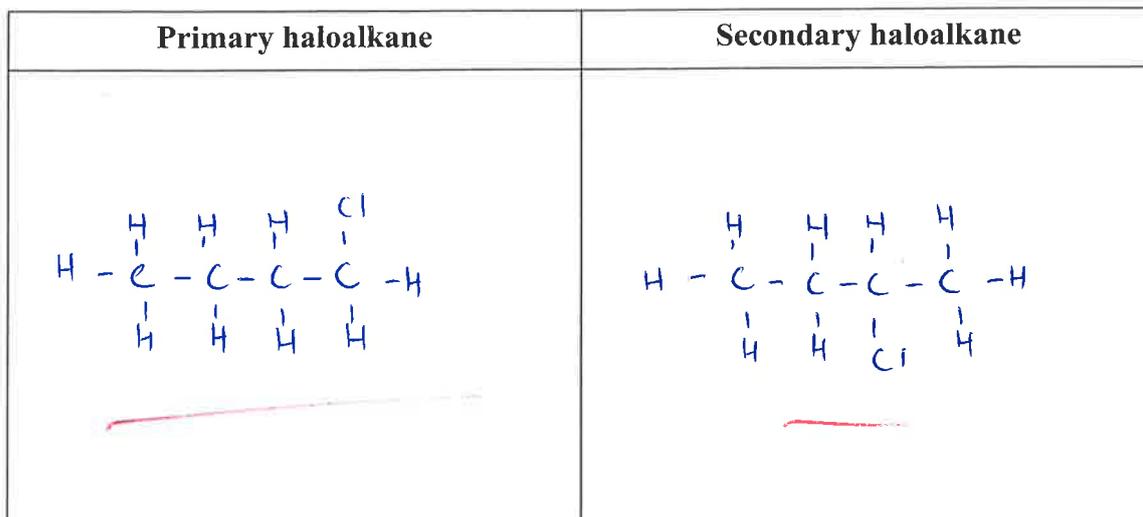
Identify the FOUR different functional groups within the aspartame molecule that are circled and numbered above:

1	<u>carboxylic acid</u>	2	<u>amine</u>
3	<u>amide</u>	4	<u>ester</u>

- (b) Complete the table below by drawing the structural formula for the named compounds.

IUPAC systematic name	Structural formula
propanoyl chloride	$\begin{array}{c} \text{H} & \text{H} & \text{O} \\ & & // \\ \text{H} - \text{C} - & \text{C} - & \text{C} \\ & & \backslash \\ \text{H} & \text{H} & \text{Cl} \end{array}$
3-bromopentan-2-one	$\begin{array}{c} \text{H} & \text{H} & \text{Br} & \text{H} & \text{H} \\ & & & & \\ \text{H} - \text{C} - & \text{C} - & \text{C} - & \text{C} - & \text{C} - \text{H} \\ & & & & \\ \text{H} & \text{H} & \text{H} & \text{O} & \text{H} \end{array}$
2-methylbutanal	$\begin{array}{c} \text{H} & \text{H} & \text{H} & \text{O} \\ & & & // \\ \text{H} - \text{C} - & \text{C} - & \text{C} - & \text{C} \\ & & & \backslash \\ \text{H} & \text{H} & \text{CH}_3 & \text{H} \end{array}$

- (c) (i) In the boxes below, draw the three structural isomers of C_4H_9Cl that represent a primary, secondary and tertiary haloalkane.

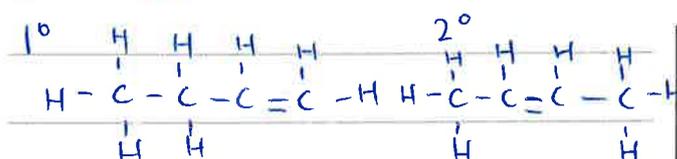


- (ii) Elaborate on the reactions occurring when each of the haloalkane isomers from (c)(i) reacts with KOH in alcohol.

In your answer you should include:

- the identification of ALL organic products formed
- an explanation of the type of reaction taking place
- reasons for the formation of any major and minor products.

As the 1° , 2° and 3° haloalkane reacts with KOH (alc) the elimination reaction occur as the -Cl is moved from the molecule and the double bond between carbon atom is formed.

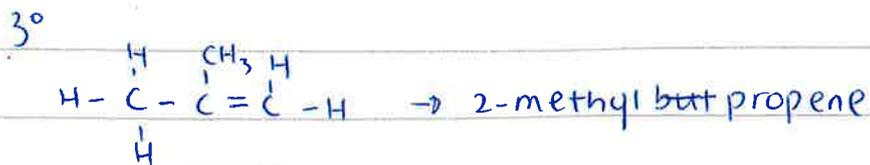


but-1-ene

but-2-ene

Chemistry 91391, 2015

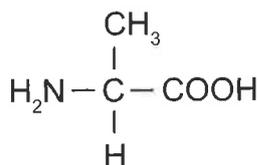
There is more space for your answer to this question on the following page.



There would be major or minor products to be formed ^(as it has formed an alkene) according to the place where -Cl was bonded to. For example, ~~but-1-ene~~ but-2-ene will be a minor product as following to the rule 'poor gets poor, richer gets richer' that the formation of double bond have removed the Hydrogen bond from the carbon which had more Hydrogen. And the but-2-ene will be a major because the ^{formation of double} carbon bond have removed the Hydrogen from the carbon which had less Hydrogen bond attached to it //

QUESTION TWO

- Alanine is an amino acid. Its structure is shown below.



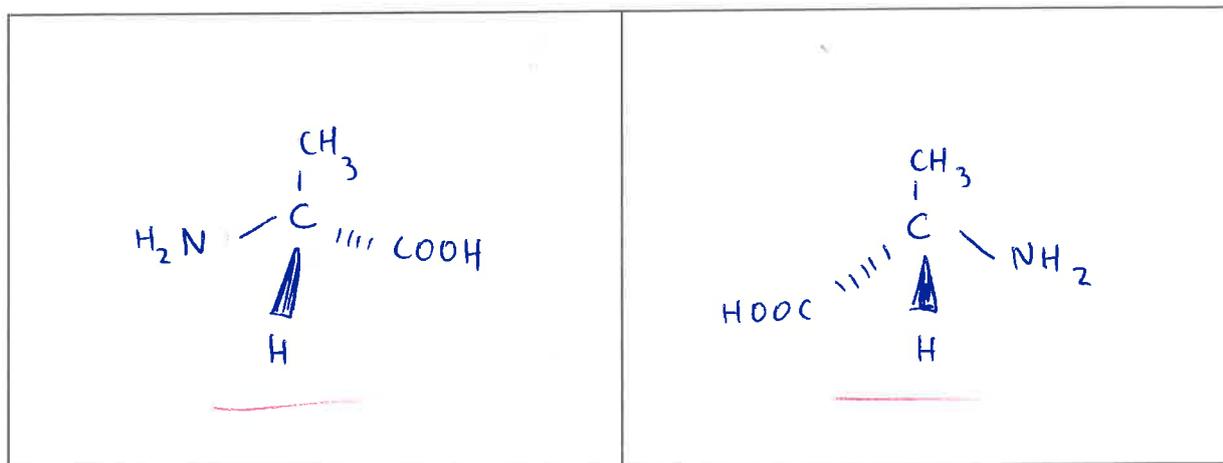
- (a) (i) Describe the structural feature necessary for a compound to exist as enantiomers (optical isomers).

For a compound to exist as enantiomers, there have ^{to be} a chiral C atom which has four different groups attached to it.

- (ii) Identify one physical property that is the same for both enantiomers of alanine, and one that is different, clearly describing how this property could be used to distinguish between the enantiomers.

The enantiomers reflect the planes of polarised light in opposite directions. ~~So if this doesn't~~ ^{one of} so if the enantiomers doesn't follow this it will be distinguished from other enantiomers.

- (b) Draw 3-D structures of the enantiomers of alanine in the boxes below.

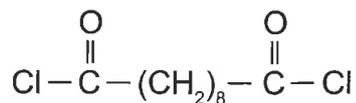


- (c) A form of the polymer nylon can be made from the two monomers below.

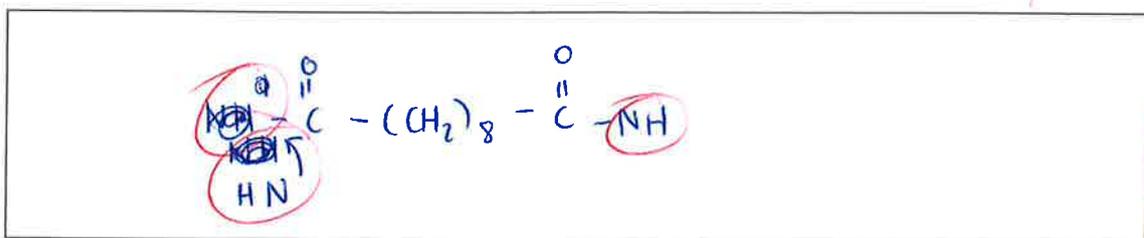
1,6-diaminohexane



Sebacoyl chloride (decanedioyl dichloride)



- (i) In the box below draw the repeating unit of the polymer formed if these two monomers are used.



Consider the formation of this form of nylon in a laboratory.

- (ii) Describe the type of reaction occurring, and explain why this reaction results in a polymer.

polymerisation
 The substitution reaction is occurring within the two monomers as the $\text{Cl}-\overset{\text{O}}{\parallel}{\text{C}}$ bond of the sebacoyl chloride is combining with H_2N bond of the 1,6-diaminohexane to form a $\text{NH}-\overset{\text{O}}{\parallel}{\text{C}}$ bond. As the small molecules of monomer join together to make a long chain of polymer.

- (iii) Explain why sebacoyl chloride is dissolved in a non-polar organic solvent rather than in water.

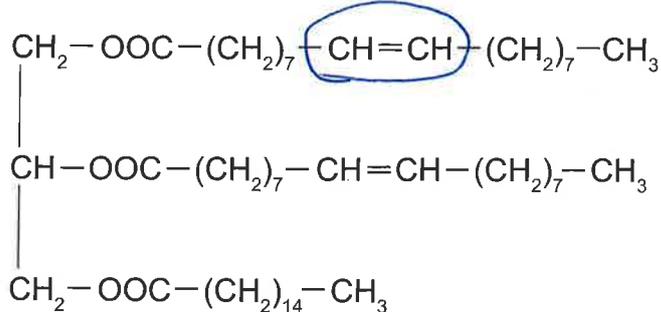
As the ~~because~~ sebacoyl is a polar molecular it won't react with other polar molecule such as water but will react with non-polar organic solvent and then dissolved.

- (iv) Elaborate on the reaction that will occur if a dilute aqueous solution of acid is mixed with the newly formed polymer.

If the newly formed polymer reacts with the dilute aqueous solution (e.g. H_2SO_4), the carboxylic acid will be formed at the end of newly formed polymer.

QUESTION THREE

- (a) A triglyceride has the following structure:



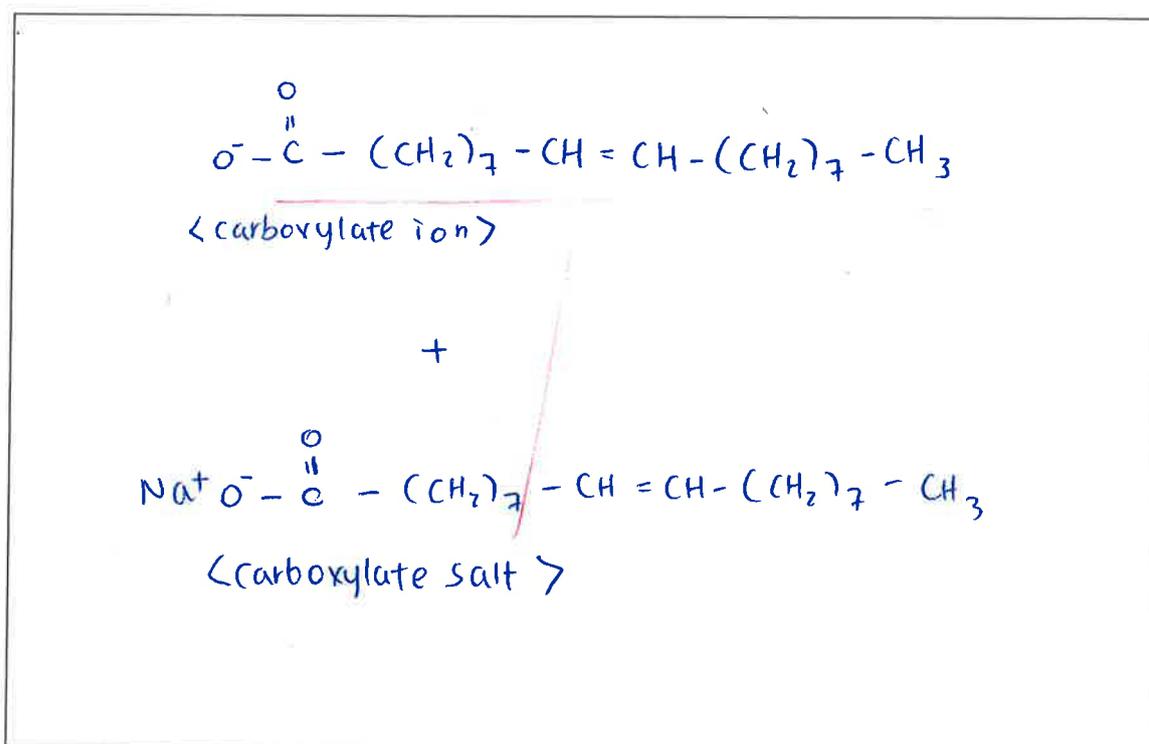
- (i) Circle one of the alkene groups in the triglyceride molecule.

This triglyceride is described as unsaturated.

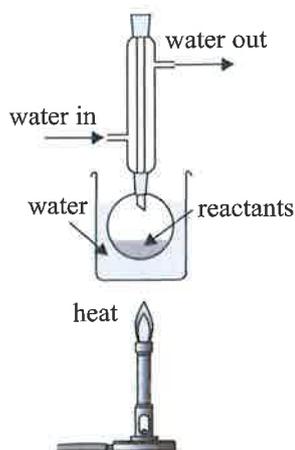
- (ii) Describe a chemical test that can be used to show that the molecule is unsaturated. Give any observations, and state the type of reaction occurring.

Handwritten answer area with a large red scribble.

- (iii) Draw the structural formulae of the organic products formed by hydrolysis of this triglyceride using aqueous sodium hydroxide.
- NaOH(aq)



(iv) Explain why the equipment below is used for hydrolysis of the triglyceride.

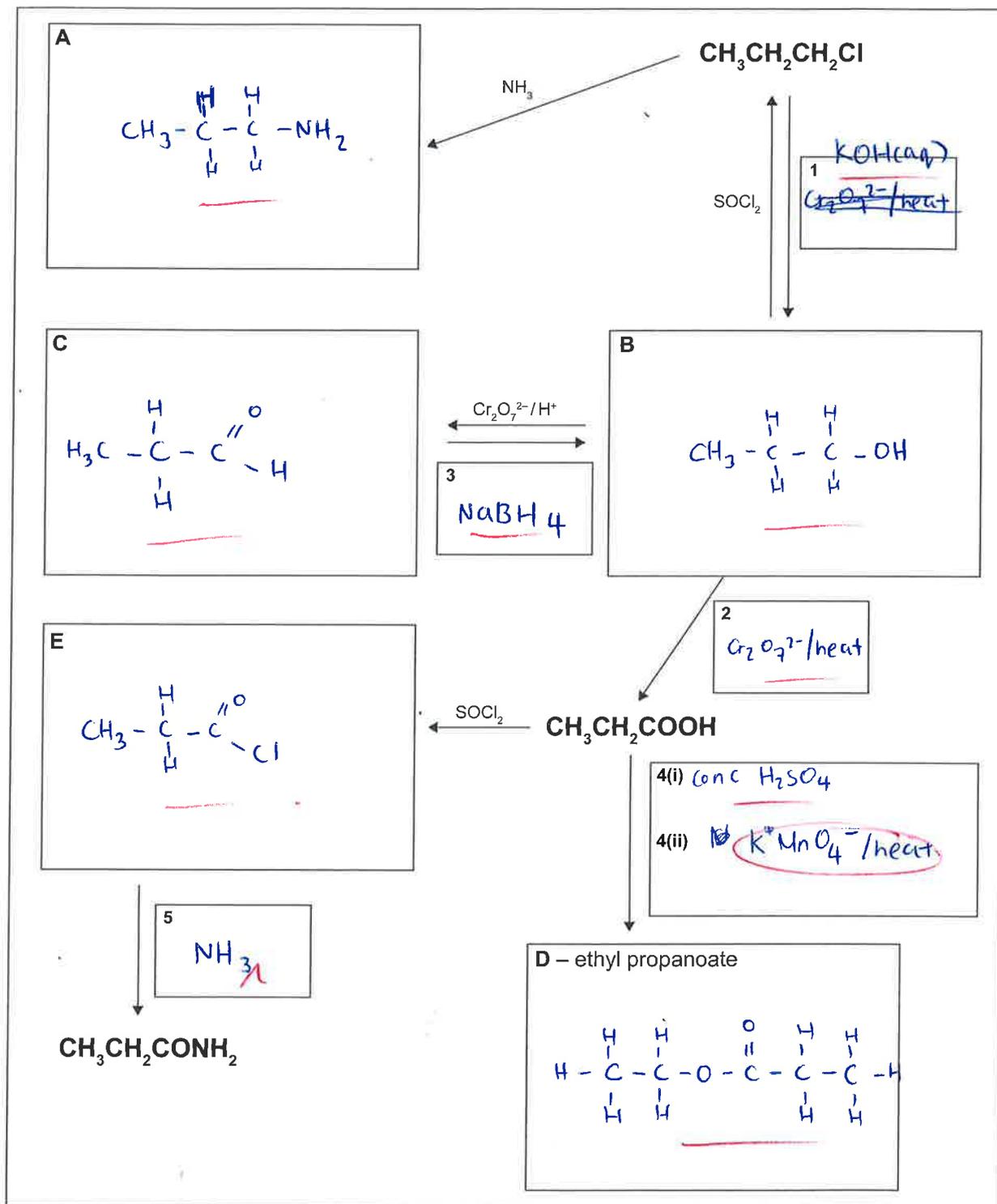


process

The equipment used for hydrolysis of the triglyceride is a refluxing. When the reactants is heated up, the refluxing prevents any water lost from the vessel. //

Question Three continues
on the following page.

- (b) Complete the following reaction scheme by drawing the structural formulae of the organic compounds **A** to **E**, and identifying reagents **1** to **5**.



**Extra paper if required.
Write the question number(s) if applicable.**

QUESTION
NUMBER

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**Extra paper if required.
Write the question number(s) if applicable.**

ASSESSOR'S
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QUESTION
NUMBER

91391

Grade score 10 – Low Achievement

Q1

(c)(ii) Lacking in the depth of explanations and reasons for type of reaction and formation of products, specifically the adjacent and asymmetric concepts

Q2

(a)(ii) Enantiomers rotate not reflect plane polarised light

(c)(i) Repeating unit incorrect

(c)(iii) Sebacyl chloride reacts vigorously in water

Q3

(a)(iii) Propan-1,2,3-ol missing

(a)(iv) Reflux is used to increase the rate of reaction and prevent volatile chemicals from evaporating

(b) States required

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Achievement

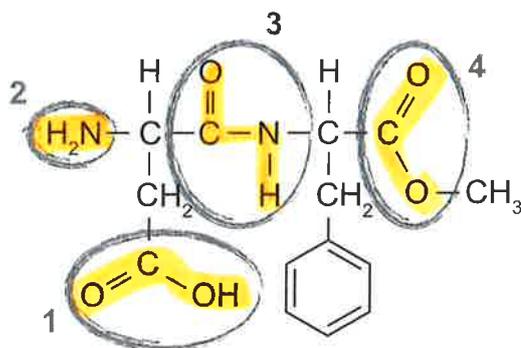
TOTAL

11

ASSESSOR'S USE ONLY

QUESTION ONE

- (a) The structure of aspartame is given below. Aspartame is often used as an artificial sweetener in drinks.



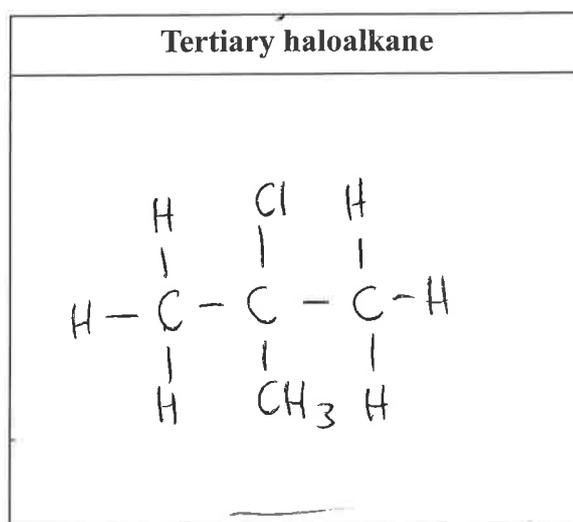
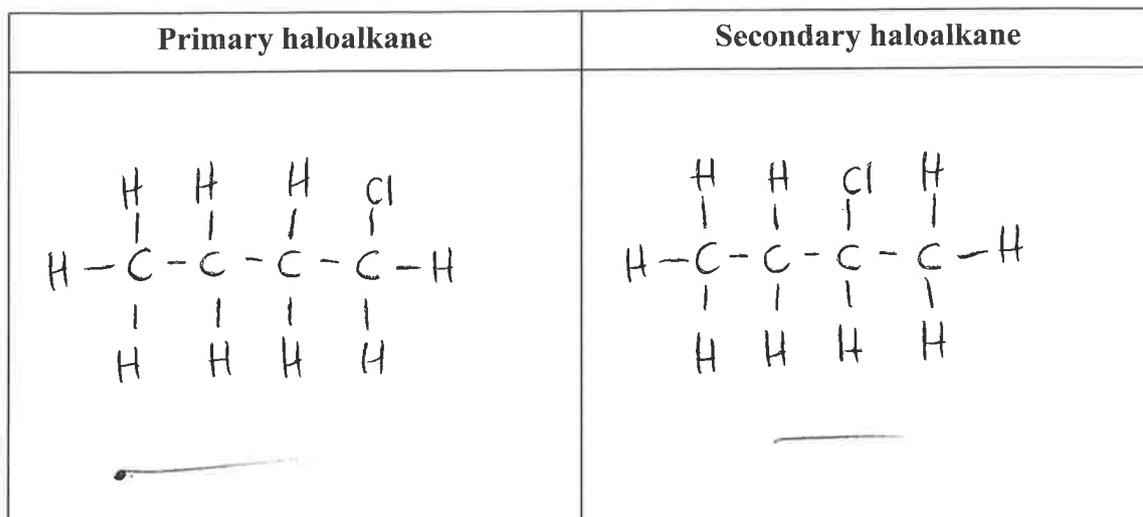
Identify the FOUR different functional groups within the aspartame molecule that are circled and numbered above:

1	<u>Carboxylic Acid</u>	2	<u>Amine</u>
3	<u>Amide</u>	4	<u>Ester</u>

- (b) Complete the table below by drawing the structural formula for the named compounds.

IUPAC systematic name	Structural formula
propanoyl chloride $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{Cl}$	$\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{O} & \\ & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - \text{Cl} \\ & & & & & & \\ & \text{H} & & \text{H} & & & \end{array}$
<u>3-bromopentan-2-one</u> $\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{C}(=\text{O})\text{CH}_3$	$\begin{array}{ccccccccc} & \text{H} & & \text{H} & & \text{Br} & & \text{O} & & \text{H} \\ & & & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\ & & & & & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & & & & \text{H} & \end{array}$
<u>2-methylbutanal</u> $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CHO}$	$\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{CH}_3 & & \text{O} \\ & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\ & & & & & & & & \\ & \text{H} & & \text{H} & & \text{H} & & & \end{array}$

- (c) (i) In the boxes below, draw the three structural isomers of C_4H_9Cl that represent a primary, secondary and tertiary haloalkane.



- (ii) Elaborate on the reactions occurring when each of the haloalkane isomers from (c)(i) reacts with KOH in alcohol.

In your answer you should include:

- the identification of ALL organic products formed
- an explanation of the type of reaction taking place
- reasons for the formation of any major and minor products.

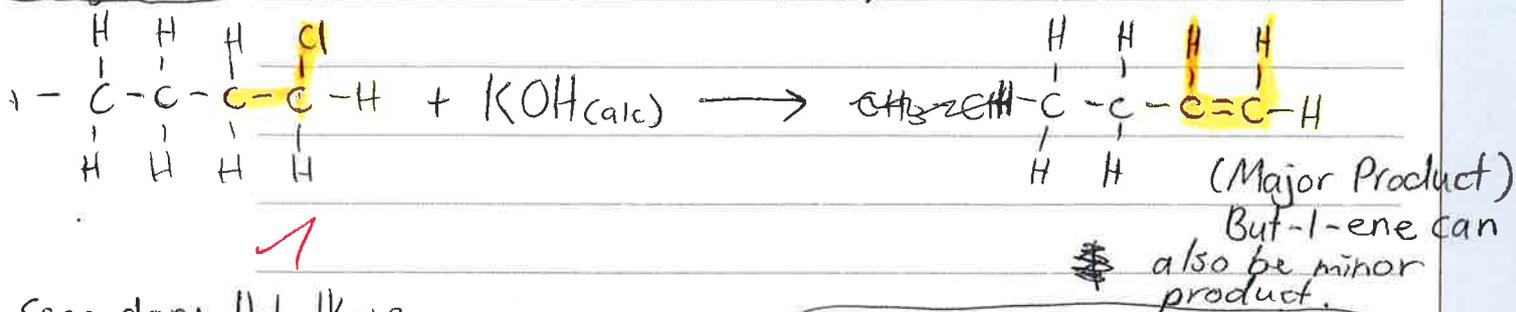
When haloalkanes react with KOH (alc) they form alkenes ($C=C$). This is an elimination reaction where the carbon with the least amount of hydrogens will receive the double bond as the Cl atom is removed.

This is known as the major product. Another product is also formed. The minor product is formed when the double bond is

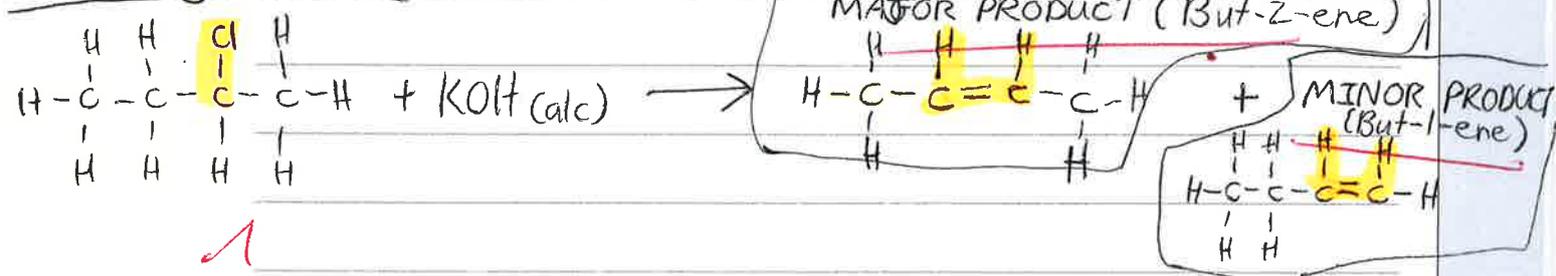
There is more space for your answer to this question on the following page.

Created with the carbon rich in hydrogens (also

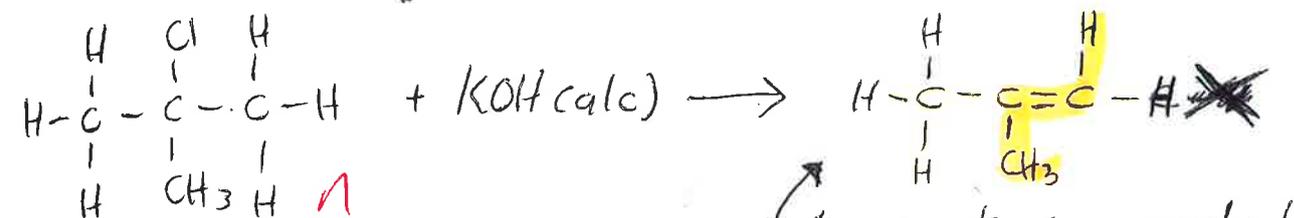
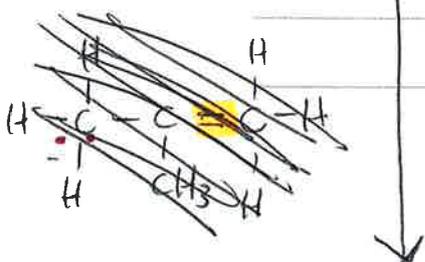
Primary Haloalkane Known as Markovnikov's rule).



Secondary Haloalkane



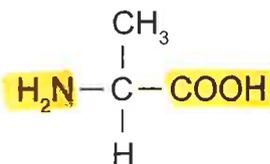
Tertiary haloalkane



* major & minor product are both the same.
2-methylbutene

QUESTION TWO

Alanine is an amino acid. Its structure is shown below.



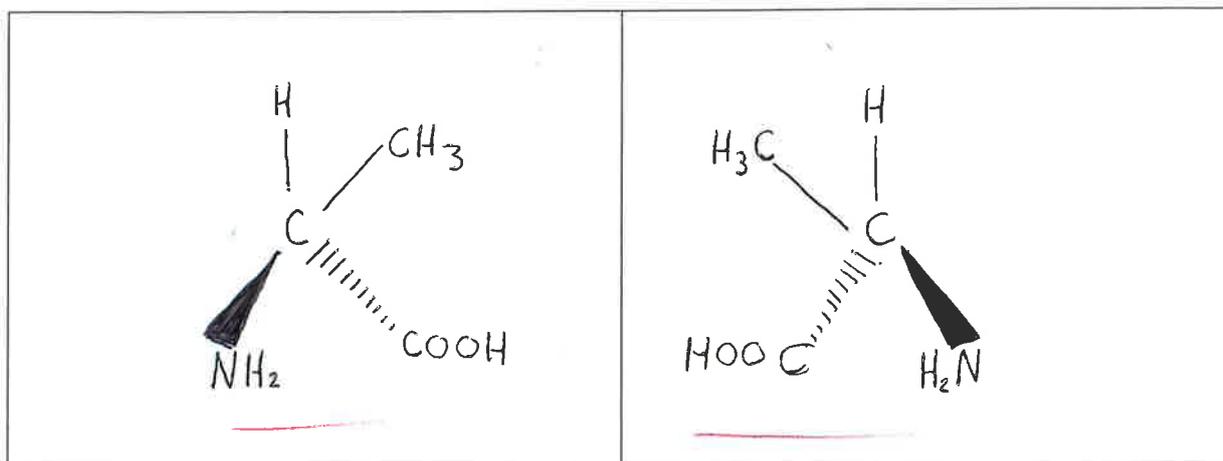
- (a) (i) Describe the structural feature necessary for a compound to exist as enantiomers (optical isomers).

For a compound to exist as an enantiomer, it must have a chiral carbon - an atom attached to four different groups of atoms.

- (ii) Identify one physical property that is the same for both enantiomers of alanine, and one that is different, clearly describing how this property could be used to distinguish between the enantiomers.

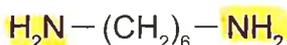
Similarities: Both have same atom groups & molecular formula. Differences: each enantiomer deflects a plane of polarised light in different directions as they are mirror images / superimposable of each other.

- (b) Draw 3-D structures of the enantiomers of alanine in the boxes below.

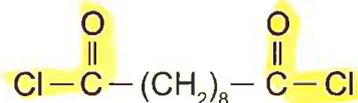


- (c) A form of the polymer nylon can be made from the two monomers below.

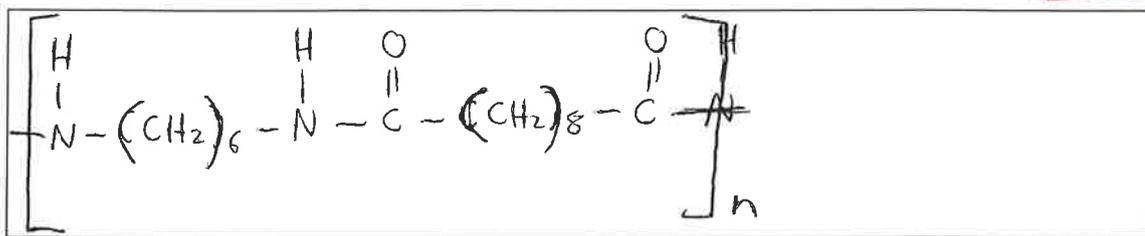
1,6-diaminohexane



Sebacoyl chloride (decanedioyl dichloride)



- (i) In the box below draw the repeating unit of the polymer formed if these two monomers are used.



Consider the formation of this form of nylon in a laboratory.

- (ii) Describe the type of reaction occurring, and explain why this reaction results in a polymer.

~~This form of nylon~~ This polymer is a condensation polymer formed by the removal of a small molecule either ~~water~~ water (H₂O) or HCl. In this case, HCl is removed. Condensation polymers undergo a reaction called hydrolysis where H₂O is removed, although in this case we have a diacid chloride that if reacted ~~with~~ ^{with} water, will react vigorously.

- (iii) Explain why sebacoyl chloride is dissolved in a non-polar organic solvent rather than in water.

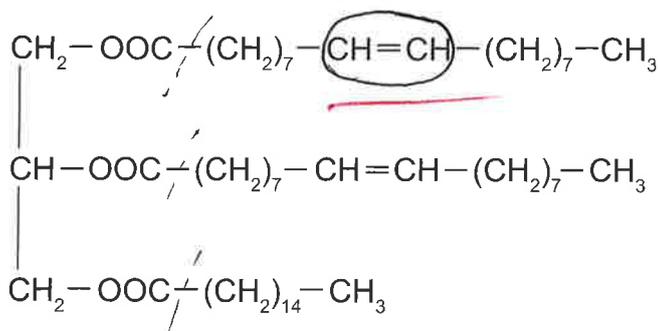
~~Because it undergoes the removal of HCl instead~~
 • Sebacoyl chloride is an acid chloride that reacts vigorously with water. Therefore, it must react with a non-polar organic solvent to avoid this vigorous reaction.

- (iv) Elaborate on the reaction that will occur if a dilute aqueous solution of acid is mixed with the newly formed polymer.

• If a dilute aqueous solution of acid is mixed with the newly formed polymer, a carboxylate salt (COO^-) & OH^- will be formed.

QUESTION THREE

- (a) A triglyceride has the following structure:



- (i) Circle one of the alkene groups in the triglyceride molecule.

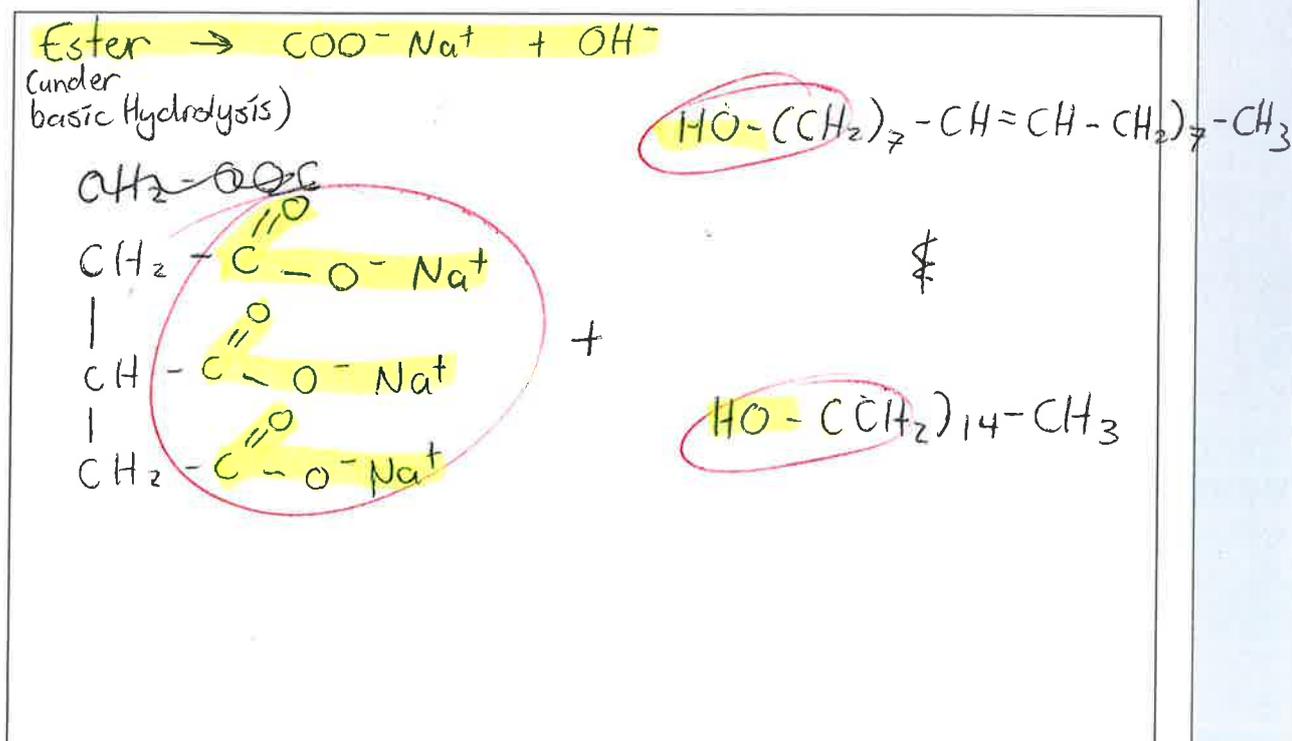
This triglyceride is described as unsaturated.

- (ii) Describe a chemical test that can be used to show that the molecule is unsaturated.

Give any observations, and state the type of reaction occurring.

• By adding the ester to water, it should form two layers because it is immiscible in water. If not / molecule is unsaturated it will dissolve in water.

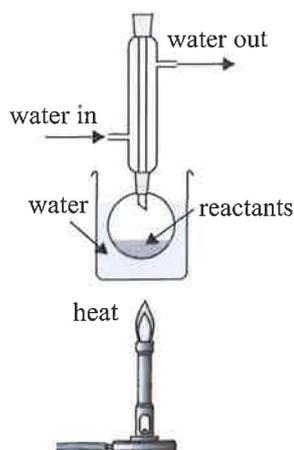
- (iii) Draw the structural formulae of the organic products formed by hydrolysis of this triglyceride using aqueous sodium hydroxide.



• ester.
~~sub~~
 COOH
 $+ \text{OH}^-$
 H_3O^+

(iv) Explain why the equipment below is used for hydrolysis of the triglyceride.

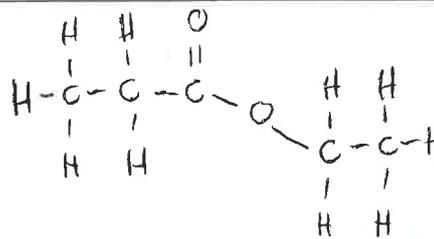
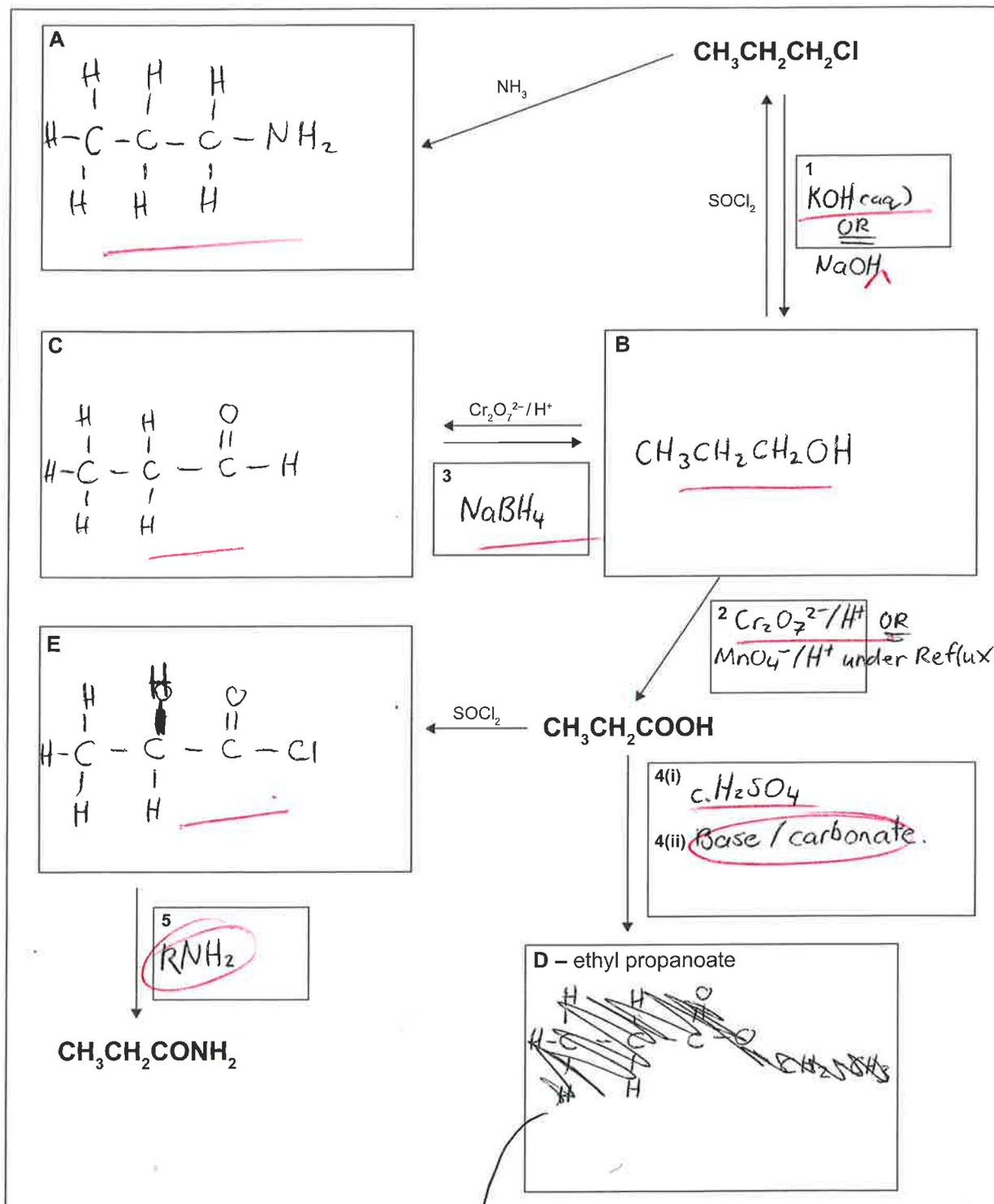
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- This process is called reflux. The reactants are heated and evaporated. As they are evaporated, the ~~oscillating~~ water ~~and~~ condenses the solution & it falls back into the flask so that the mixture can keep reacting.
- It is used for hydrolysis as it removes H_2O (using a dehydrating agent) & volatile substances driving the reaction to completion.

Question Three continues
on the following page.

- (b) Complete the following reaction scheme by drawing the structural formulae of the organic compounds A to E, and identifying reagents 1 to 5.



**Extra paper if required.
Write the question number(s) if applicable.**

QUESTION
NUMBER

ASSESSOR'S
USE ONLY

Grade score 11 – Higher Achievement

Q1

(c)(ii) Lacking in the depth of explanations and reasons for type of reaction and formation of products

Q2

(a)(ii) Lacking one physical property that is the same for both enantiomers

(c)(ii) Reference to why a polymer is formed missing

(c)(iv) Elaboration including the type of reaction and products produced required

Q3

(a)(ii) Incorrect chemical test

(a)(iii) Structural formulae incorrect

(a)(iv) Reflux is used to increase the rate of reaction

(b) The use of the generic R-NH₂ is not a specific reagent