91391

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

3

SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2014

91391 Demonstrate understanding of the properties of organic compounds

2.00 pm Tuesday 11 November 2014
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–15 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 23

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QUESTION ONE

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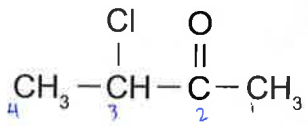
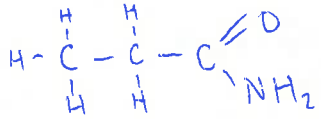
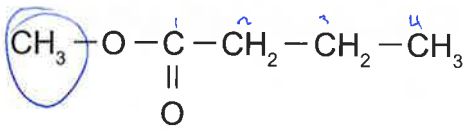
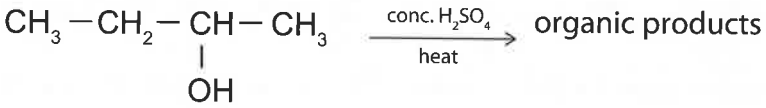
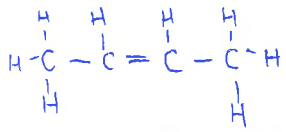
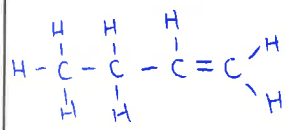
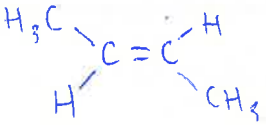
(a) Complete the table below giving the IUPAC systematic name or the structural formula for each compound.

Structural formula	IUPAC systematic name
	3-chloro butan-2-one / 3-chloro butanone
	propanamide
	methyl butanoate

(b) When butan-2-ol undergoes a reaction with concentrated H_2SO_4, three possible organic products form, which are isomers of each other.



(i) In the boxes below, draw the three isomers formed during this reaction.

1	2	3
 cis but-2-ene	 but-1-ene	 trans but-2-ene

(ii) Which of the three isomers from part (i) will be formed in the smallest amount? Explain your answer.

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Both isomer 1 and 3 will form in the highest amount as they are the geometric isomers of the major product. But-1-ene will form in the smallest amount, due to being the minor product. This is because butan-2-ol is an assymetric carbon with different numbers of Hs on the Cs adjacent to the carbon with the OH group. But-1-ene occurs when the ~~Hydr~~ carbon with the most hydrogens loses its hydrogen atom, and so this is the minor product due to Zaitseff's rule.

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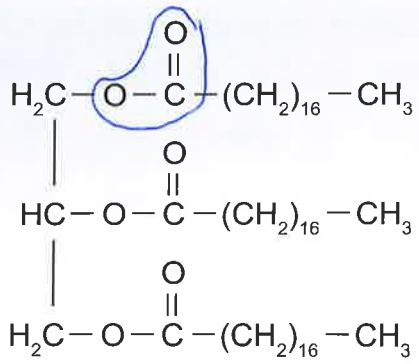
(c) The triglyceride below is shown in condensed form.



(i) Circle a functional group on the diagram above and give its name.

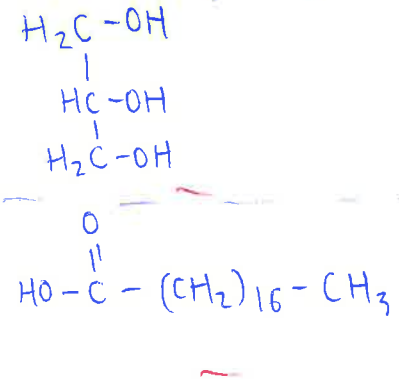
Functional group name: Ester linkage

(ii) Compare and contrast the reaction of the above triglyceride when it undergoes both acidic and basic hydrolysis.

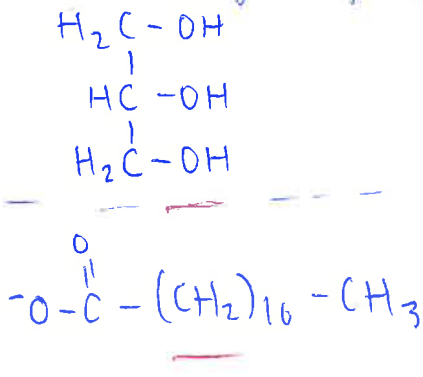
In your answer you should include:

- drawings of condensed structures of the organic products
- any reagents and conditions required for the reaction to proceed.

Acidic Hydrolysis =



Basic Hydrolysis =



The triglyceride will undergo hydrolysis with both dilute acids, such as $HCl_{(aq)}$, and dilute bases, such as $NaOH_{(aq)}$, where the ester linkage will break. In both reactions, a trialcohol (propan-1,2,3-triol) will form, as shown above. However, under acidic conditions and basic conditions, the carbonyl carbon (or group of atoms) will receive a different atom. In acidic conditions, a carboxylic acid group

will form, and this will undergo no further reactions. In basic hydrolysis, the carbonyl carbon ~~doe~~ only receives the O atom, so forms the carboxylate ion. ~~This~~ It will then further reaction with the base in an acid-base reaction, where a salt will form. For instance, with NaOH, the sodium ~~xxx~~ carboxylate salt will form.

A dilute acid ~~and~~ or dilute base is required, and heat will also help the reaction occur.

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QUESTION TWO

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(a) Identify the reagents, conditions required, and observations linked to species, to enable the following pairs of chemicals to be distinguished from each other.

(i) Aqueous solutions of propanamine and propanamide.

Place water dampened red litmus paper in a solution of each. In the propanamine solution, the red litmus paper will turn blue due to the presence of OH^- ions, as propanamine is basic so partially dissociates into OH^- ions in water. Propanamide is not basic, so litmus paper no colour change will be seen.

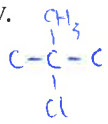
(ii) Propanone and propanal.

Add ~~acidified~~ acidified $Cr_2O_7^{2-}$ to both. With propanal, the orange $Cr_2O_7^{2-}$ will turn blue-green, as propanal will be oxidised to propanoic acid, and $Cr_2O_7^{2-}$ will be reduced to the blue-green Cr^{3+} ion. With propanone, ~~the~~ $H^+/Cr_2O_7^{2-}$ will remain orange, as ~~it is unable~~ propanone is unable to be oxidised further.

(iii) Propanoyl chloride and propyl propanoate.

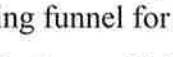
Add a small amount of water to each beaker. Propanoyl chloride will react vigorously in water to produce fumes of HCl gas. $CH_3CH_2C(=O)Cl + H_2O \rightarrow CH_3CH_2C(=O)OH + HCl(g)$.
These fumes can be identified as they are acidic so will ~~form~~ turn water dampened blue litmus paper red. With propyl propanoate, no reaction with water occurs and so ~~the~~ it will remain the same.

(b) Instructions for the preparation of 2-chloro-2-methylpropane are given below.



Read the instructions carefully and answer the questions that follow.

1.	Shake 10 mL of 2-methylpropan-2-ol with 30 mL of concentrated hydrochloric acid in a separating funnel for 10 minutes.
2.	Run off the bottom acid layer and discard it. Add saturated sodium hydrogen carbonate ($NaHCO_3$) to the organic product. Shake, releasing the tap every few seconds to relieve the pressure.
3.	Run off the bottom aqueous layer and discard it. Transfer into a conical flask and add some anhydrous sodium sulfate (Na_2SO_4), and stir thoroughly.
4.	Transfer the organic product into a round-bottom flask, and collect the fraction boiling within 2°C of the boiling point of 2-chloro-2-methylpropane.



$HCl + NaHCO_3 \rightarrow H_2O + CO_2 + NaCl$

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(i) Explain why the solution of sodium hydrogen carbonate is added in instruction 2.

Name the gas produced in this step.

Name of gas formed: CO_2

Explanation: $HCl + NaHCO_3 \rightarrow H_2O + CO_2 + NaCl$. $NaHCO_3$ is basic, and so will neutralise the excess HCl acid which has not been used in replacing the OH group on the main organic molecule.

(ii) Explain why anhydrous sodium sulfate is added in instruction 3.

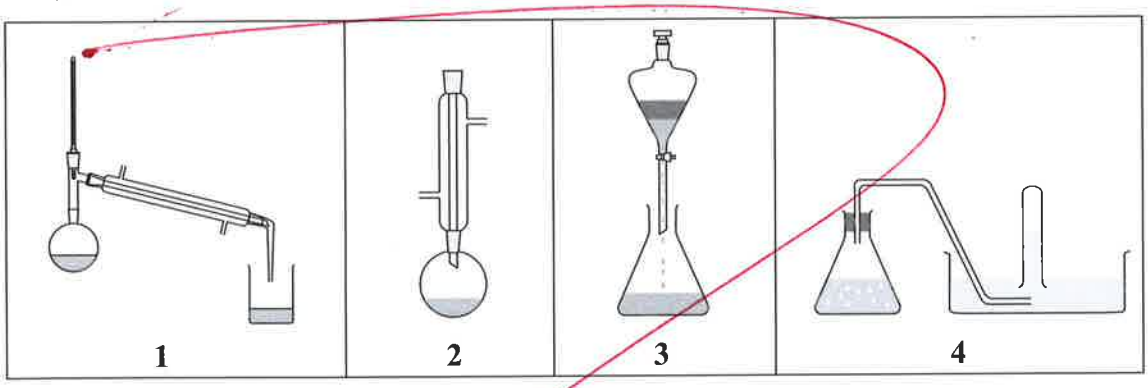
a. Na_2SO_4 acts as a catalyst in the formation of ~~2-ct~~ 2-chloro-2-methyl propane, and speeds up the substitution reaction.

(iii) Name the process used in instruction 4 to purify the organic product.

Process used: Distillation

Write the number of the equipment that a student would use to perform this process from the diagrams below.

Diagram no: 1



(iv) Discuss the process carried out in instruction 4 on page 6.

Include in your answer:

- the purpose of this process
- an explanation of how it works.

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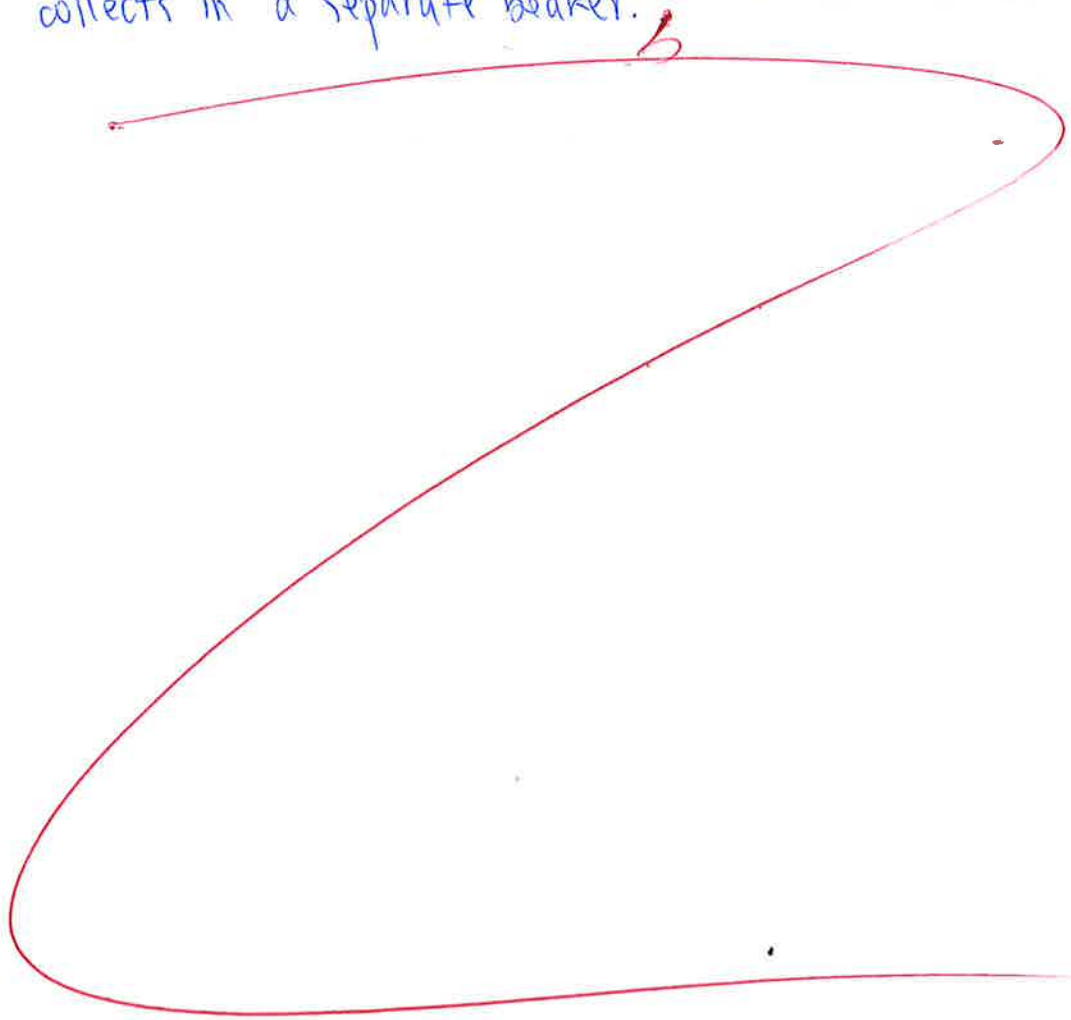
In instruction four, the solution is distilled to extract ~~a pure~~ 2-chloro-2-methylpropane in a pure form, as without ~~distilling~~ distillation the required product is still mixed in with many other molecules so is not in a purified form. Distillation requires the wanted product to have a lower boiling point than the other substances in solution. The flask is heated until it is very close to the boiling point of 2-chloro-2-methyl propane, which is therefore released as a gas, and travels down the condensation column which has cold water flowing around it and therefore the product is cooled into a liquid and collects in a separate beaker.



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The examination continues on the following page.

QUESTION THREE

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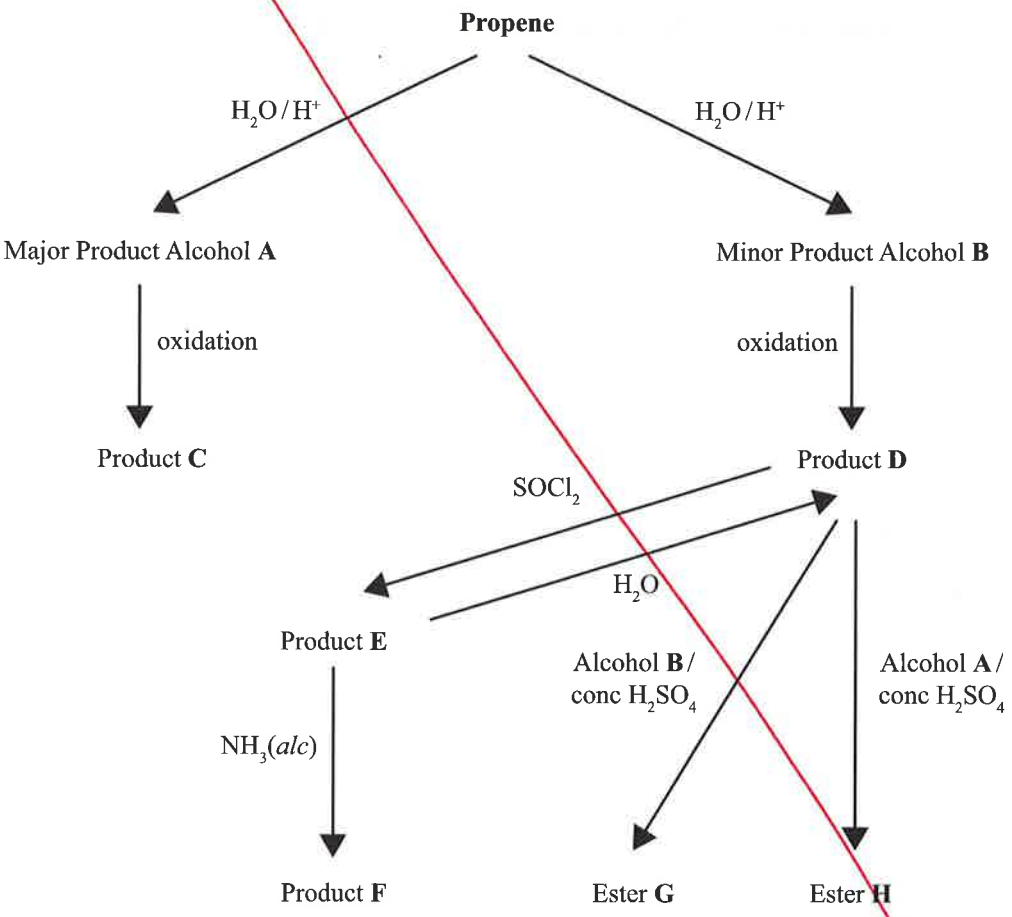
(a) Propene can be reacted with water in the presence of acid to form a major product (**A**) and a minor product (**B**).

- **A** is oxidised to form product **C**.
- **B** is oxidised to form product **D**.
- When **D** is reacted with $SOCl_2$, it forms product **E**.
- When **D** is reacted with alcohol **B**, it forms an **ester G**.
- When **D** is reacted with alcohol **A**, it forms **ester H**, which is an isomer of **G**.
- When **E** is reacted with alcoholic ammonia, it forms product **F**.
- When **E** is reacted with water, it forms product **D**.



Name compounds **A** to **G**, and draw structural formulae for compounds **A** to **H**.

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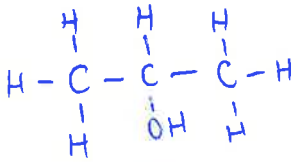
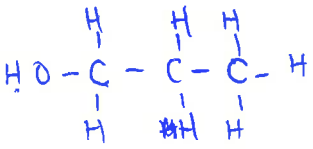
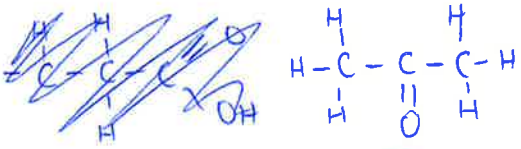
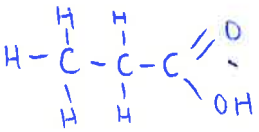
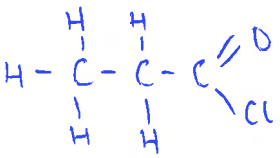
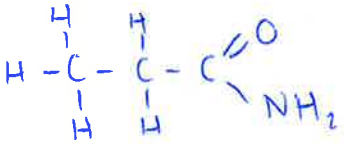
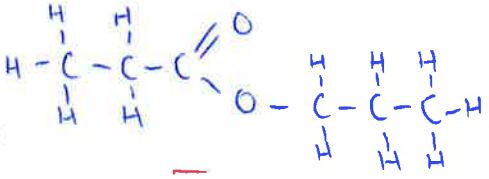
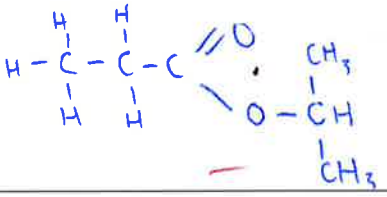
	Name	Structural Formula
A	propan-2-ol	
B	propan-1-ol	
C	propanone	
D	propanoic acid	
E	propanoyl chloride	
F	propanamide	
G	propyl propanoate	
H		

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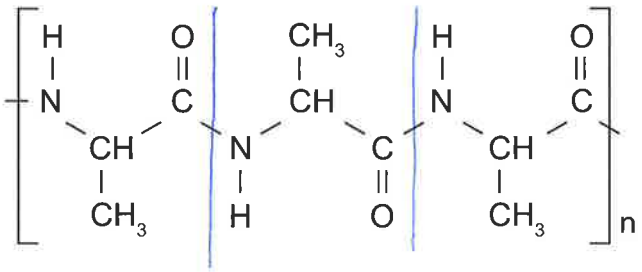
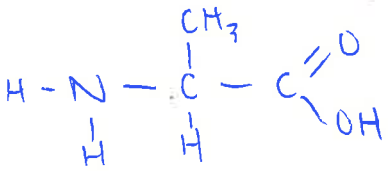
(b) The following polymer will, under the correct conditions, hydrolyse.



(i) Draw the monomer(s) from which this polymer is formed.



(ii) Discuss the hydrolysis of the polymer.

In your answer you should include:

- the conditions under which it can be hydrolysed
- structures of the organic products formed as a result of hydrolysis.

This polymer can be hydrolysed under acidic and basic conditions, with ~~an ac~~ a dilute acid such as HCl, or a dilute base such as NaOH. The hydrolysis will result in the amide linkages breaking, but different products will form.

Under acidic conditions; ~~the N~~ each N atom will gain sufficient H atoms to become a positive ion, in this case, $-NH_3^+$. The carbonyl carbon will form a carboxylic acid.

In basic hydrolysis, the N atom will gain enough

Hs to have ~~a neutro~~ no charge. in this case, an NH_2 group will form. The carbonyl carbon will only receive an O so will form the carboxylate ion. This will then undergo a further acid-base reaction with the base to form a salt. For instance, if dilute NaOH is used, the sodium carboxylate salt will form.

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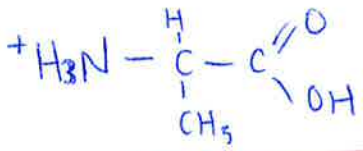
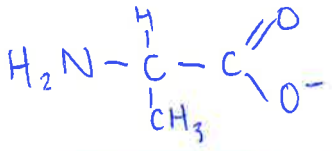
Acidic Hydrolysis:



Basic Hydrolysis:



E7

Excellence

Q1

(b)(ii) Very good explanation identifying what groups are being eliminated and which carbon atoms they are eliminated from

(c)(ii) Very good comparison and contrast using conjunctions. Reagents and all conditions mentioned.

Q2

(a) All species identified fully

(b)(ii) Sodium sulfate is not a catalyst

(b)(iv) a full discussion stating the purpose, the physical property used to separate the chemicals and how the equipment enables this.

Q3

(a) All correct

(b)(ii) A very good discussion with correct structures; however, it is missing heat.