EXCELLENCE.

3

SUPERVISOR'S USE ONLY

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 3 Chemistry, 2013

91391 Demonstrate understanding of the properties of organic compounds

2.00 pm Tuesday 19 November 2013
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 2–11 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.

TOTAL 24

ASSESSOR'S USE ONLY

You are advised to spend 60 minutes answering the questions in this booklet.

ASSESSOR'S USE ONLY

QUESTION ONE

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

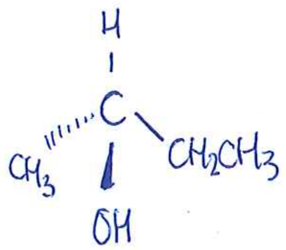
Structural formula	IUPAC systematic name
$HO-CH_2-CH_2-C(=O)H$	3hydroxy propanal
$CH_3-CH_2-C(=O)NH_2$	propanamide
$CH_3-C(=O)-CH_2-CH(CH_3)-CH_3$	4 methyl 2 pentanone

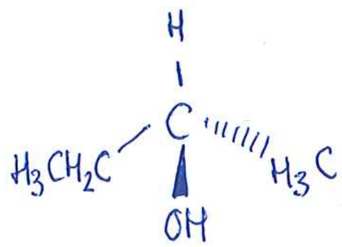
2-pentanone accepted, but pentan-2-one is preferable.

(b) The alcohol below can exist as two enantiomers (optical isomers).

$CH_3CH(OH)CH_2CH_3$

(i) Draw three-dimensional structures for the two enantiomers.





3-D structures are well drawn.

(ii) Link the structure of enantiomers to a physical property that can be used to distinguish them from non-optically active molecules.

Enantiomers are organic molecules that contain an assymetric chiral carbon bonded to four different groups. The mirror images are non-superimposable and they can be distinguished as they rotate the plane of polarised light in opposite directions. 2 butanol is an enantiomer as it has a chiral carbon bonded to four different groups: H, CH_3, OH and CH_2CH_3.

Enantiomer structures are linked to the physical property.

ASSESSOR'S USE ONLY

(c) Draw the structural formulae of three different isomers of $HO-CH_2-CH_2-C(=O)H$, which show the following properties:

- Isomer 1 turns moist blue litmus paper red.
- Isomer 2 is an ester.
- Isomer 3 is a ketone.

Property	**Structural formula**
turns moist blue litmus paper red	$CH_3-CH_2-C(=O)-OH$
is an ester	$CH_3-C(=O)-O-CH_3$
is a ketone	$CH_3-C(=O)-CH_2-OH$

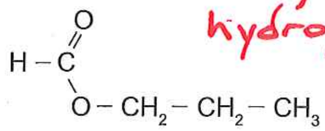
(d) Give the structures and names of the products of the reactions below.

These reactions are carried out by heating in either:

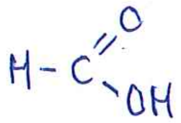
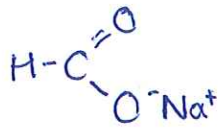
- dilute hydrochloric acid solution, or
- dilute sodium hydroxide solution.

All products correctly identified, plus acid/base hydrolysis explained.

ASSESSOR'S USE ONLY



dilute hydrochloric acid solution → | dilute sodium hydroxide solution →

	$HO-CH_2-CH_2-CH_3$		$HO-CH_2-CH_2-CH_3$
Name: methanoic acid	Name: propan-1-ol	Name: sodium methanoate	Name: propan-1-ol

Compare and contrast the reactions above.

In your answer, you should include the type of reaction(s) taking place.

In the first reaction between propyl methanoate and dilute HCl, the ester is undergoing hydrolysis under acidic conditions to produce a carboxylic acid and an alcohol. In contrast, in the second reaction propyl methanoate is undergoing hydrolysis under basic conditions to produce ~~an alcohol~~ the same alcohol as reaction 1 but also a carboxylate salt. This is because, once ~~the~~ methanoic acid is formed, it then reacts with the base in solution to form sodium methanoate

E8

ASSESSOR'S USE ONLY

QUESTION TWO

(a) For the following conversions, identify the reagent required, and state the type of reaction occurring.

(i) Pentan-2-one is converted to pentan-2-ol.

Reagent required: $NaBH_4$

Type of reaction: Reduction reaction (redox)

(ii) Butan-2-ol is converted to a mixture of but-1-ene and but-2-ene.

Reagent required: conc. H_2SO_4

Type of reaction: Elimination

(iii) Discuss the reaction occurring in (ii) above, with reference to the structures of the organic reactant and products.

In reaction (ii) Butan-2-ol is undergoing an elimination reaction where H and OH are removed in place for a double bond C=C. This means the saturated butan-2-ol molecule becomes unsaturated about the double bond. There are two possible products, one major and one minor. The major product, according to Zaitsev's rule is the molecule where the C=C bond is situated where the C with the least number of hydrogens ~~loses a hydrogen~~ either side of the C-OH, loses a hydrogen, which in this case is but-2-ene making the minor product but-1-ene.

Zaitsev's rule stated and partly described.

(b) Discuss the laboratory procedures used to convert butan-1-ol into butanal, and butan-1-ol into butanoic acid.

ASSESSOR'S USE ONLY

In each discussion, you should:

- outline the process for each conversion
- state and justify the type of reaction occurring
- identify the reagents used, and explain any observations made.

Butan-1-ol to butanal: Good description of distillation.

Butan-1-ol must be oxidised in a distillation tube ~~to form~~ butanal. The distillation tube allows butanal to be separated from the reaction mixture (as it is volatile) and then condensed in a separate flask as it moves down the distillation tube. The reaction ~~[illegible]~~ of butan-1-ol to form butanal is an oxidation reaction as the C-OH group is oxidised to a carbonyll C=O group on the end ~~of~~ the carbon. An oxidant such as $Cr_2O_7^{2-}$ must be used and a colour change from orange $Cr_2O_7^{2-}$ to green Cr^{3+} will be observed in the process of oxidation. $Cr_2O_7^{2-}$ needs to be acidified.

Butan-1-ol to butanoic acid:

Butan-1-ol must undergo an oxidation/reduction reaction to ~~form~~ butanoic acid, as the C-OH group is oxidised to COOH carboxyll group. For this reaction to occur, an oxidant must be used, such as ~~[illegible]~~ $Cr_2O_7^{2-}$ and the conditions must be warm and acidic. ~~[illegible]~~ This reaction must take place under reflux so that no volatile products made during the reaction, can escape the system. Butanal is a volatile substance and butan-1-ol must oxidise to this first so it is essential to do the reaction in closed conditions to make sure nothing escapes. If the oxidant being used is $Cr_2O_7^{2-}$ then a colour change from orange to green will be observed as orange $Cr_2O_7^{2-}$ reduces to green Cr^{3+}

(c) Devise a method for distinguishing between the three liquid compounds, butan-1-ol, butanoic acid, and butanoyl chloride, using only blue litmus paper and water.

Explain each of the observations in your method, with reference to the structure of the organic compounds.

First add H_2O to each sample. The butanoyl chloride will react vigorously while it undergoes a substitution reaction to form butanoic acid and HCl. (as the Cl is substituted for an OH group) The butanoic acid will show no observable change. The butan-1-ol will ~~also show~~ form two layers with water as it is immiscible (due to long non-polar carbon chain) ~~no observable change~~. Adding blue litmus to the solutions, butan-1-ol will show no change while butanoic acid and butanoyl chloride (+ water) solution will turn the litmus paper red

$CH_3CH_2CH_2COCl + H_2O \rightarrow CH_3CH_2CH_2COOH + HCl$

$CH_3CH_2CH_2COOH + H_2O \rightleftharpoons CH_3CH_2CH_2COO^- + H_3O^+$ acidic

Feasible method outlined with reference to structures.

ASSESSOR'S USE ONLY

E8

QUESTION THREE

ASSESSOR'S USE ONLY

(a) (i) Three alcohol compounds are listed below.

methylpropan-2-ol butan-1-ol butan-2-ol

Compare and contrast the structures of the compounds above.

~Alcohols have been contrasted AND Compared.

Butan-1-ol is a primary alcohol as the hydroxy group is bonded to a terminal carbon that is only bonded to one other carbon. Butan-2-ol is a secondary alcohol as the hydroxy group is bonded ~~to~~ to a middle carbon bonded to two other carbons. Methylpropan-2-ol is a tertiary alcohol as the hydroxy group is bonded to a carbon which is bonded to three other carbons. All three of these alcohols are structural isomers as they have the same molecular formula.

(ii) Describe how you could distinguish between the alcohols in (i) above, using chemical tests on the alcohols and/or their oxidation products.

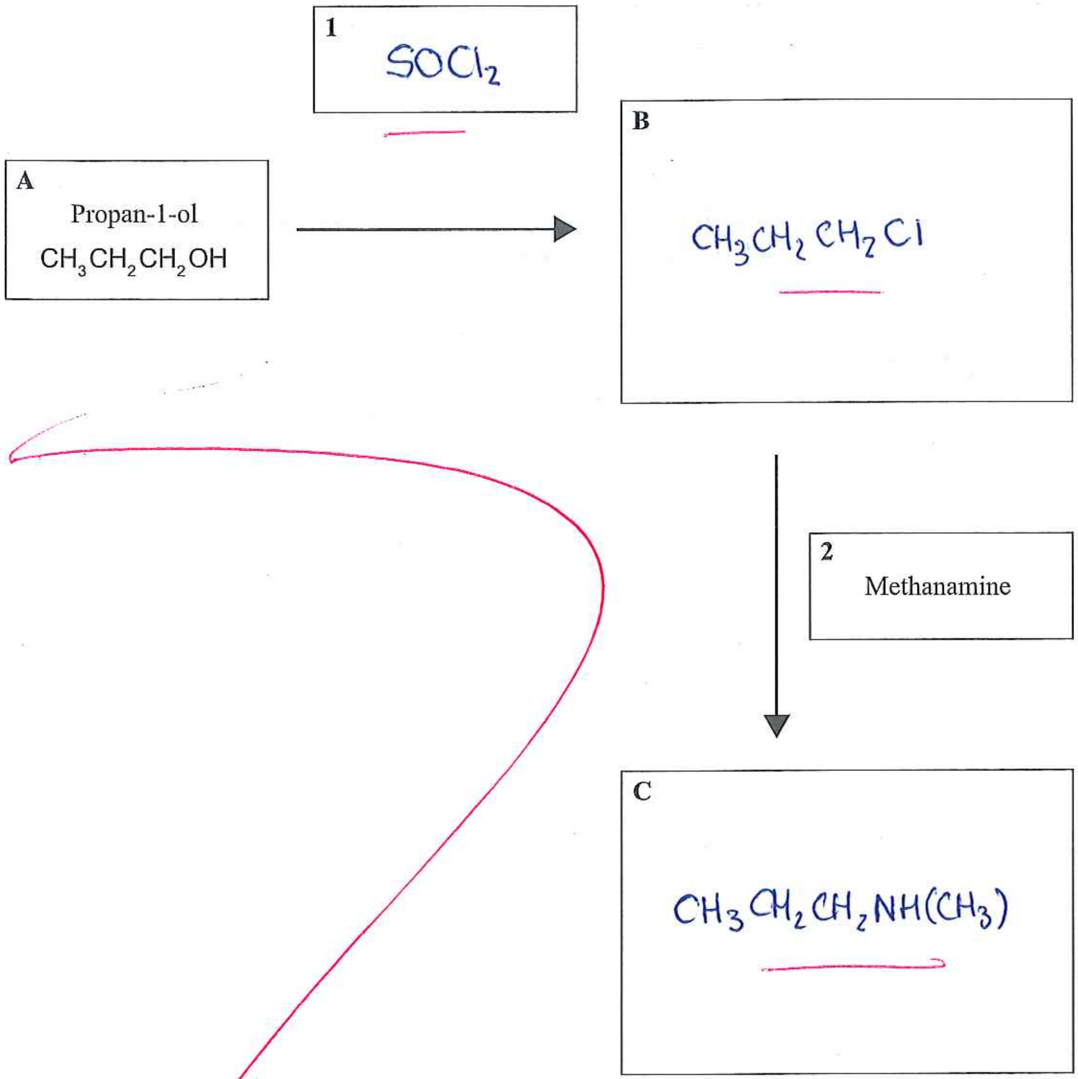
~Feasible method outlined with reference to observations.

Adding $H^+/Cr_2O_7^{2-}$ to all three samples. Butan-1-ol and Butan-2-ol will oxidise to form Butanal and butanone respectively. This will show a colour change from orange to green as $Cr_2O_7^{2-}$ reduces to green Cr^{3+}. ~~But~~ Methylpropan-2-ol will not oxidise as it is a tertiary alcohol and will therefore show no change in colour.
Now add Tollen's Reagent. Butanal will oxidise further to butanoic acid and the Ag^+ ions will reduce to form a silver mirror on the glass of the test tube. Butanone will not oxidise any further and so there will be no observable change. Methylpropan-2-ol will also show no change. Methylpropan-2-ol will be the solution that shows no observable change. Butan-2-ol will be the solution that changes from orange to ~~red~~ green but then does not react with Tollen's and Butan-1-ol will ~~react with~~ be the solution that oxidises in both reactions.

ASSESSOR'S USE ONLY

(b) Complete the following reaction scheme by drawing the structural formulae of the organic compounds **B** and **C**, and identifying reagent **1**.

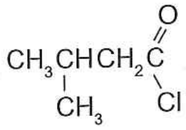
Include any necessary conditions, needed to bring about the transformation from reactant **A** to the organic compound **C**, which is a **base**.



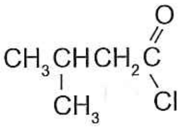
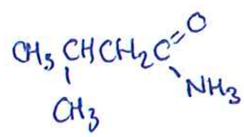
Identified that the secondary amine was basic, thus the intermediate must be a haloalkane.

Question Three continues on the following page.

ASSESSOR'S USE ONLY

(c) When ammonia reacts with  , two products are formed.

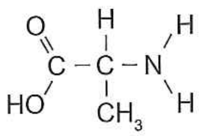
Complete the equation below by naming compounds or drawing the structure.

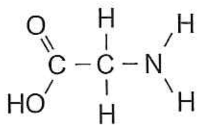
		Structural formula of organic product:		Name of inorganic product:
Ammonia +  Name: 3methyl butanoyl chloride	→		+	Ammonium chloride

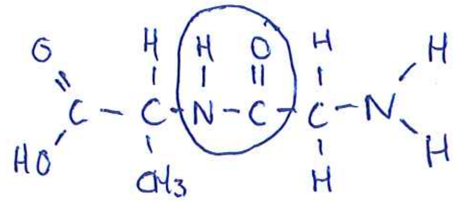
Ammonium chloride OR hydrogen chloride are acceptable.

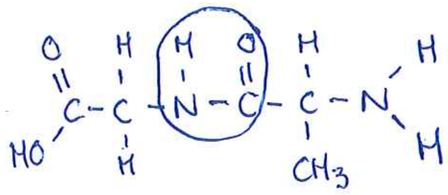
(d) Peptides are formed when amino acids combine.

(i) In the boxes below, show two possible dipeptides that can be formed by combining the amino acids:









(ii) Circle the amide link in each dipeptide.

E8