LOW ACHIEVEMENT.

3

3:54

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 08

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
$HO-CH_2-CH_2-C(=O)-H$	butanal.
$H-C(H)(H)-C(H)(H)-C(=O)-NH_2$ $CH_3CH_2C(=O)-NH_2$	propanamide
$CH_3-C(=O)-CH_2-CH(CH_3)-CH_3$	4- methylpent-2- one. missing 'an' in 4-methylpentan-2-one

(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.

$H_3C-C(H)(OH)-CH_2CH_3$	$H_3CH_2C-C(H)(OH)-CH_3$

ASSESSOR'S USE ONLY

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

Enantiomers must have a chiral carbon / asymmetrical carbon which has four different functional groups attached to it. Enantiomers must also be able to rotate the plane of polarised light. One enantiomer will rotate it clockwise (d) and the other anticlockwise (l).

enantiomers do not require four different 'functional' groups.

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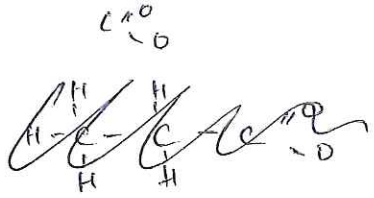
(c) Draw the structural formulae of three different isomers of $HO-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$, which show the following properties:

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

$C_3H_6O_2$.

Property	Structural formula
turns moist blue litmus paper red carboxylic acid.	$CH_3-CH_2-C(=O)-OH$.
is an ester 	$CH_3-C(=O)-O-CH_3$.
is a ketone $C=O$.	$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-OH$.

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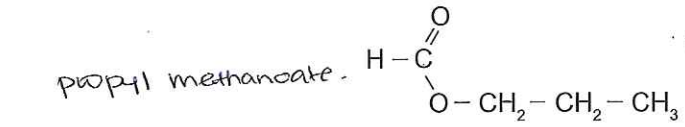
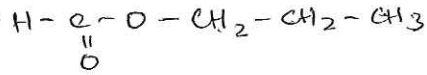
ASSESSOR'S USE ONLY

(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.

propyl methanoate. 



dilute hydrochloric acid solution

dilute sodium hydroxide solution

Name: _____	Name: _____	Name: _____	Name: _____
_____	_____	_____	_____

Compare and contrast the reactions above.

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

The type of reaction taking place is addition. This is because the double bond in the alkene is being broken to form two new products which one is the minor and the other is major.

Does not understand hydrolysis reactions.

N2

QUESTION TWO

ASSESSOR'S USE ONLY

(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 reaction)

(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 reaction.

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

Pentan-2-one converted to pentan-2-ol is a reduction reaction as a ketone is being reduced back to a secondary alcohol.

$CH_3-\underset{\underset{O}{\|}}{C}-CH_2-CH_2-CH_3 + NaBH_4 \rightarrow CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CH_2-CH_3$

pentan-2-one — pentan-2-ol.

Butan-2-ol being converted to but-1-ene and but-2-ene is an elimination reaction as a functional group (OH) is eliminated and a double bond is formed. This results in a minor and major product.

$CH_3-\underset{\underset{OH}{|}}{CH}=CH_2-CH_3$ (Butan-2-ol) + conc. H_2SO_4

Major product: $CH_3-CH=CH-CH_3$. But-2-ene.

Minor product: $CH_2=CH-CH_2-CH_3$

Needed to elaborate on the elimination reaction - water is removed. Also an explanation on why the two products are produced.

(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:

Distillation needed to be explained.

Butan-1-ol is a primary acid which is being oxidised to butanal which is an aldehyde. The reagent which would be used $Cr_2O_7^{2-}/H^+$. This would show a colour change from orange to green. The reaction which is occuring between this is an oxidation reaction. The mixture is then heated and then goes through the process of distillation. This results in a primary alcohol turning into an aldehyde.

Oxidation must be justified.

Butan-1-ol to butanoic acid:

As mentioned above, butan-1-ol is a primary alcohol which is being oxidised to butanoic acid which is a carboxylic acid. The reaction occuring is an oxidation reaction. The reagent which can be used is $Cr_2O_7^{2-}/H^+$ which goes from orange to green or MnO_4^-/H^+ which goes from purple to colourless. The ~~reaction~~ The mixture than has to go through the process of reflux which results in the primary alcohol turning to a carboxylic acid.

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(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.

ASSESSOR'S USE ONLY

To distinguish butanoic acid which is a carboxylic acid, blue litmus paper could be used. In a test-tube, pour 5-6 drops of butanoic acid. ~~Add~~ Drop a piece of moist blue litmus paper into the test tube. If the litmus paper turns red, a carboxylic acid is present (butanoic acid).

To distinguish butanoyl chloride which is an acyl chloride, a test tube of water can be used. Pour a few drops of butanoyl chloride into the test tube with water in it and this will result in the acyl chloride to vigorously react with the water to produce white HCl fumes.

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The litmus paper must be damp for the observation to be made.

A4

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.

Butan-1-ol is a primary alcohol as the functional group (-OH) is attached to a carbon which is attached to only one other carbon. → $CH_3CH_2CH_2CH_2OH$.

Butan-2-ol is a secondary alcohol is a secondary alcohol as the (-OH) group is attached to a carbon which is attached to 2 other carbons. → $CH_3CH(OH)CH_2CH_3$.

Methylpropan-2-ol is a tertiary alcohol.

→ back

The alcohols have been contrasted but not compared.

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

Methylpropan-2-ol is a tertiary alcohol. This means that it cannot be oxidised to form any other product.

Butan-2-ol can be oxidised using $Cr_2O_7^{2-}/H^+$ or MnO_4^-/H^+ which will result in a ketone being formed. However, a ketone cannot be oxidised any further as it is unreactive when tested. A ketone however can be reduced back to a secondary alcohol using $NaBH_4$.

Butan-1-ol can be oxidised to an aldehyde using $Cr_2O_7^{2-}/H^+$ and then heated and goes through the distillation process. It can also be oxidised further using $Cr_2O_7^{2-}/H^+$ or MnO_4^-/H^+ and then refluxed to produce a carboxylic acid. The aldehyde too, like the ketone, can be reduced back to a primary alcohol with the help of the reagent $NaBH_4$

The description needed to include observations.

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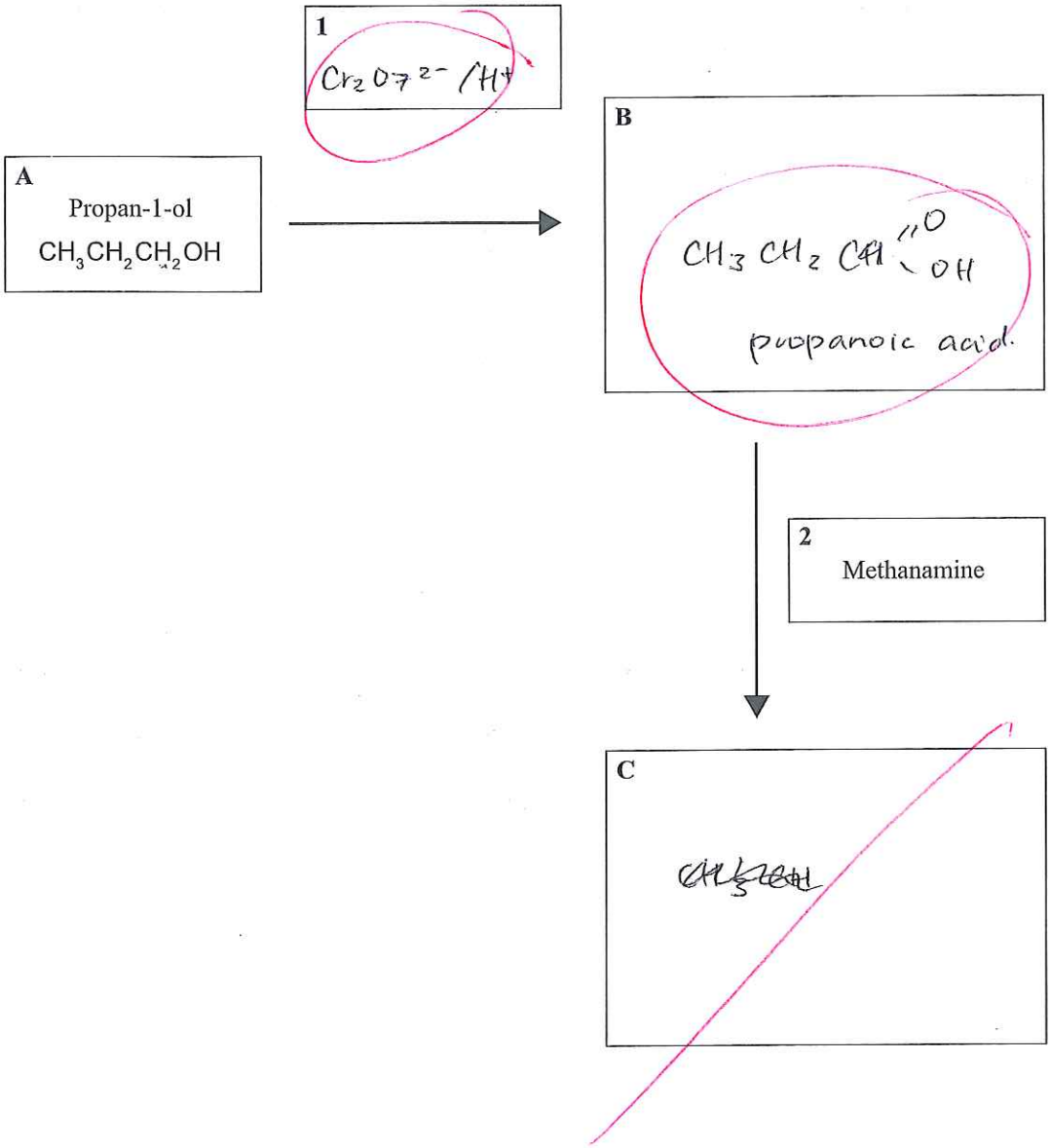
ASSESSOR'S USE ONLY

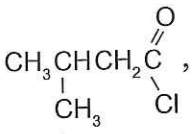
(b) Complete the following reaction scheme by drawing the structural formulae of the organic compounds **B** and **C**, and identifying reagent **1**.

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



Question Three continues on the following page.

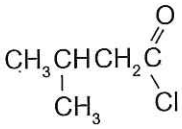
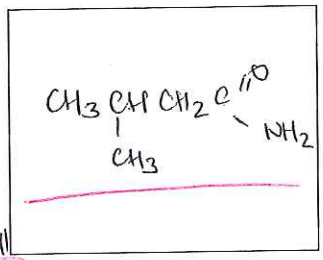
ASSESSOR'S USE ONLY

(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 +  → 

+ 3- methyl butanamide

Name:

3-methyl-butanoyl chloride

The name needed to be the inorganic product.

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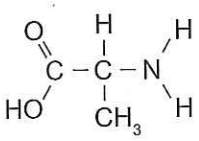
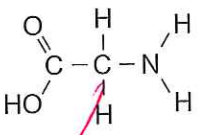
(d) Peptides are formed when amino acids combine.

(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.

N2

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

3a (i) butan-1-ol can be oxidised to an aldehyde or further to a carboxylic acid. Butan-2-ol can be oxidised to a ketone but no further. Methylpropan-2-ol can not be oxidised to any other product. Butan-2-ol and Butan-1-ol can be reduced using $NaBH_4$ while methylpropan-1-ol cannot.

HIGH ACHIEVEMENT

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SUPERVISOR'S USE ONLY

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TOTAL 12

ASSESSOR'S USE ONLY

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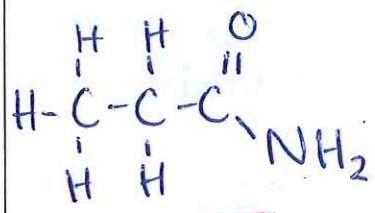
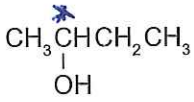
ASSESSOR'S USE ONLY

QUESTION ONE

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

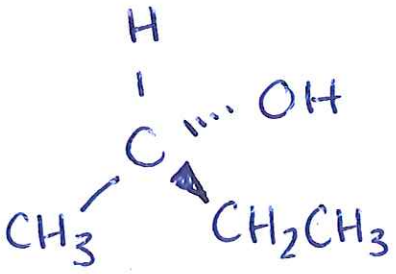
Structural formula	IUPAC systematic name
$HO-CH_2-CH_2-C(=O)-H$	3-oxopropanal
	propanamide
$CH_3-C(=O)-CH_2-CH(CH_3)-CH_3$	4-methylpentan-2-one

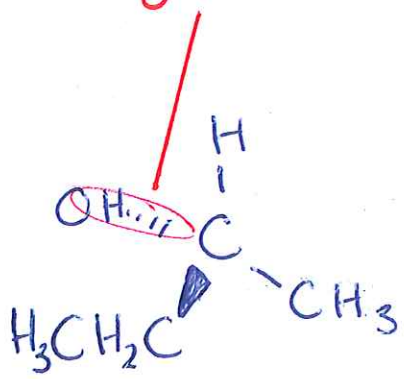
(b) The alcohol below can exist as two enantiomers (optical isomers).



The central C atom must bond to the O of the hydroxyl group.

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





ASSESSOR'S USE ONLY

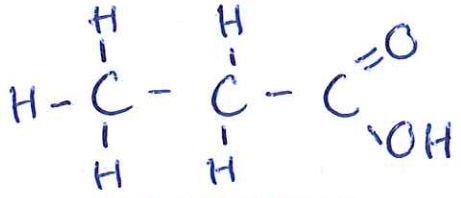
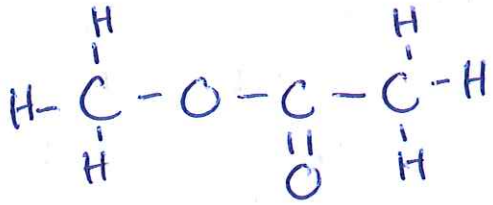
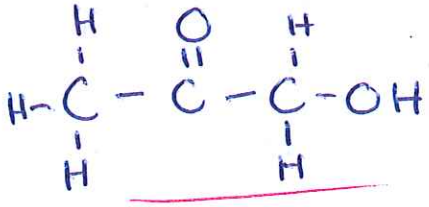
(ii) Link the structure of enantiomers to a physical property that can be used to distinguish them from non-optically active molecules.

Enantiomers can ~~be distinqui~~ only exist when there is a chiral carbon that is bonded to four different structural groups. They can be distinguished as they bend polarised light at different angles.

Enantiomers rotate, not bend, plane polarised light.

(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	
is an ester	
is a ketone	

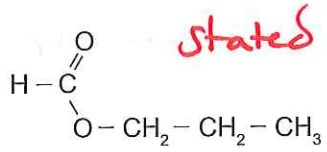
(d) Give the structures and names of the products of the reactions below.

These reactions are carried out by heating in either:

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

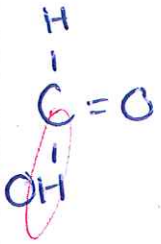
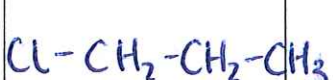
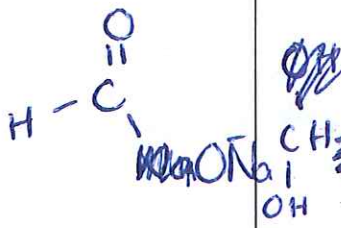
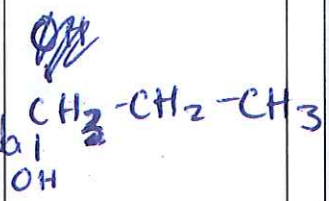
ASSESSOR'S USE ONLY

Most products were identified, however, hydrolysis was not stated nor explained.



dilute hydrochloric acid solution — HCl

dilute sodium hydroxide solution — NaOH

			
Name: methanoic acid	Name: ~~1-chloro~~ propane	Name: sodium methanoate	Name: ~~propan-1-ol~~ ~~propane~~ propan-1-ol

Compare and contrast the reactions above.

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

In both instances addition reactions are occuring. In the presence of the HCl acid an acidic product was formed, HCOOH (methanoic acid), along with a haloalkane, $CH_3CH_2CH_2Cl$. Whats different in the NaOH reaction is that in the presence of a basic solution a basic product is formed, sodium methanoate, as well as an alcohol, propan-1-ol. 4

A4

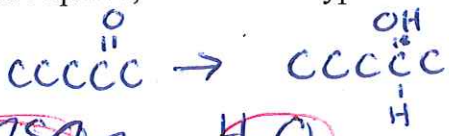
A4

QUESTION TWO

ASSESSOR'S USE ONLY

(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: dilute H_2SO_4 H_2O

Type of reaction: addition Reduction not understood.

(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 order to convert an alcohol to an alkene an elimination reaction must take place. As H_2O needs to be eliminated a dehydrating reagent is required, conc. H_2SO_4. As Butan-2-ol is a secondary alcohol an elimination reaction will form both major and minor products. Due to the arrangement of H atoms in Butan-2-ol, these major and minor products are But-2-ene and but-1-ene respectively.

Needed to elaborate on the elimination reaction
- ~ double C=C bond is formed
- ~ explain why two products are formed
- ~ butan-2-ol is asymmetric.

(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:

This is an oxidation reaction, which requires dichromate ~~solut~~ reagent and heat in order to work. As aldehydes are volatile and can also oxidise to form carboxylic acids, a distillation apparatus is required to collect and remove the Butanal from this reaction. //2

Dichromate must be acidified.
Distillation needed to be explained.

Butan-1-ol to butanoic acid:

As primary alcohols, during oxidation reactions, first oxidise to aldehydes which then oxidise to carboxyllic acids, a reflux apparatus is required to collect the volatile aldehydes to allow them to continue undergoing oxidation. For this reaction to occur Butan-1-ol must be added to an oxidising reagent, such as dichromate, then placed in a reflux apparatus over a bunsen burner, as heat is required. //

(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.

ASSESSOR'S USE ONLY

~~By mixing each compound with water and then testing the solutions,~~
~~By testing each~~
First, mix each compound with water and test each solution with the litmus paper.
- Butan-1-ol solution will not change the litmus, as it is a basic compound.
- Both butanoic acid and butanoyl chloride solutions change the litmus to red, as butanoic acid is acidic and butanoyl chloride reacts with the water to form HCl acid, which is also acidic.

Secondly, test ~~acid~~ the 2 unknown liquid with blue litmus paper but not water.
- Butanoic acid, being acidic, makes the paper change to red.
- In butanoyl chloride the litmus remains blue, as without the presence of water the liquid has no acidic properties.

Butanoic acid will not react with litmus paper unless water is present.

A4

A4

QUESTION THREE

ASSESSOR'S USE ONLY

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

methylpropan-2-ol (3°) butan-1-ol (1°) butan-2-ol (2°)

Compare and contrast the structures of the compounds above.

- Butan-1-ol is a primary alcohol, as the C-OH group is bonded to 1 other carbon atoms.
- butan-2-ol is a secondary alcohol, as the C-OH group is bonded to 2 other carbon atoms.
- Methylpropan-2-ol is a tertiary alcohol, as the C-OH group is bonded to 3 other carbon atoms.

The alcohols have been contrasted but not compared.

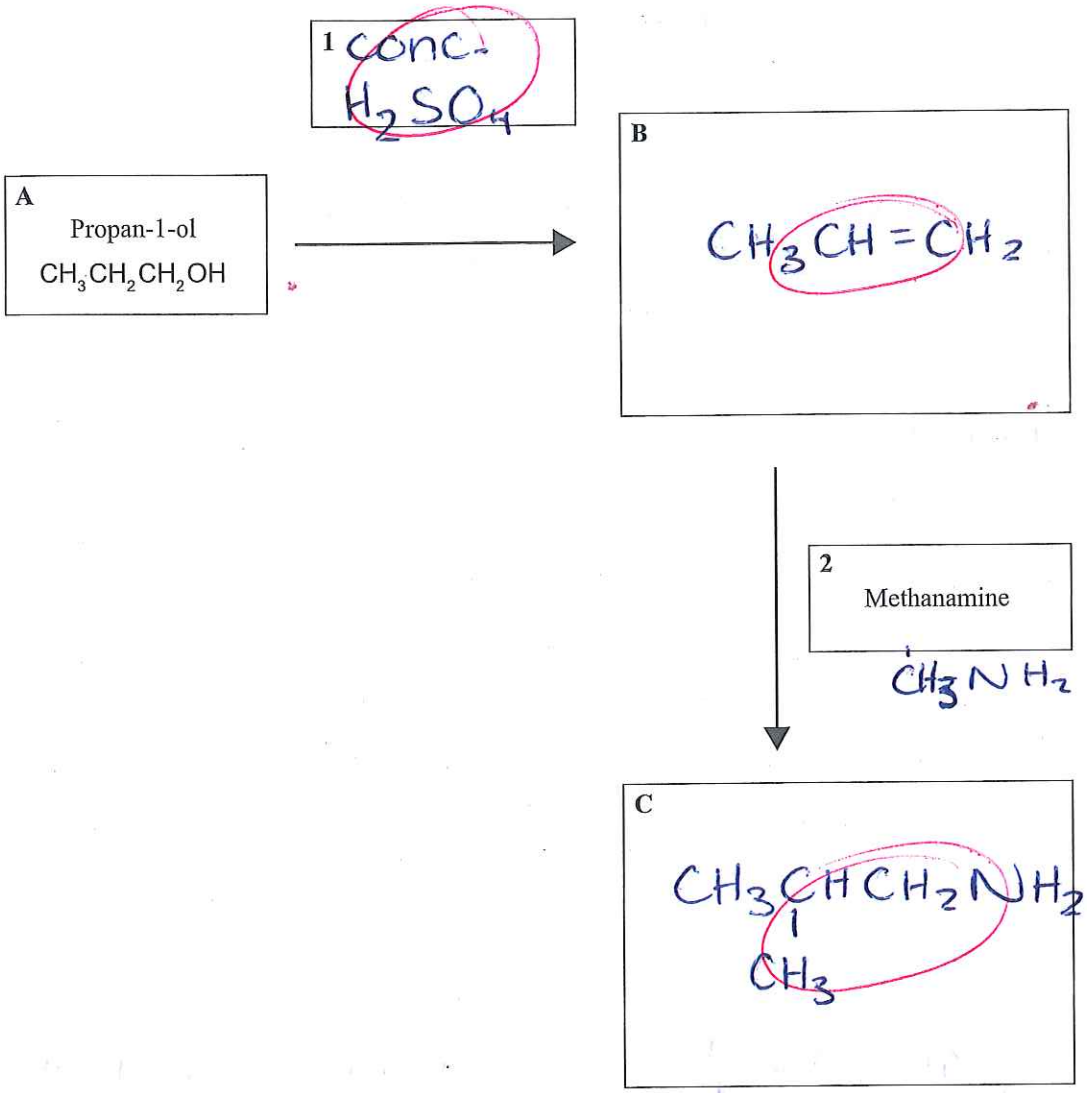
(ii) Describe how you could distinguish between the alcohols in (i) above, using chemical tests on the alcohols and/or their oxidation products.

Firstly, oxidise all 3 compounds using a distillation apparatus. Then test the products using red litmus paper. One product will turn the red litmus blue, methylpropan-1-ol, as tertiary alcohols cannot be oxidised, meaning the compound is still an alcohol. Then test the 2 remaining solutions with Tollens reagent, because the primary alcohol has been oxidised to an aldehyde and the secondary alcohol has been oxidised to a ketone. The ketone will not react with the Tollens, which means it came from the Butan-2-ol compound, whereas the aldehyde will react to form a 'silver mirror', meaning it was originally the butan-1-ol compound. ½

Methyl propan-2-ol has not been identified with observations.

(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**.



Candidate did well to identify that product C was an amine, but should have identified the amine as a secondary amine.

Question Three continues on the following page.

ASSESSOR'S USE ONLY

(c) When ammonia reacts with $CH_3CH(CH_3)CH_2C(=O)Cl$, 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 + $CH_3CH(CH_3)CH_2C(=O)Cl$ → $CH_3CH(CH_3)CH_2C(=O)NH_2$ + NH_4Cl

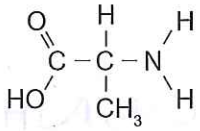
Name:

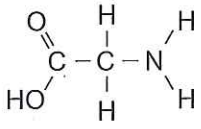
3 2-methyl propanamide

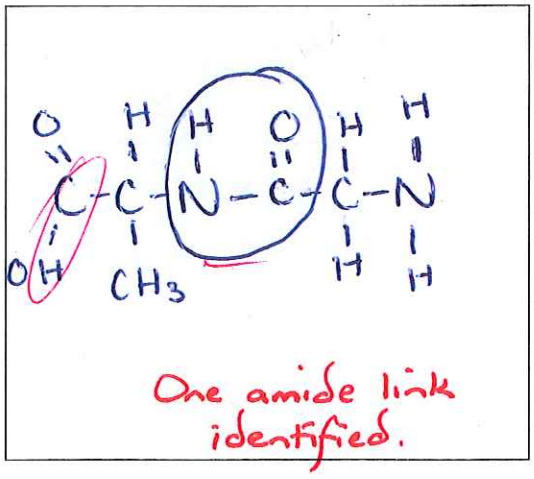
Four carbons means the name should have the prefix 'but' not 'prop'.

(d) Peptides are formed when amino acids combine.

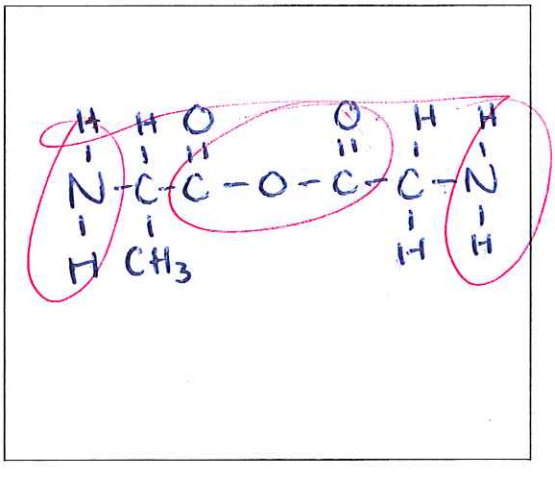
(i) In the boxes below, show two possible dipeptides that can be formed by combining the amino acids:







One amide link identified.



(ii) Circle the amide link in each dipeptide.

A4

A4