3

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91391

913910

NZQA

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QUALIFY FOR THE FUTURE WORLD
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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.

Excellence

TOTAL 22

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QUESTION ONE

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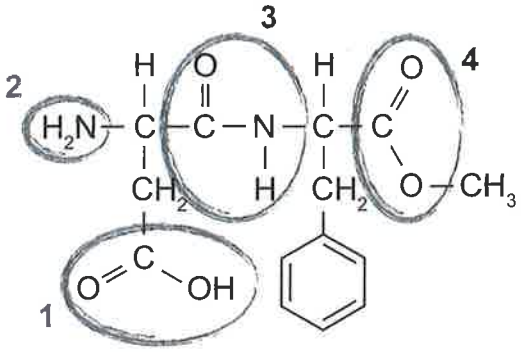
(a) The structure of aspartame is given below. Aspartame is often used as an artificial sweetener in drinks.



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

1	1° amine group
3	2° amide group ~~(amide link)~~

2	carboxylic acid group
4	ester group

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

IUPAC systematic name	Structural formula
propanoyl chloride	$CH_3-CH_2-C(=O)-Cl$
3-bromopentan-2-one	$CH_3-C(=O)-CH(Br)-CH_2-CH_3$
2-methylbutanal	$CH_3-CH_2-CH(CH_3)-C(=O)-H$ ~~CH_3~~ ~~CH_3~~

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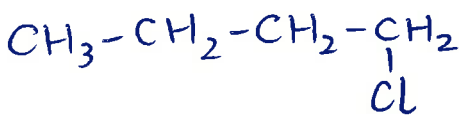
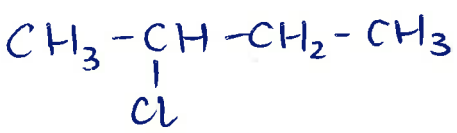
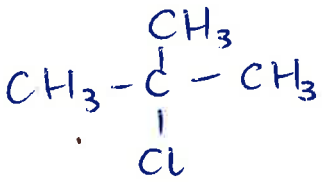
(c) (i) In the boxes below, draw the three structural isomers of C_4H_9Cl that represent a primary, secondary and tertiary haloalkane.

Primary haloalkane	Secondary haloalkane
	

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.

A haloalkane will react with KOH (alc) in an elimination reaction, as the chlorine ~~group~~ and a hydrogen ~~atom~~ attached to a carbon adjacent to the carbon that has the chlorine attached, are removed from the organic molecule as a molecule of HCl, and replaced by

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

a double bond, which results in the organic product being less saturated (than the organic reactant). 1-chlorobutane will produce but-1-ene. 2-chlorobutane will produce a major product, but-2-ene, and a minor product, but-1-ene, ~~The major product~~ as there are two places for the double bond to form and the molecule is not symmetrical. The major product arises when the hydrogen ~~atom~~ is lost from the carbon adjacent to the chlorine ~~atom~~ with the least number of hydrogen atoms attached. (Hence but-2-ene is major and but-1-ene is minor). 2-chloro-2-methyl ~~pro~~ will produce 2-methylpropene; although there is more than one place for the double bond to form, there is only one product because the organic reactant is symmetrical.

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E7

QUESTION TWO

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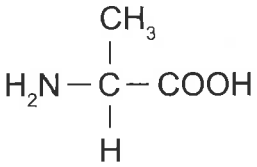
Alanine is an amino acid. Its structure is shown below.



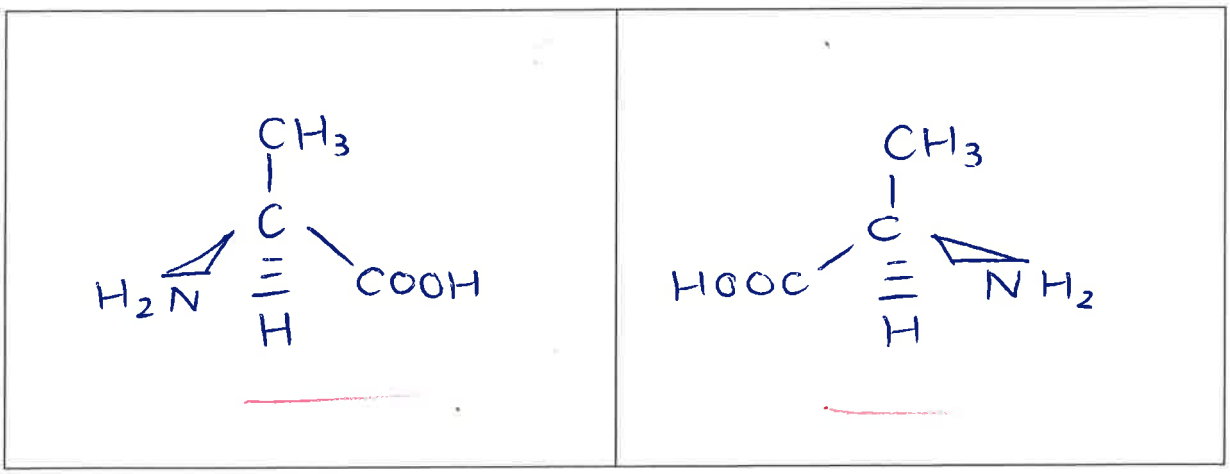
(a) (i) Describe the structural feature necessary for a compound to exist as enantiomers (optical isomers).

The compound must be chiral - one of the carbon atoms must have four different groups attached.

(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.

Both enantiomers of alanine will have the same boiling point. In contrast, the two enantiomers will rotate plane polarised light in opposite directions. Hence, the enantiomers could be identified by exposing them to plane polarised light, and observing whether the light is rotated left or right.

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



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

1,6-diaminohexane

$$H_2N-(CH_2)_6-NH_2$$

Sebacoyl chloride (decanedioyl dichloride)

$$Cl-\overset{\overset{O}{\|}}{C}-(CH_2)_8-\overset{\overset{O}{\|}}{C}-Cl$$

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

$$\left(NH-(CH_2)_6-NH-\overset{\overset{O}{\|}}{C}-(CH_2)_8-\overset{\overset{O}{\|}}{C}\right)_n$$

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 reaction is an example of condensation polymerisation, as the nitrogen substitutes for the chlorine with the loss of a small molecule - HCl - across each (amide) ~~linkage~~ join. This reaction results in a polymer because each monomer has ~~two~~ a functional group on ~~each~~ either end, thus can produce ~~two~~ a linkages to ~~two different~~ other monomers. ~~The propagation step can~~ ~~continue indefinitely.~~

This allows a chain to form.

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

Sebacoyl chloride ~~is~~ is an acid chloride and will react violently with water to produce a carboxylic acid. It is therefore dissolved in a non-polar organic solvent instead.

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

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The polymer is a polyamide, and will undergo acid hydrolysis in the presence of dilute acid. (and water). This will produce the 1,6-diaminohexane polymer as an ammonium salt, $H_2N^+-(CH_2)_6-H_2N^+$, and the acid chloride polymer as its equivalent carboxylic acid, $HOOC(CH_2)_8COOH$.

~~acid chloride, Cl~~ ~~COCl~~ ~~$Cl-C-(CH_2)_8-C$~~

07

E7

QUESTION THREE

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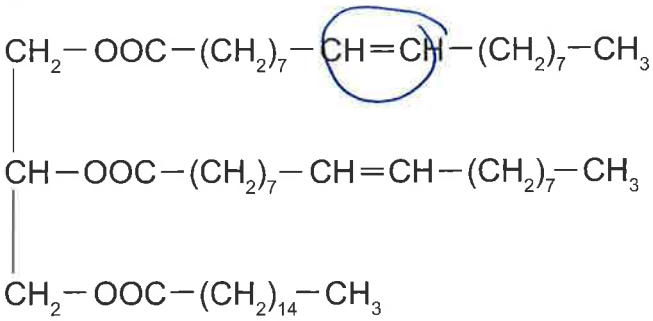
(a) A triglyceride has the following structure:



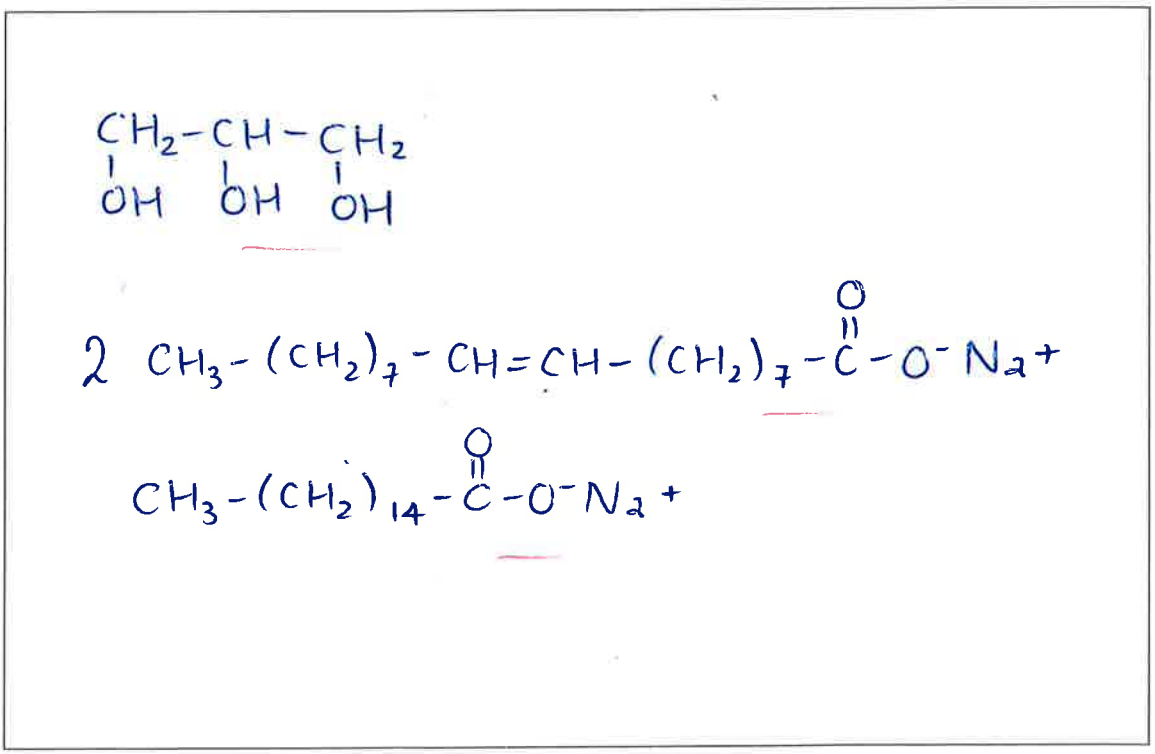
(i) Circle one of the alkene groups in the triglyceride molecule.

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.

Add bromine water to a sample of the triglyceride and shake. The orange bromine water will rapidly decolourise as an addition reaction occurs: a bromine molecule is added across each double bond. ✓✓

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



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

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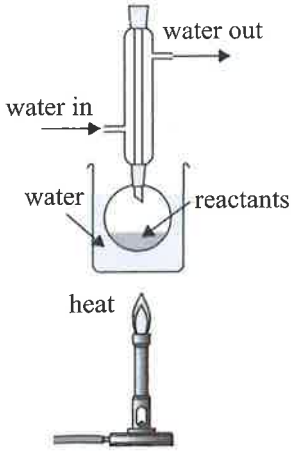
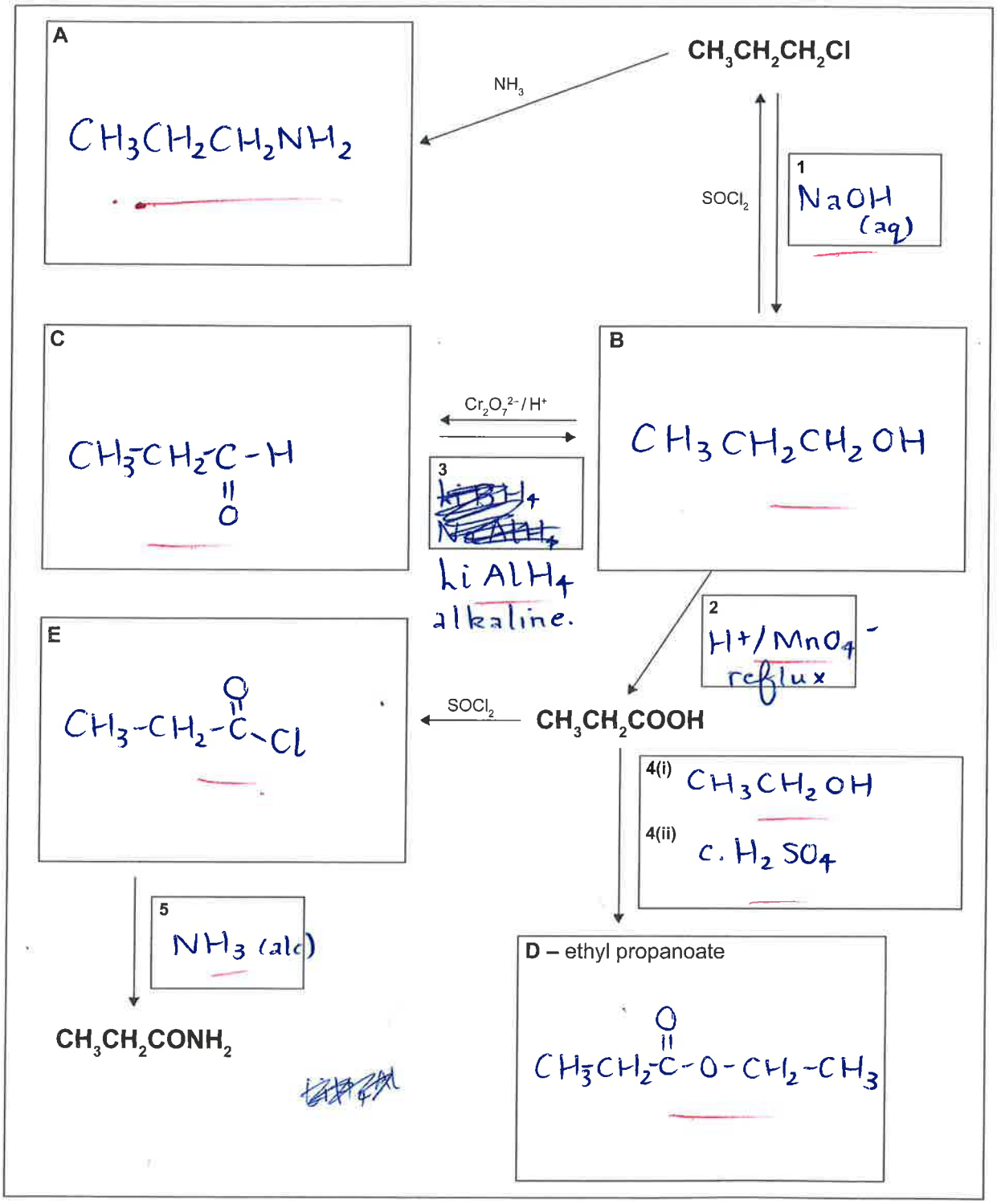


The triglyceride is heated under reflux in this hydrolysis reaction using this refluxer. This allows the rate of the hydrolysis reaction to increase without loss of the volatile organic triglyceride due to evaporation. As the volatile organic substances evaporate, they molecules cool at the condensor and condense back into the mixture. //

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**.



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Write the question number(s) if applicable.

QUESTION NUMBER

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

QUESTION NUMBER

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Grade score 22 – Excellence

Q1

(a) Amine and carboxylic acid around the wrong way

(c)(ii) Very good discussion. In order to achieve E8 the candidate needed to identify all products formed, which include geometric isomers of but-2-ene

Q2

(c) The candidate stated the ammonium salt was produced however, wrote the formula incorrectly

Q3

Everything is correctly answered.