3

SAMPLE PAPER

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 3 Chemistry

3.5: Demonstrate understanding of structure and reactivity of organic compounds

Credits: Five

Check that you have completed ALL parts of the box at the top of this page.

Check that you have been supplied with the resource sheet for Chemistry 3.5.

You should answer ALL parts of ALL questions in this booklet.

If you need more room for any answer, use the space provided at the back of this booklet.

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 YOUR TEACHER AT THE END OF THE ALLOTTED TIME.

EXEMPLAR FOR LOW ACHIEVED

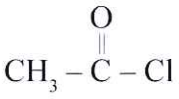
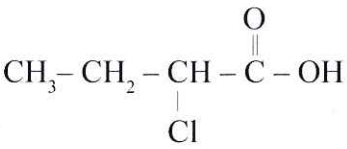
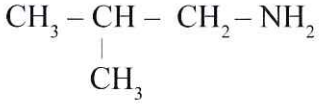
NOTE: These exemplars do not fully show Grade Score Marking (GSM) because of the small sample of student scripts involved, and the absence of a cut score meeting to determine grade boundaries. GSM can be seen in the level 1 and level 2 exemplars from the 2012 examinations, which will be published on the NZQA website when the assessment schedules are published.

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

Assessor's use only

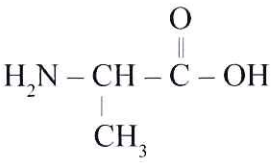
QUESTION ONE

(a) Give the IUPAC systematic names for the following compounds.

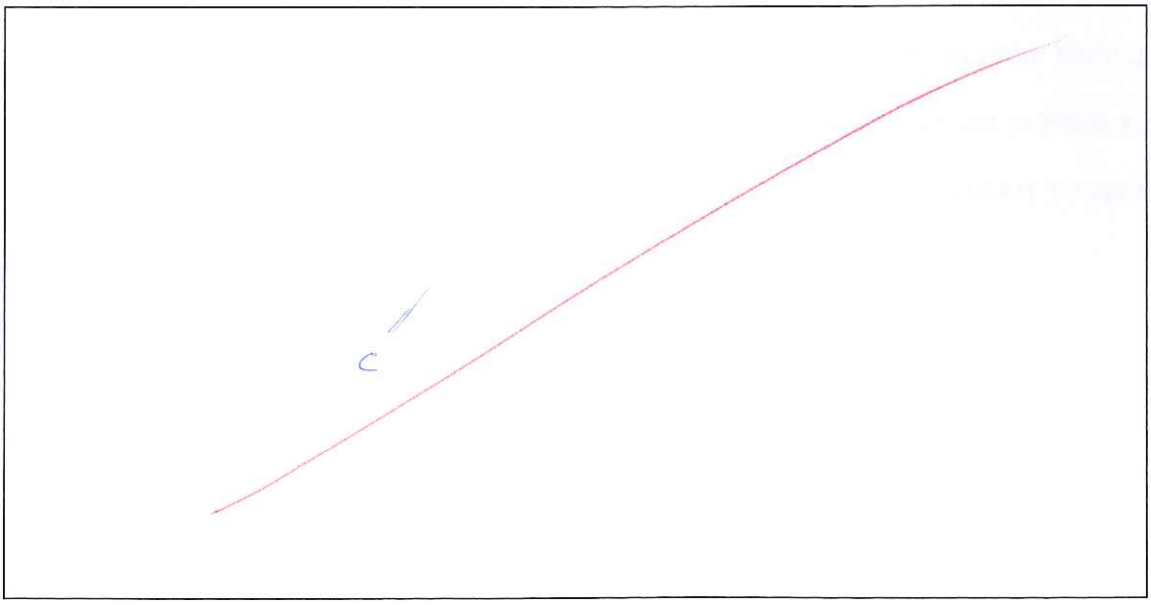
Compound	IUPAC systematic name
	ethanoyl chloride
	2chlorobutanoic acid
	2methylaminopropamine ~~propanamine~~.

Two correct names.

(b) The amino acid alanine below can exist as two enantiomers (optical isomers).



(i) Draw three-dimensional structures for the two enantiomers that clearly show the relationship between them.



(ii) Alanine has two straight chain isomers that do not show acidic properties. One of these isomers, **P**, can exist as an enantiomer, the other isomer, **Q**, cannot.

Assessor's use only

Draw **P** and **Q**.

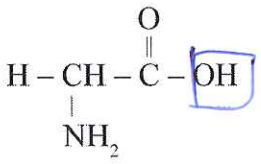
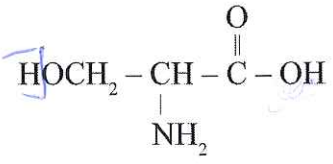
P	**Q**

Explain why **P** exists as an enantiomer.

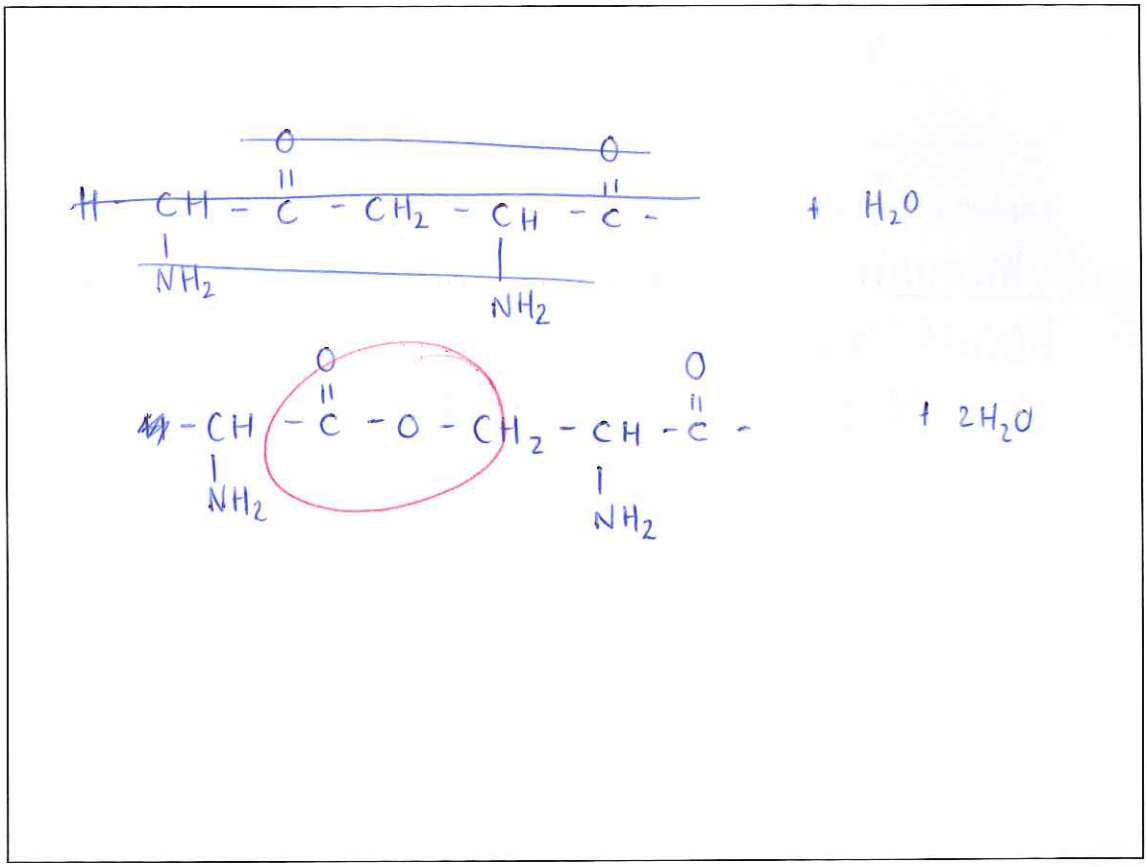
through the polarisation between molecules having ~~d~~ alike charges which keep the molecules at distance from eachother like charges repel. //

(c) Glycine and serine are two amino acids, which can combine to form dipeptides.

Assessor's use only

	
glycine	**serine**

(i) Draw the structure(s) of the possible dipeptide(s) formed from a combination of glycine and serine.

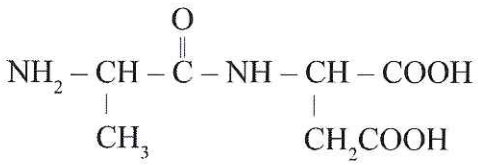


(ii) Explain your answer in terms of the structure and functional groups present in the amino acids and in the dipeptide(s).

when these two molecules goin together in a condensation reaction they form dipeptide and will therefore form a large ester chain

(d) Determine the products of hydrolysis of the molecule shown below in BOTH acidic and basic conditions.

Assessor's use only



Acidic conditions	
Basic conditions	

Justify your answer in terms of structure and reactivity.

One correct achieved statement.

N2

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QUESTION TWO

Assessor's use only

(a) For the following conversion, identify the reagent required and state the type of reaction occurring. You should give a reason for your answer in terms of the structure of the reactants and products.

Reagent required: concentrated sulfuric acid.

Type of reaction: ~~em~~ elimination.

Reason: elimination reaction will take away the Cl attached to the ~~double~~ central carbon atom and will form a double bond.

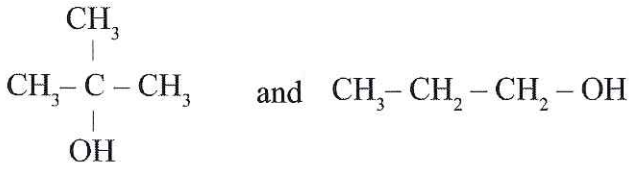
Omits hydrogen removed to for HCl.

(b) Explain a laboratory prodecure that would allow the following pairs of compounds to be distinguished. In your answers, you should include:

- the reagent used
- the expected result for any reactions that may or may not occur
- the structural formulae of the organic product(s) formed when the reaction(s) occur.

Assessor's use only

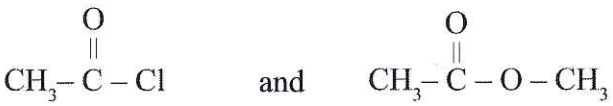
(i) A B



both of these solutions were to be oxidised the first solution would form a ketone and the other would form an aldehyde. when added to acified potassium dichromate solution B will go ~~to~~ from green to colour. The ~~an~~ aldehyde will be oxidised where as a ketones can not be oxidised any further.

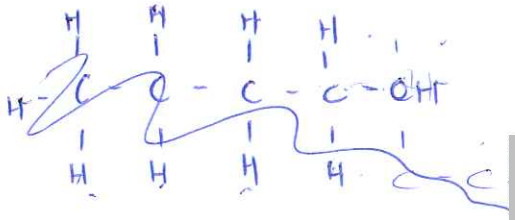
Correct reagent but no correct observation and product.

(ii)



methyl ethanoate ~~can be hy~~ through hydrolysis will produce an alcohol and a acid methanol and ethanoic acid. //

ethanoyl chloride will react with an acid and will produce HCl with ~~red litmus~~ blue damp litmus turn red. //



(c) Use the following information to answer this question.

Assessor's use only

Compound W is a branched chain molecule with a molecular formula $C_4H_{10}O$.
butan-1-ol

When **Compound W** is heated with excess acidified potassium dichromate it is readily oxidised to **Compound X,** which has acidic properties.
butanoic acid.

A substitution reaction occurs when **Compound X** is reacted with $SOCl_2$. The molecular formula of **Compound Y** is C_4H_7OCl.

When **Compound Y** reacts with aminomethane, $CH_3–NH_2$, a substitution reaction occurs and **Compound Z** forms.

Determine the structural formulae of **Compounds W, X, Y,** and **Z.**

Justify your answer by explaining how you arrived at these structures from the information given above. In your answer, you should:

- include other possible structural formulae you considered
- give your reasons for rejecting the other structural formulae.

Two Achieved statements below.

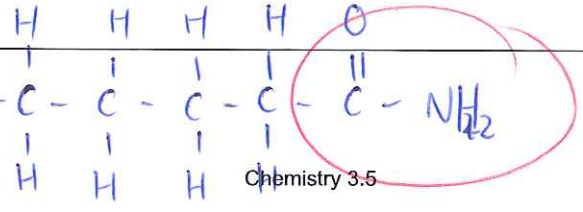
compound w- butan-1-ol = $CH_3CH_2CH_2CH_2OH$

compound w is added to acidified dichromate solution turns ~~in~~ from orange to green. being oxidised it forms butanoic acid ~~w~~ and being an acid will there for have acidic properties turning blue damp litmus red.

compound X = butanoic acid $CH_3CH_2CH_2COOH$
when this compound is reacted with $SOCl_2$ the molecule that is formed is an acly chloride giving it the formula of ~~CH4~~ C_4H_7OCl
butanacyl chloride.
this then reacts with CH_3-NH_2 and will form an amide ~~it~~ and when tested with damp litmus there will be no change.
~~$CH_3CH_2CH_2CH$~~

Correct functional groups identified.

Some reasons given: oxidation of alcohol, reaction with $SOCl_2$, amide formation.



Two structures but not branchal chain.

A3

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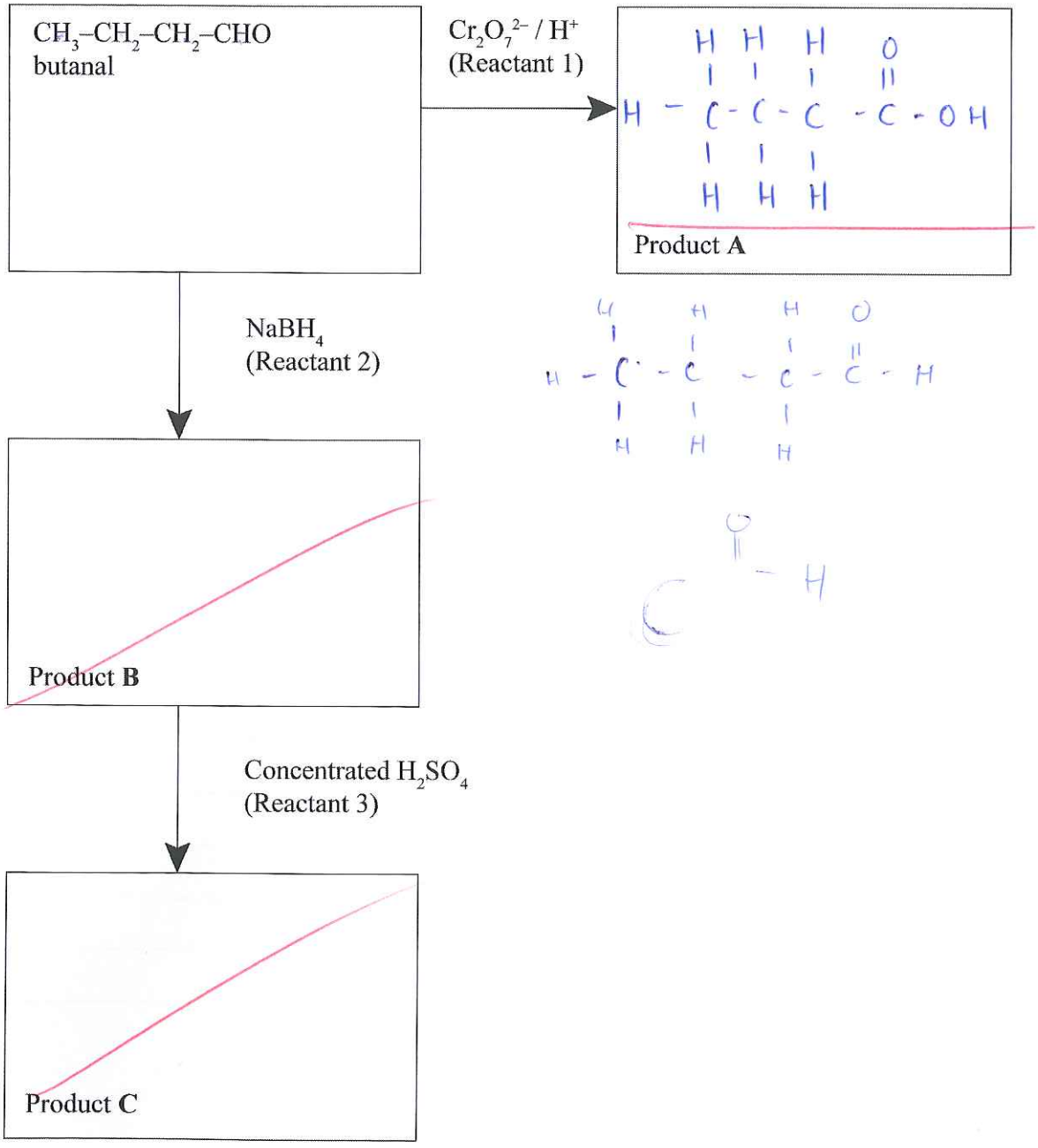
QUESTION THREE

Assessor's use only

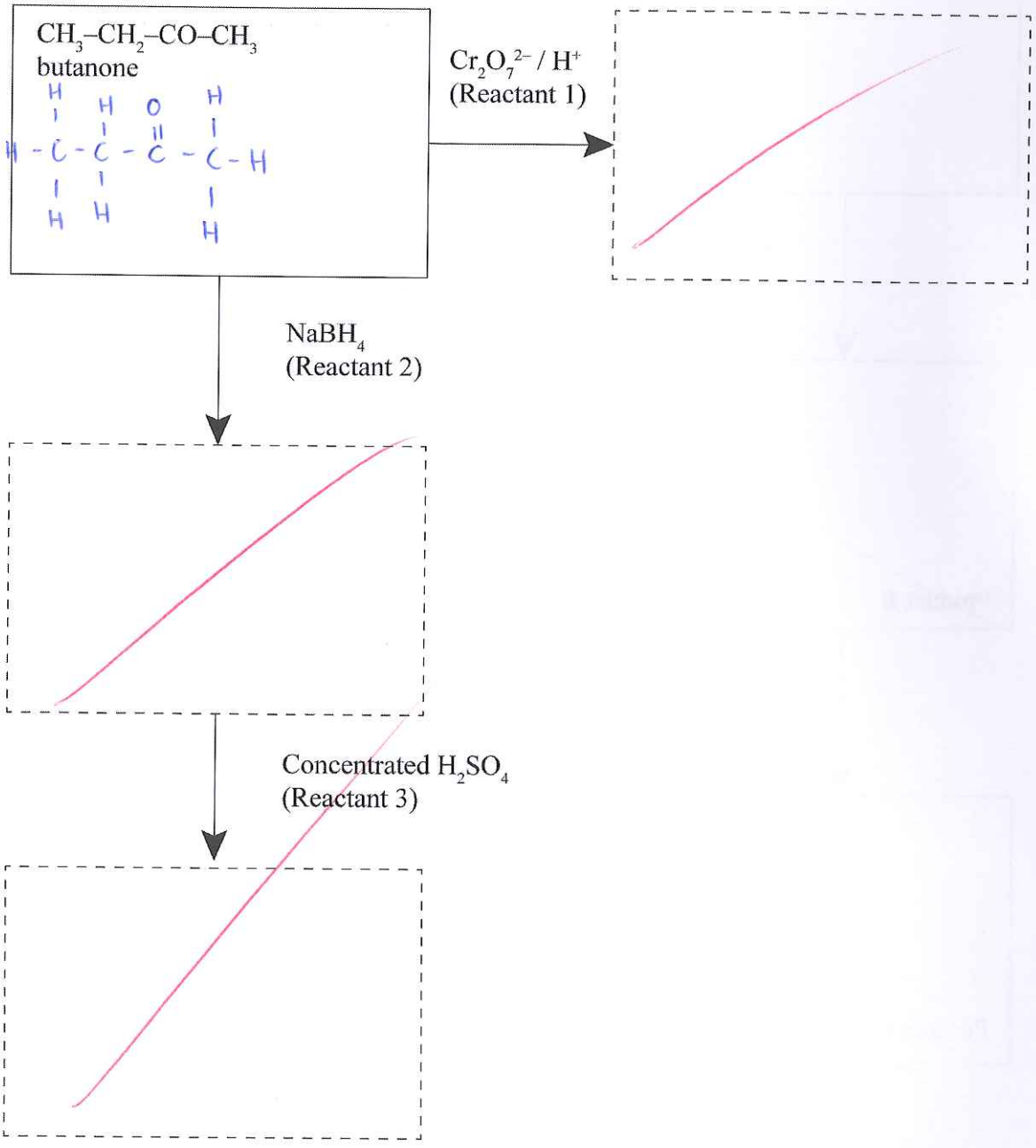
(a) Complete the following reaction scheme that shows some reactions starting with butanal. Give the structural formulae of the organic products **A**, **B**, and **C**.



(b) Devise and complete the reaction scheme starting with butanone in place of butanal to show how butanone would react with the reactants 1–3. In your answer, you should:

- identify the products formed in each reaction step; state if no reaction occurs
- write the structural formula for each product formed, including major and minor products **(if any)**.

Assessor's use only



(c) Compare and contrast the two reaction schemes. In your answer, justify the reasons for:

- the similarities and the differences between these two schemes
- the products formed in each reaction.

Assessor's use only

One structure in calculation.

N2

3

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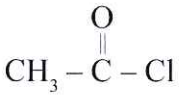
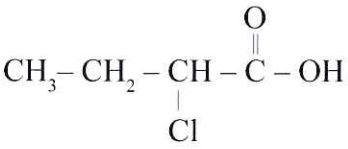
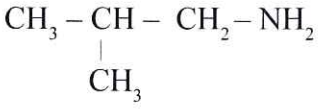
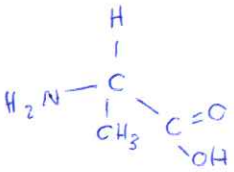
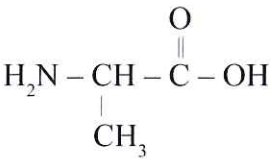
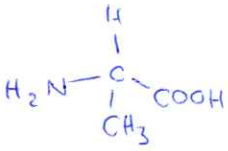
	ethanoyl chloride.
	2-chlorobutanoic ~~acid~~ acid.
	3-methyl ~~amide~~ amide.

Two correct names.

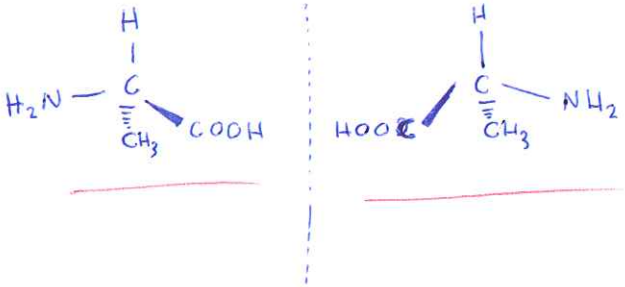
(b) The amino acid alanine below can exist as two enantiomers (optical isomers).







(i) Draw three-dimensional structures for the two enantiomers that clearly show the relationship between them.



Mirror images drawn correctly.

(ii) Alanine has two straight chain isomers that do not show acidic properties. One of these isomers, **P**, can exist as an enantiomer, the other isomer, **Q**, cannot.

Assessor's use only

Draw **P** and **Q**.

P	**Q**

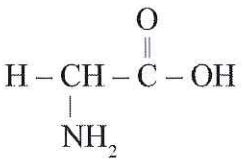
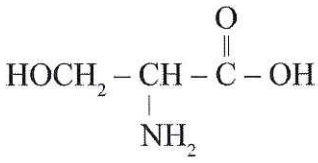
Explain why **P** exists as an enantiomer.

Enantiomers exist if the ~~molecule~~ central C atom in the molecule is chiral. That is: assymetric. P exists as an ~~ext~~ enantiomer because the 4 ~~di~~ groups ~~attatche~~ attached to the central C atom are all different.

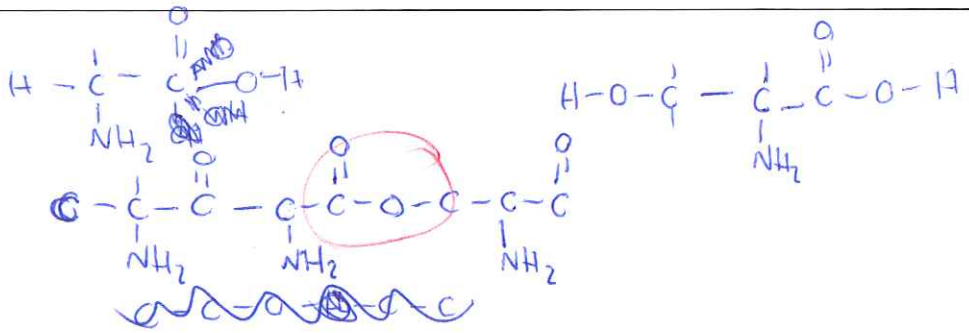
Explanation of enantiomers correct.

(c) Glycine and serine are two amino acids, which can combine to form dipeptides.

Assessor's use only

 **glycine**	 **serine**

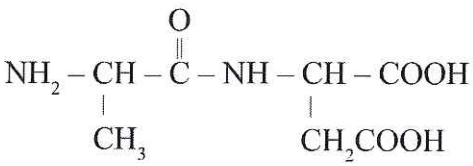
(i) Draw the structure(s) of the possible dipeptide(s) formed from a combination of glycine and serine.



(ii) Explain your answer in terms of the structure and functional groups present in the amino acids and in the dipeptide(s).

(d) Determine the products of hydrolysis of the molecule shown below in BOTH acidic and basic conditions.

Assessor's use only



Acidic conditions	
Basic conditions	

Justify your answer in terms of structure and reactivity.

One correct Merit answer.

M5

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QUESTION TWO

Assessor's use only

(a) For the following conversion, identify the reagent required and state the type of reaction occurring. You should give a reason for your answer in terms of the structure of the reactants and products.

$CH_3 - \underset{\underset{Cl}{|}}{CH} - CH_3$ is converted to $CH_3 - CH = CH_2$

Reagent required: ~~Elimination~~ KOH (-) 1

Type of reaction: Elimination.

Reason: The haloalkane 2-chloropropane loses the Cl atom and a double bond is formed. 1

Omits alcoholic. Omits removal of H to form HCl.

(b) Explain a laboratory prodecure that would allow the following pairs of compounds to be distinguished. In your answers, you should include:

- the reagent used
- the expected result for any reactions that may or may not occur
- the structural formulae of the organic product(s) formed when the reaction(s) occur.

Assessor's use only

(i) $CH_3-CH_2-CH_2-OH \xrightarrow{Cr_2O_7^{2-}/H^+} CH_3-CH_2-C(=O)H$ aldehyde.

$CH_3-C(CH_3)(OH)-CH_3$ and $CH_3-CH_2-CH_2-OH$

Possible product but no observation.

To distinguish between 3° and 1° alcohols: use $Cr_2O_7^{2-}/H^+$. (or ~~Tollens reagent~~ Lucas reagent) ($ZnCl/HCl$) → 1° alcohols will react instantly - Alcohol will turn cloudy straight away. ~~3°~~ 3° alcohols do not oxidise at all readily with $Cr_2O_7^{2-}$. So, no reaction / colour change will take place. //

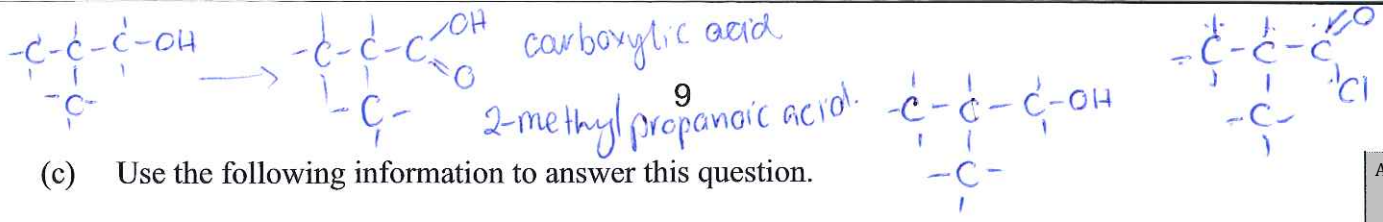
Incorrect observation for Lucas reagent. Correct observation for 3° alcohol and $Cr_2O_7^{2-}/H^+$.

(ii)

$CH_3-C(=O)-Cl$ and $CH_3-C(=O)-O-CH_3$

~~ethanoly~~ ethanoyl chloride. methyl ~~e~~methanoate.

Ketones will not oxidise. Add an alcohol to each with ~~conc H_2O. H_2SO_4 → es~~ //



(c) Use the following information to answer this question.

Assessor's use only

Compound W is a branched chain molecule with a molecular formula $C_4H_{10}O$. 1° alc.

When **Compound W** is heated with excess acidified potassium dichromate it is readily oxidised to **Compound X,** which has acidic properties. $Cr_2O_7^{2-}$

A substitution reaction occurs when **Compound X** is reacted with $SOCl_2$. The molecular formula of **Compound Y** is C_4H_7OCl. acyl chloride.

When **Compound Y** reacts with aminomethane, $CH_3–NH_2$, a substitution reaction occurs and **Compound Z** forms.

Determine the structural formulae of **Compounds W, X, Y,** and **Z.**

Justify your answer by explaining how you arrived at these structures from the information given above. In your answer, you should:

- include other possible structural formulae you considered
- give your reasons for rejecting the other structural formulae.

Compound W must be a primary alcohol, as it was readily oxidised to form a molecule with acidic properties. 2-methylpropan-1-ol. $CH_2CH(CH_3)CH_2OH$

Compound X must be a carboxylic acid, as it has acid properties, and the oxidation of a primary alcohol would give a carboxylic acid. (2-methyl propanoic acid.) ~~CH_3CH_2COOH~~. $CH_3CH(CH_3)COOH$.

When compound X (the propanoic acid.) is reacted with thionyl chloride ($SOCl_2$): this gives us a compound, compound Y, with a molecular formula of C_4H_7OCl. The reaction is a substitution reaction, producing 2-methylpropanoyl chloride. $CH_3CH(CH_3)COCl$. Compound Z: $CH_3-CH_2-CH_2-O-CH_2NH_2$ $CH_3CH(CH_3)CH(Cl)OCH_2NH_2$

Initially I considered the alcohol 2-methylpropan-2-ol, however remembered that tertiary alcohols do not oxidise readily, and will not oxidise with $Cr_2O_7^{2-}$. Instead, I chose the primary alcohol (2-methylpropan-1-ol) → primary alcohols are readily oxidised.

Three correct structures with reasons.

M5

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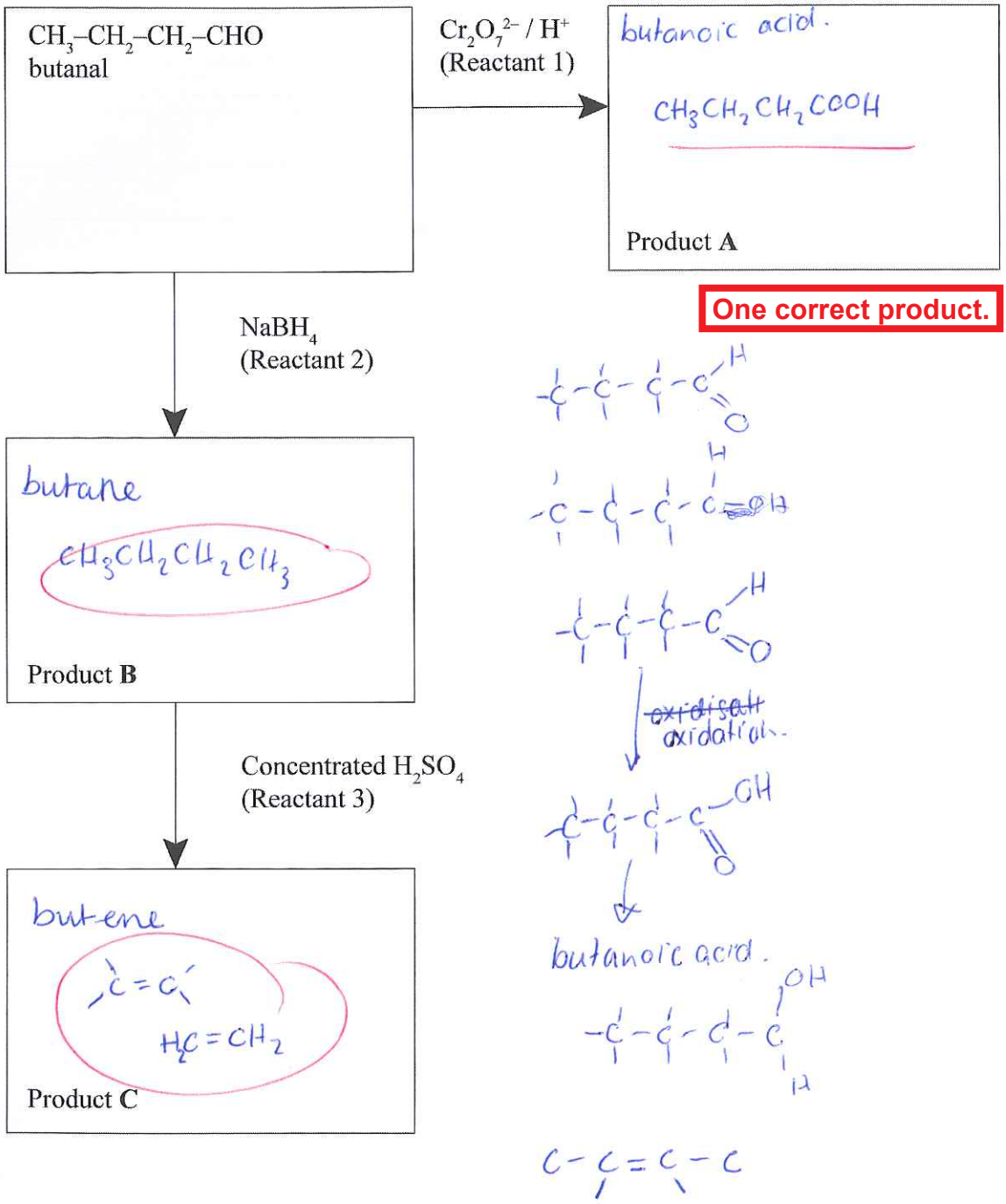
QUESTION THREE

Assessor's use only

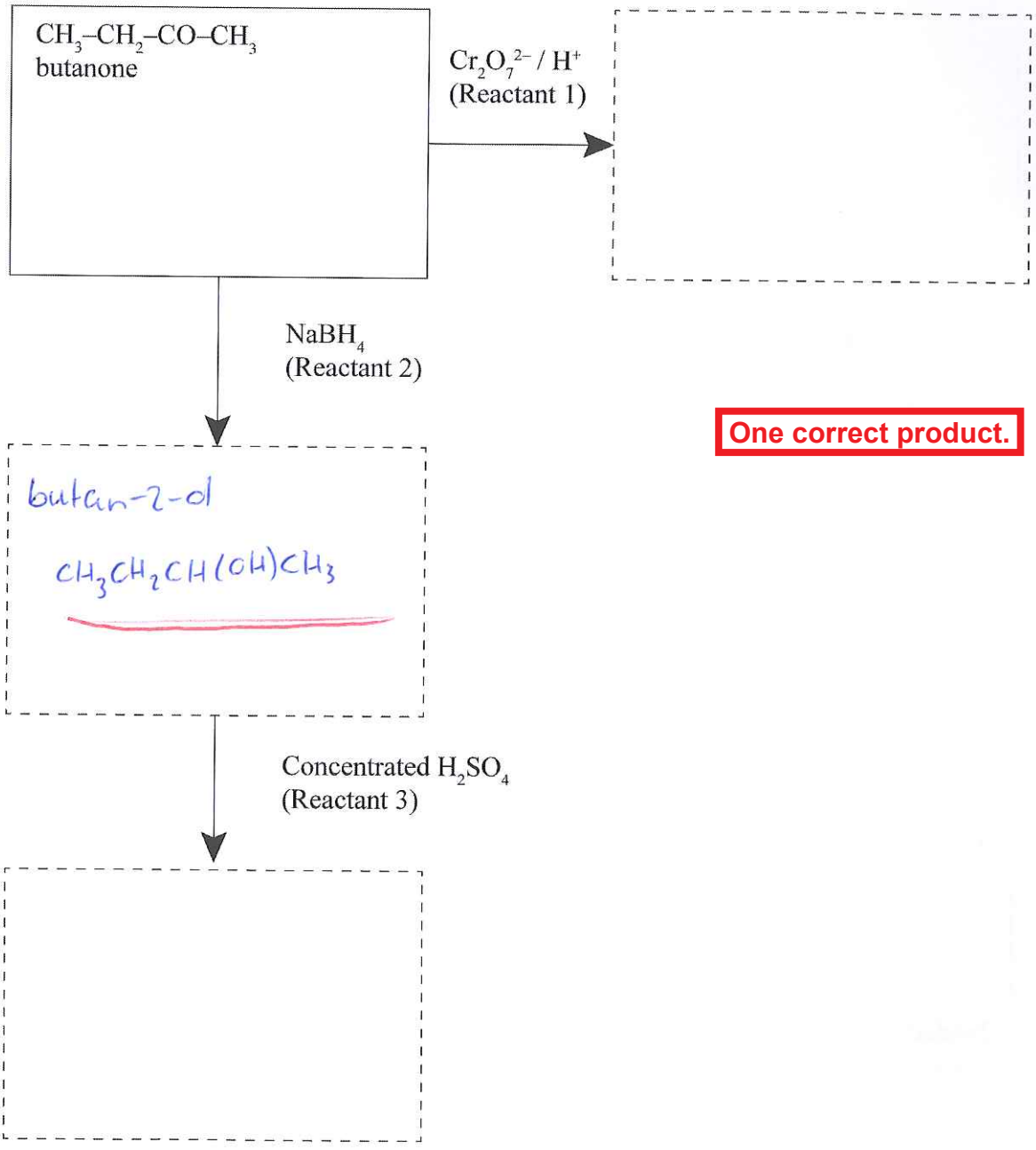
(a) Complete the following reaction scheme that shows some reactions starting with butanal. Give the structural formulae of the organic products **A**, **B**, and **C**.



(b) Devise and complete the reaction scheme starting with butanone in place of butanal to show how butanone would react with the reactants 1–3. In your answer, you should:

- identify the products formed in each reaction step; state if no reaction occurs
- write the structural formula for each product formed, including major and minor products **(if any)**.

Assessor's use only



One correct product.

(c) Compare and contrast the two reaction schemes. In your answer, justify the reasons for:

- the similarities and the differences between these two schemes
- the products formed in each reaction.

Assessor's use only

One correct part answer in (a) and (b).

N1