Chemistry 3.5 AS 91391

Demonstrate understanding of the properties of organic compounds

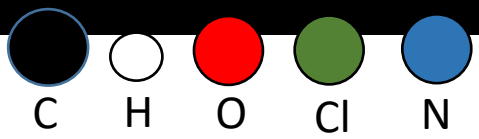
WORKBOOK

Working to Excellence & NCEA Questions

CONTENTS

All NCEA answers can be found on C3.5 ppt

Summary Notes

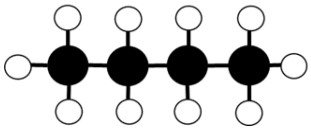


1. Functional groups – Naming and properties: Alkanes, alkenes, haloalkanes (primary, secondary, tertiary), alcohol, amines, carboxylic acids, Aldehydes, ketones, acids chlorides, amides and esters

Alkanes

1. identify the longest C chain
2. Identify any branches
3. Number the C atoms in longest chain so branches are on the lowest numbers
4. Location of branch
5. Name of branch
6. Prefix of long chain
7. –ane

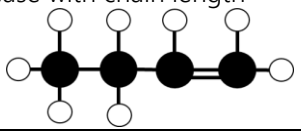
Non-polar with ID-ID bonding only and insoluble.



Alkenes

1. Location of branch
2. Name of branch
3. Prefix of long chain
4. Location of C=C
5. -ene
6. If in an alkene there are more than one double bond is present, it named as a –diene or –triene.

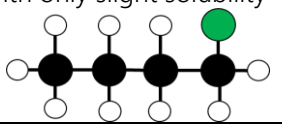
Also Non-polar with ID-ID bonding only and insoluble. BP and MP increase with chain length



Haloalkanes

Halogen named as a branch
Bromine – bromo
Chlorine – chloro
Fluorine – fluro
Iodine-iodo

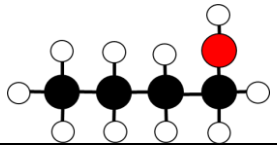
primary (1°) – bonded to a C tha
bonded to only 1 other C
secondary (2°) – bonded to a C
bonded to 2 other C
tertiary (3°) – bonded to a C tha
bonded to 3 other C
Polar with only slight solubility



Alcohols

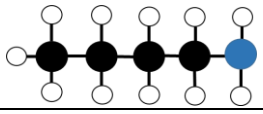
1. Location of branch
2. Name of branch
3. Prefix of long chain
4. an-
5. Location of OH (if multiple di, tri, tetra)
6. –ol

Hydrogen bonding, so higher BP and soluble



Amines

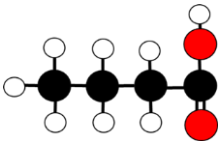
1. Identify the longest C chain
2. Identify any branches
3. Number the C atoms in longest chain so number Carbon 1 attached to amino group (NH_2)
4. Location /Name of branch
5. Amino-
6. Prefix of long chain
7. -ane



Carboxylic acids

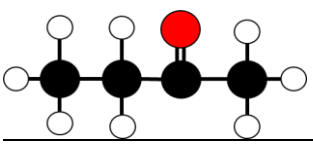
1. Longest –C chain with -(
2. Identify branches
3. No. 1 C is the C in -COO
4. Location of branches
5. Name branch
6. Prefix
7. -anoic acid

Turn blue litmus red. Act as weak a



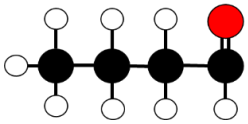
Ketones

Suffix is "-one"., and indicating which carbon the =O is attached



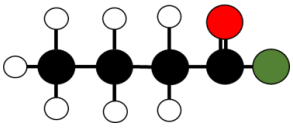
Aldehydes

Aldehydes are named by changing "-e" at the end of the alkane to "-al".



Acid Chlorides

suffix is "-oyl chloride"
prefix is alkyl group including th
carbon on the -COCl group



Amides

1. The carbon attached to the $CONH_2$ will be carbon 1

Esters

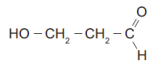
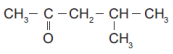
1. Split between C-O bond
2. Identify name for side with –O-

Amino acids

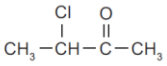
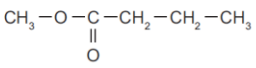
Do not need to name

Past NCEA questions Functional Groups (Part ONE)

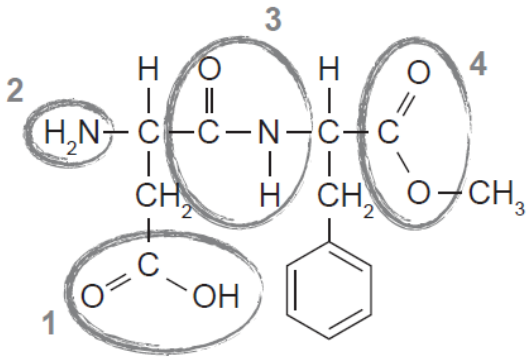
2013: 1a Complete the table below by giving the IUPAC systematic name or the structural formula for each compound.

Structural formula	IUPAC systematic name
	
	propanamide
	

2014: 1a. Complete the table below giving the IUPAC systematic name or the structural formula for each compound.

Structural formula	IUPAC systematic name
	
	propanamide
	

2015: 1a. 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 below:



2015: 1b. Complete the table below by drawing the structural formula for the named compounds.

IUPAC systematic name	Structural formula
propanoyl chloride	
3-bromopentan-2-one	
2-methylbutanal	

Past NCEA questions Functional Groups (part TWO)

2015: 1c (i) draw the three structural isomers of C_4H_9Cl that represent a primary, secondary and tertiary haloalkane.

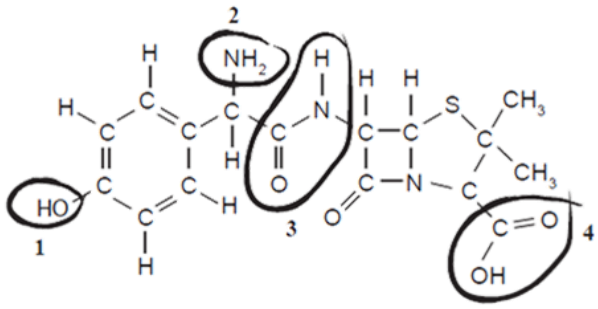
Primary haloalkane	Secondary haloalkane

Tertiary haloalkane

2016: 1a. Complete the table below by drawing the structural formula for the named compounds.

IUPAC systematic name	Structural Formula
butylethanoate	
2-hydroxybutanal	
ethanamide	

2016: 1b. The structure of amoxycillin is given below. It is an antibiotic used in the treatment of bacterial infections. Name the four different functional groups circled within the amoxycillin molecule below.



1		2	
3		4	

2016: 2b. The structures of four different organic substances are shown in the table below. (i) Name the organic substances A to D.

Letter	Structure	Name
A	$CH_3CH_2CH_2-NH_2$	
B	$CH_3CH_2-C(=O)-H$	
C	$CH_3CH_2-C(=O)-Cl$	
D	$CH_3-C(=O)-CH_3$	

Past NCEA questions Functional Groups (part THREE)

2017: 1a. Complete the table below to indicate the IUPAC name, functional group, and / or the structural formula for organic compounds that contain only four carbon atoms. The first row has been completed for you.

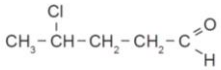
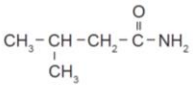
Functional group	Structural formula	IUPAC (systematic) name
Alkene	$CH_3CH_2CH{=}CH_2$	but-1-ene
		2-methylpropan-1-amine
Acyl chloride		
		propyl methanoate
	$CH_3CH_2{-}\overset{\overset{O}{\|}}{C}{-}CH_3$	
Aldehyde		
Amide		butanamide

2018: 1a. Complete the table below to show either the structural formula or the IUPAC (systematic) name for each organic molecule.

Structural Formula	IUPAC (systematic) name
$CH_3{-}\overset{\overset{Cl}{\|}}{C}H{-}CH_2{-}\overset{\overset{O}{\|}}{C}{-}Cl$	
$CH_3{-}CH_2{-}CH_2{-}\overset{\overset{O}{\|}}{C}{-}CH_3$	
	4-methylhexanal
	propanamide

Past NCEA questions Functional Groups (part FOUR)

2019: 1a: Complete the table below to show either the structural formula or the IUPAC (systematic) name for each organic molecule.

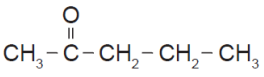
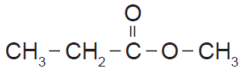
Structural formula	IUPAC (systematic) name
	
	Ethyl hexanoate
	

Question 2c: $C_5H_{10}O$ can exist as a number of different constitutional (structural) isomers.

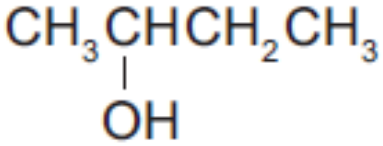
Draw the structural formulae for the isomers of $C_5H_{10}O$ that meet the following requirements.

Requirements	Structure
(i) Straight-chain molecule that forms a silver mirror when heated with Tollens' reagent.	CH3-CH2-CH2-CH2-CHO
(ii) Branched-chain molecule that does not form a silver mirror when heated with Tollens' reagent.	
(iii) Five-carbon ring cyclic molecule that forms steamy fumes when reacted with thionyl chloride, $SOCl_2$.	
(iv) Straight-chain secondary alcohol that decolourises bromine water, and can exist as both *cis-trans* (geometric) isomers and enantiomers (optical isomers).	

2020: Question 1a: Complete the table below to show either the structural formula or the IUPAC (systematic) name for each organic molecule.

Compound	IUPAC (systematic) name	Structural Formula
A	3-chloropropanamide	
B		
C		
D	2-methylbutanal	

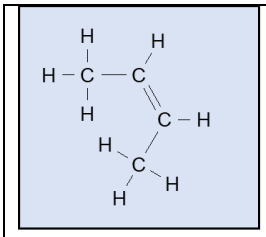
Writing Excellence answers to Optical Isomers questions

Optical Isomers QUESTION
Question: The alcohol below can exist as two enantiomers (optical isomers). (i) Draw three-dimensional structures for the two enantiomers. (ii) Link the structure of enantiomers to a physical property that can be used to distinguish them from non-optically active molecules.   

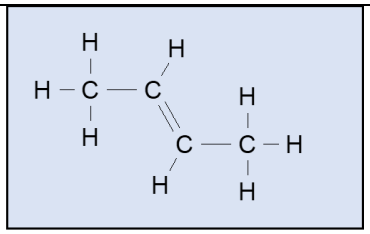
ANSWER		
1. Draw the two optical isomers isomers If you need to select the molecule make sure that it has: a Chiral carbon with 4 different groups attached	left	right
2. link the requirements of an enantiomer to the presence of four different groups joined to a C		
3. explain the isomers have the same molecular formula but are non-superimposable mirror images		
4. link the requirements above to your specific molecule (D)		
5. link different physical properties to rotating (plane) polarised light in opposite directions.		

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

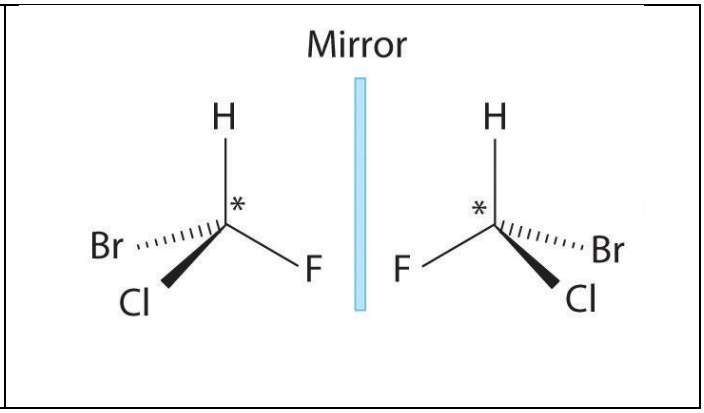
2. Isomers: cis/trans and optical isomers (enantiomers)

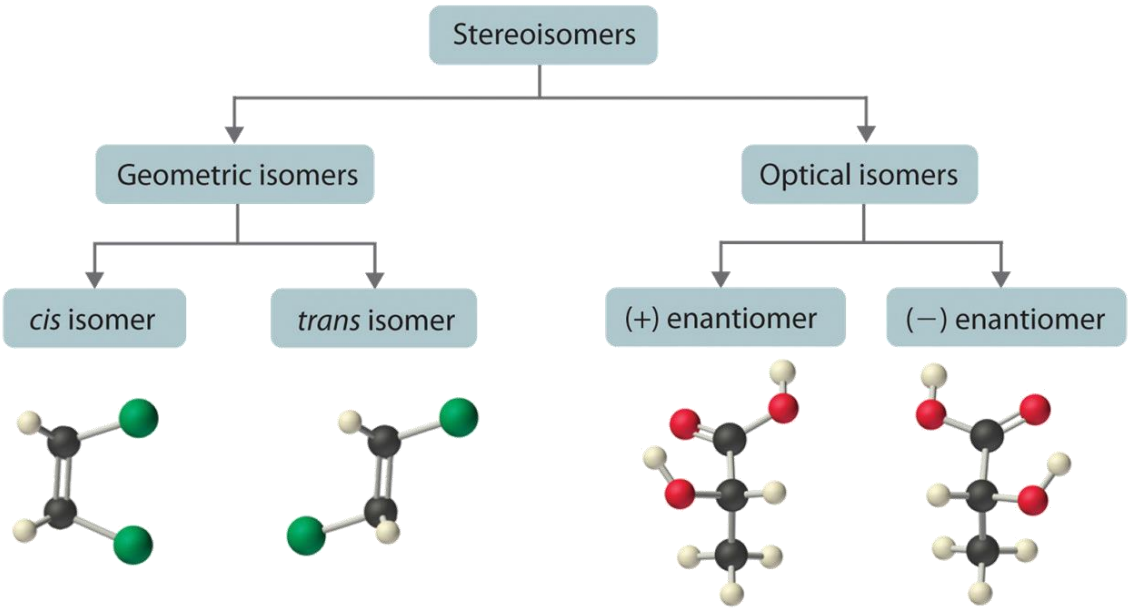


Cis but-2-ene



Trans but-2-ene

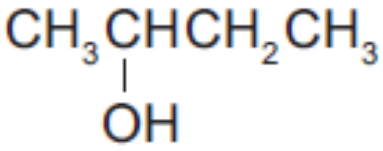




Examples: ***cis*-Dichloroethene** ***trans*-Dichloroethene** **L-(+)-Lactic acid** **D-(−)-Lactic acid**

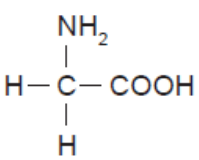
Past NCEA questions Optical Isomers

2013: 1b (i). The alcohol below can exist as two enantiomers (optical isomers). Draw three-dimensional structures for the two enantiomers.

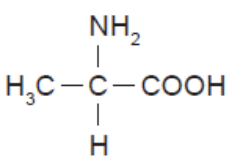


2013: 1b (ii). Link the structure of enantiomers to a physical property that can be used to distinguish them from non-optically active molecules.

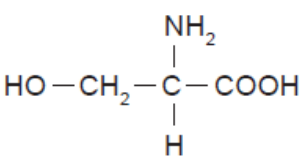
2016: 1c (i) Glycine, alanine, and serine are three amino acids shown below. Draw the 3-D structures of the enantiomers (optical isomers) of serine.



glycine



alanine



serine

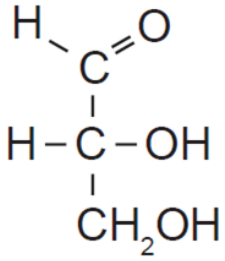
Past NCEA questions Optical Isomers

2016: 1c: (ii) Which amino acid above does NOT display optical isomerism: Explain your answer

2017: 1c: (i) Some organic compounds can exist as enantiomers (optical isomers).
An example is a secondary alcohol with the molecular formula C_4H_9OH.
Draw the enantiomers of C_4H_9OH

2017: 1c: (ii) Explain what is meant by the term enantiomers (optical isomers).
In your answer, you should:
• identify the structural requirement for a molecule, such as C_4H_9OH, to exist as enantiomers
• explain how enantiomers can be distinguished from each other.

2018: 2a. The structural formula of 2,3-dihydroxypropanal, more commonly known as glyceraldehyde, is shown below. Glyceraldehyde can exist as enantiomers (optical isomers).
(i) Draw the enantiomers of glyceraldehyde



2018: 2a:

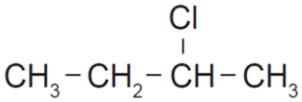
(ii) Explain why glyceraldehyde can exist as enantiomers.

(iii) How could the two enantiomers of glyceraldehyde be distinguished?

Explain your answer.

2019: 2a. 2-chlorobutane can exist as enantiomers (optical isomers).

(i) Draw the enantiomers of 2-chlorobutane in the box below.
(ii) Explain how the two enantiomers of 2-chlorobutane could be distinguishe



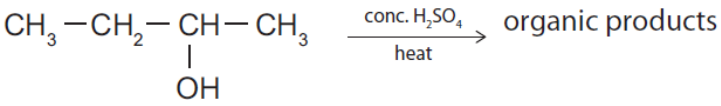
2020: Question 2a: 1-bromopropan-2-ol exists as enantiomers (optical isomers). $OHCH_3CHCH_2Br$

(i) Draw the enantiomers of 1-bromopropan-2-ol below.

(ii) Why can 1-bromopropan-2-ol exist as enantiomers?

(iii) Explain how the two enantiomers of 1-bromopropan-2-ol could be distinguished.

Writing Excellence answers to Elimination Reaction – Multiple Products questions

Elimination Reaction – Multiple Products QUESTION		
Question: When butan-2-ol undergoes a reaction with concentrated H_2SO_4, three possible organic products form, which are isomers of each other. (i) Draw the three isomers formed during this reaction. (ii) Which of the three isomers from part (i) will be formed in the smallest amount? 		
ANSWER		
1. Draw the minor product If you need to select the molecule make sure that it has both: a C=C double bond and 2 different groups of each C	Name:	
2. State reaction type and name molecule as the minor product linking to forming in the smallest amount.		
3. Explain how the minor product is formed using Saytzeff's rule		
4. Link to your specific molecule (i.e. groups removed, double bond formed)		
5. Draw the major product as cis and trans isomers	Cis Name:	Trans Name:
6. link the presence of a double C=C bond to lack of rotation and two different groups off each of the C		

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

Writing Excellence answers to Multiple reactants - Substitution and Elimination questions

Substitution and Elimination reactions QUESTION
Question: Chloroethane, CH_3CH_2Cl, reacts with aqueous KOH, alcoholic KOH, and with NH_3. Compare and contrast the reactions of chloroethane with the three reagents. In your answer you should include: • the type of reaction occurring and the reason why it is classified as that type • the type of functional group formed • equations showing structural formulae for reactions occurring.

ANSWER	
Reaction 1 Chloroethane reacts with **$KOH_{(aq)}$**	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 2 Chloroethane reacts with **$KOH_{(alc)}$**	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 3 Chloroethane reacts with **$NH_{3(alc)}$**	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

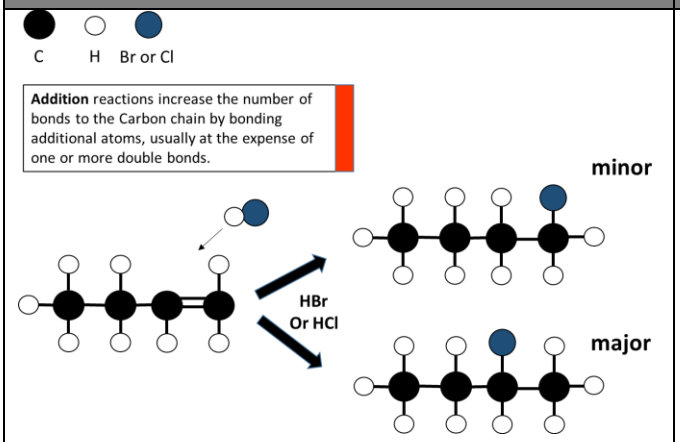
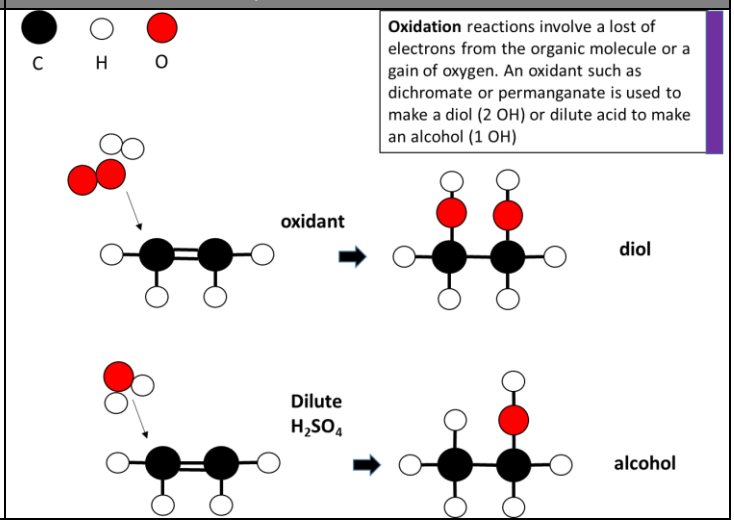
Writing Excellence answers to Multiple Reactants - Addition Reactions questions

Addition Reactions QUESTION
Question: Ethene, $C_2H_{4(g)}$, reacts with aqueous potassium permanganate solution, $KMnO_{4(aq)}$, dilute acid, H_2O / H^+, and hydrogen bromide, HBr. Compare and contrast the reactions of ethene gas with each of these three reagents. In your answer, you should: • describe any observations that can be made • identify, with reasons, the type of reaction ethene undergoes with each reagent • describe the functional group of the products formed • include equations showing the structural formulae for the organic compounds for each reaction.

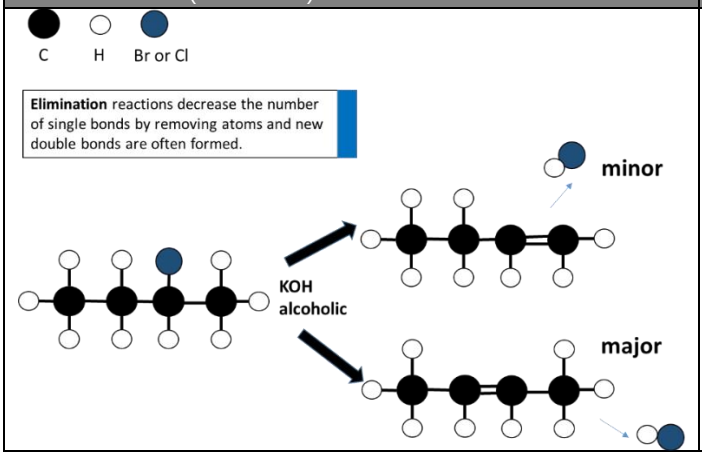
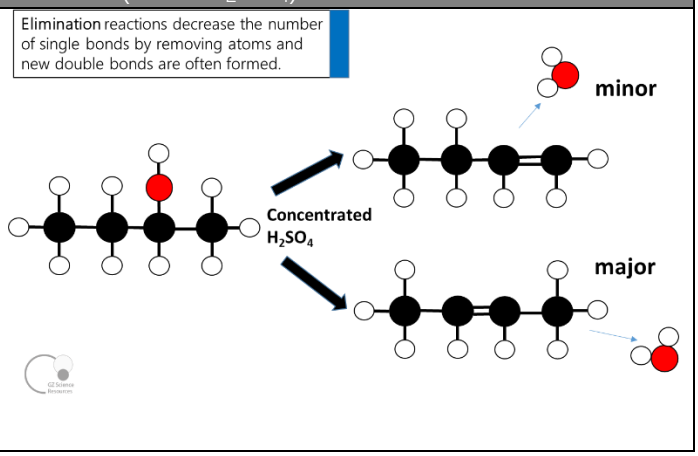
ANSWER	
Reaction 1 Ethene, $C_2H_{4(g)}$ *reacts with* aqueous potassium permanganate solution, **$KMnO_{4(aq)}$,**	Observations
	Reaction type
	Functional group of products
	Structural Formula equation
Reaction 2 Ethene, $C_2H_{4(g)}$ *reacts with* dilute acid, **H_2O / H^+**	Observations
	Reaction type
	Functional group of products
	Structural Formula equation
Reaction 3 Ethene, $C_2H_{4(g)}$ *reacts with* hydrogen bromide, **HBr.**	Observations
	Reaction type
	Functional group of products
	Structural Formula equation
Summary of the three reactions	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

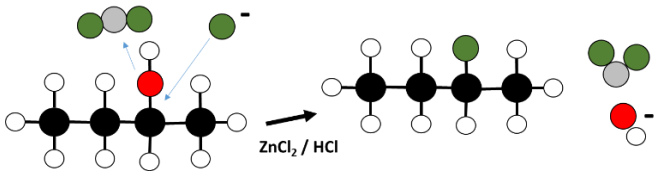
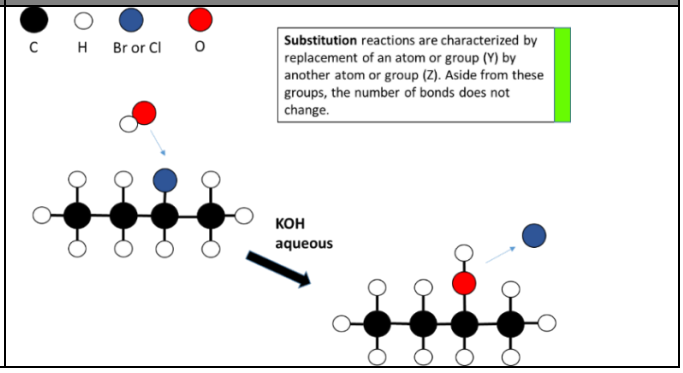
3. Addition reactions of alkenes:

Alkene to alcohol (H_2O/H^+) or haloalkane (PCl_5) using Markovnikov's rule / major (2°) minor (1°)	Comparing Addition (Oxidation) of alkenes: alkene + MnO_4^- → -diol OR alkene + H_2O/H^+ → -ol
	

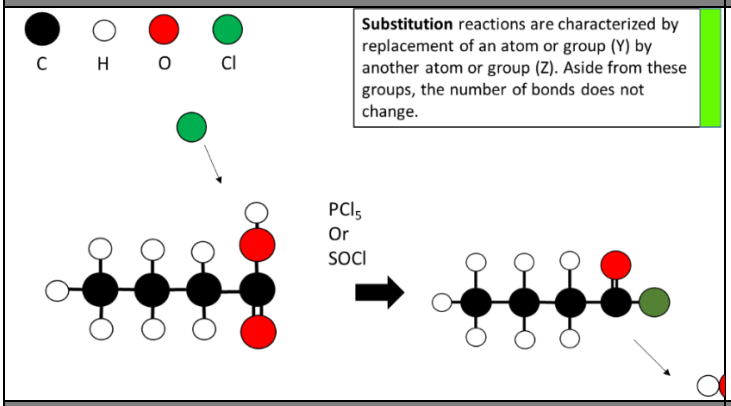
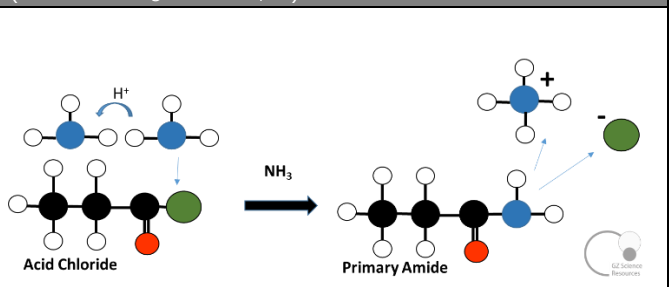
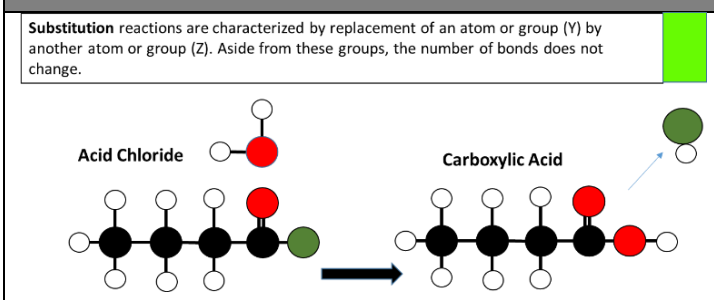
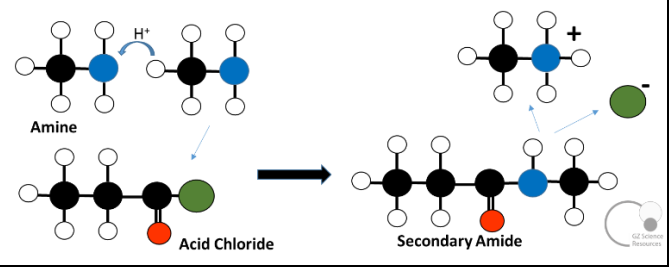
4. Elimination reactions - Saytzeff's rule (poor get poorer) major (-2-) /minor (-1-)

haloalkanes (alc KOH) to alkenes	Alcohol (conc H_2SO_4) to alkenes
	

5. Substitution reactions:

Alcohols ($SOCl_2$ or $ZnCl_2$/HCl Lucas reagent) to haloalkanes	Haloalkanes (aq KOH) to alcohols
	

5. Substitution reactions:

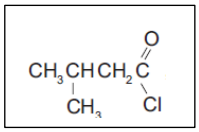
<table>
<tr><th>carboxylic acids→ acids chlorides (PCl_5 or $SOCl_2$) reflux</th><th>acid chlorides +ammonia → 1° amide + HCl ($HCl + NH_3 \rightarrow NH_4Cl$)</th></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><th>Acid chloride (water) → carboxylic acids</th><th>acid chlorides +amines → 2° amide + amine salt</th></tr>
<tr><td> 
</td><td> 
</td></tr>
</table>

Past NCEA questions Addition, Substitution and Elimination reactions

2013: 2a. For the following conversions, identify the reagent required, and state the type of reaction occurring.
(ii) Butan-2-ol is converted to a mixture of but-1-ene and but-2-ene.

2013: 2a (ii) Butan-2-ol is converted to a mixture of but-1-ene and but-2-ene.

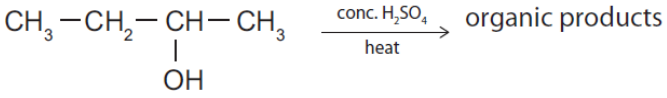
Discuss the reaction occurring in (ii) above, with reference to the structures of the organic reactant and products.

2013: 3c. When ammonia reacts with  two products are formed.

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

Past NCEA questions Addition, Substitution and Elimination reactions

2014: 1b. When butan-2-ol undergoes a reaction with concentrated H_2SO_4, three possible organic products form, which are isomers of each other.



(i) Draw the three isomers formed during this reaction.
(ii) Which of the three isomers from part (i) will be formed in the smallest amount?

2015: 1c (i) draw the three structural isomers of C_4H_9Cl that represent a primary, secondary and 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.

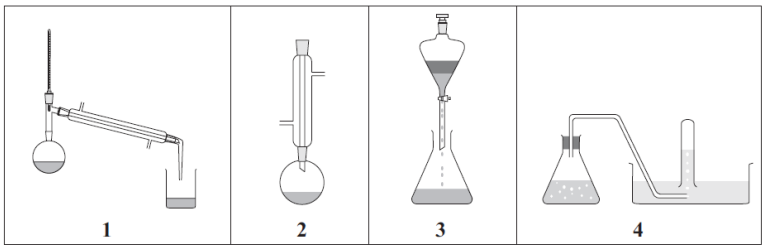
2018: 1c. Unknown X has the molecular formula $C_4H_8O_3$ and undergoes the following reactions:

• It reacts with sodium carbonate solution to release carbon dioxide gas.
• When X is heated with acidified potassium dichromate, the colour changes from orange to green, but the product does not react with Benedict's solution.
• X undergoes an elimination reaction with concentrated sulfuric acid to produce two organic products.
Based on the information above, draw the structural formula of Unknown X.
Justify your structural formula of X, including:
• structural formulae of any organic products
• an explanation of any major and minor products.

2020: Question 1b: Devise a reaction scheme to convert 1-bromobutane into butanoyl chloride.

$CH_3CH_2CH_2COCl$ butanoyl chloride
For each step of the reaction scheme, include:
• reagents and conditions
• structural formula of the organic product after each step.

Writing Excellence answers to Oxidation Reactions of Alcohol questions

Oxidation Reactions of Alcohol QUESTION
Question: Discuss the laboratory procedures used to convert butan-1-ol into butanal, and butan-1-ol into butanoic acid. 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 Identify which piece of the equipment that a student would use to perform each process from the diagrams below. 

ANSWER	
1. For the conversion of butan-1-ol into butanal: Identify the laboratory procedure used and select the numbered equipment	
2. give the reagent used: butan-1-ol into butanal	
3. Explain why this laboratory procedure was required: butan-1-ol into butanal	
4. give any observations seen: butan-1-ol into butanal	
5. For the conversion of butan-1-ol into butanoic acid Identify the laboratory procedure used and select the numbered equipment	
6. give the reagent used: butan-1-ol into butanoic acid	
7. Explain why this laboratory procedure was required: butan-1-ol into butanoic acid	
8. give any observations seen: butan-1-ol into butanoic acid	

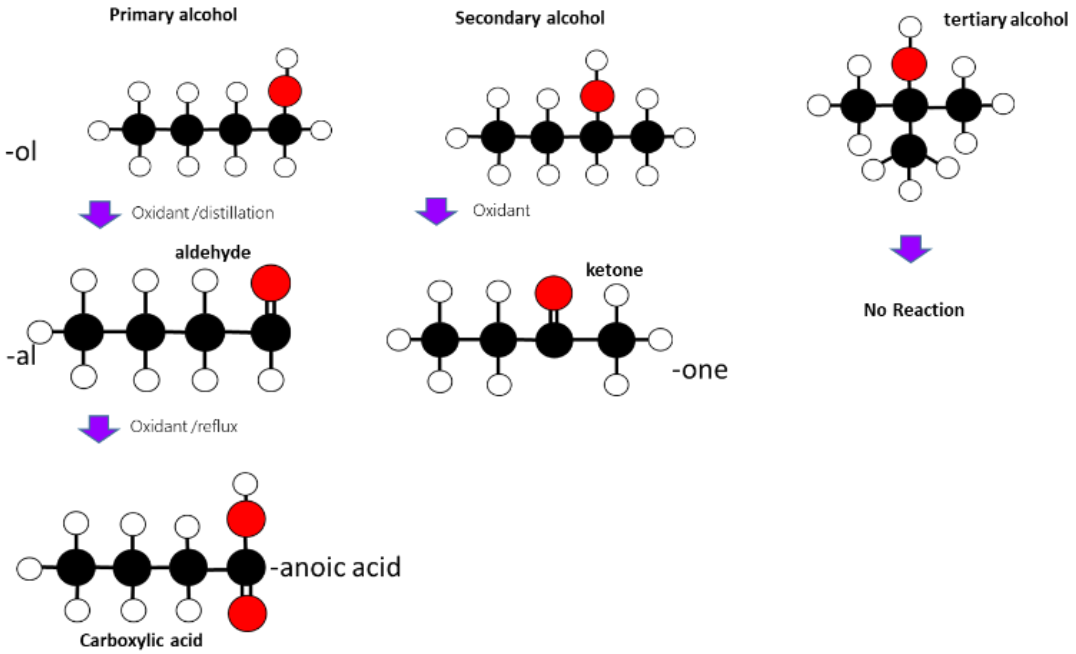
NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

Writing Excellence answers to Redox Reactions of Ketones and Aldehydes questions

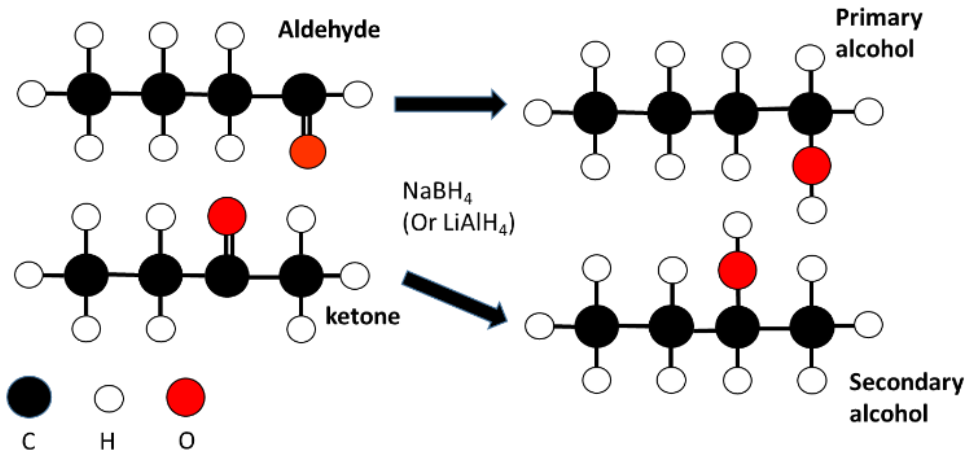
Redox Reactions of Ketones and Aldehydes QUESTION	
Question: (i) What reagent can be used to reduce aldehydes and ketones? (ii) For the reduction of pentanal and pentan-2-one, draw the structure of the organic product formed in each case. Identify the functional group of each product formed. (iii) Using Benedict's reagent (Cu^{2+}) Give a description of test observations that could be used to distinguish between pentanal and pentan-2-one. Plus any equations to show the organic products formed, if applicable.	
ANSWER	
1. Name the reagent for reduction of Aldehydes and Ketones	
2. Draw the products for the reduction reaction of pentanal and name the functional group	Functional Group:
3. Draw the products for the reduction reaction of pentan-2-one and name the functional group	Functional Group:
4. Give the expected observations of the test for pentanal Plus any equations if applicable	
5. Give the expected observations of the test for pentan-2-one Plus any equations if applicable	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

6. Oxidation reactions of alcohols:



7. Reduction reactions of aldehydes/ketones:



Past NCEA questions Oxidation and Reduction reactions

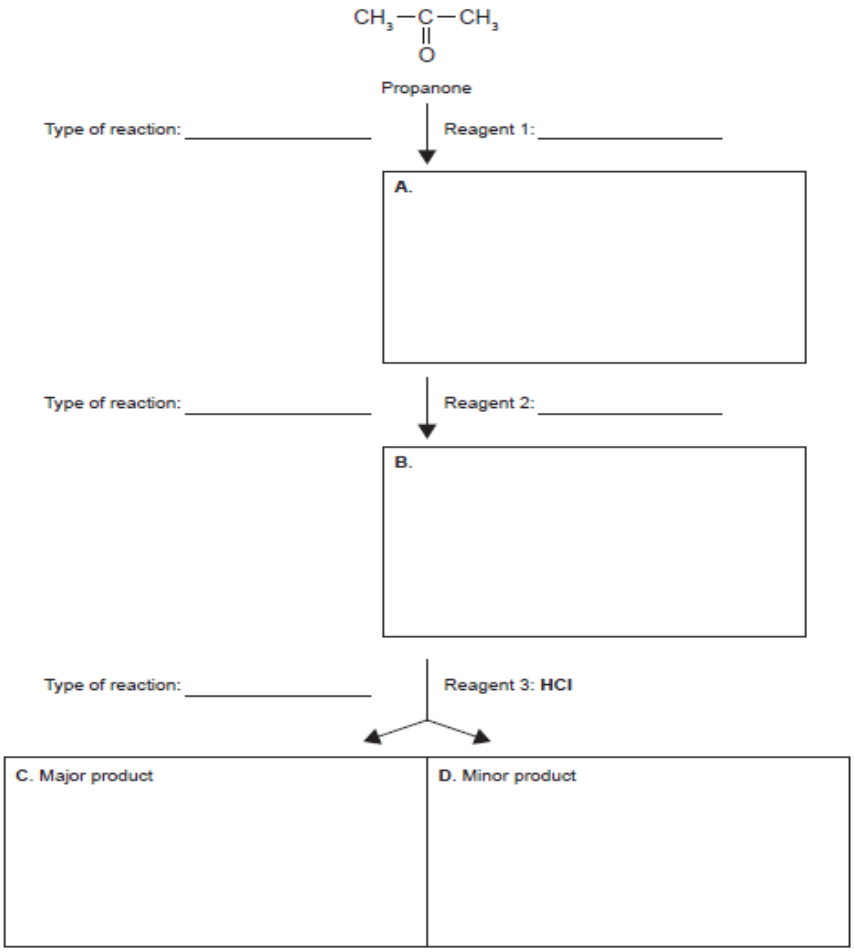
2013: 2a. For the following conversions, identify the reagent required, and state the type of reaction occurring.
(i) Pentan-2-one is converted to pentan-2-ol.

2013: 2b. Discuss the laboratory procedures used to convert butan-1-ol into butanal, and butan-1-ol into butanoic acid.
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.

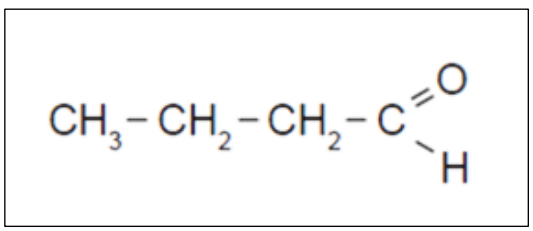
2016: 2a: (i) What reagent can be used to reduce aldehydes and ketones?
(ii) For the reduction of pentanal and pentan-2-one, draw the structure of the organic product formed in each case. Identify the functional group of each product formed.

2016: 3b. Draw a reaction scheme to show the conversion of butan-1-ol to butan-2-one.
You should include any relevant reagents, conditions required, and the structures of all organic substances involved.

2017. 1b Complete the following reaction scheme by drawing the structural formulae of both organic compounds A and B, as well as the major and minor products C and D.
Identify both reagents 1 and 2, and indicate the type of reaction occurring at each step.



2018: 2c: The structural formula of butanal is:



Devise a reaction scheme to convert butanal into butanone.
For each step include:
• the reagents and conditions
• structural formula of the organic product after each step.

2019: 1a (i): Propanal, $CH_3 - CH_2 - CHO$, can be formed from the oxidation of a primary alcohol.

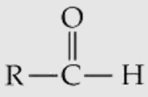
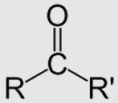
Draw the structural formula of the primary alcohol and explain why distillation is required to obtain the aldehyde product during the oxidation process.

Writing Excellence answers to Identification Tests questions

Identification Tests QUESTION	
Question: 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. Write equations if any products formed	
ANSWER	
1. state method (general)	
2. Give observations with water and litmus paper for butan-1-ol and link to functional group Write equations if any products formed	
3. Give observations with water and litmus paper for butanoic acid and link to functional group Write equations if any products formed	
4. Give observations with water and litmus paper for butanoyl chloride and link to functional group Write equations if any products formed	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

8. Distinguishing tests/redox equations: aldehyde positive for Tollens/Benedicts/permanganate

Testing Reagent	observations	
	Aldehyde 	Ketone 
Potassium permanganate MnO_4^- to Mn^{2+} 	Oxidises into carboxylic acid Purple to colourless	No reaction
Tollens' reagent $[Ag(NH_3)_2]^+$ to Ag 	Oxidise aldehydes (but not alcohols) Silver 'mirror' forms	No reaction
Benedict's solution Cu^{2+} ions to Cu^+ 	Oxidises aldehydes (but not alcohols) to form Cu^+ ions Red/brown ppt forms	No reaction

Past NCEA questions Identification Tests (Part One)

2013: 3a:(ii) Describe how you could distinguish between the alcohols in (i) above, using chemical tests on the alcohols and / or their oxidation products.

2013: 2c: 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.

2014: 2(a): (iv) Explain why the equipment to the right is used for hydrolysis of the triglyceride.

(i) Aqueous solutions of propanamine and propanamide.
(ii) Propanone and propanal.
(iii) Propanoyl chloride and propyl propanoate.

2016: 2b: Explain how you would identify each of the organic substances, A to D, from the table in In your answer, you should include:

- a description of any tests carried out and any observations you would make
- equations to show the organic products formed, if applicable.

A: Propan-1-amine. (1-propanamine)	B: Propanal.
C: Propanoyl chloride.	D: Propan-2-one. (propanone)

(i) using only moist litmus paper, water, and Benedict's solution.

Past NCEA questions Identification Tests (Part Two)

2017: 2b (i): Adding an acidified potassium dichromate solution to propan-1-ol can produce either propanal or propanoic acid.

Explain the laboratory procedure used to convert propan-1-ol to propanal.

In your answer, you should:
• outline the procedure for the conversion, and describe any colour changes linked to the species involved
• state the type of reaction occurring
• explain how the procedure ensures only propanal is collected.

2017: 2b (ii): Explain how Benedict's solution can be used to distinguish between propanone and propanal.

In your answer, you should include:
• any observations made linked to the organic compounds involved
• the type of reaction occurring
• relevant equations showing any organic reactants and products involved.

2018: 1b: Three bottles, each containing a different colourless liquid, have been incorrectly labelled. The three colourless liquids are known to be:

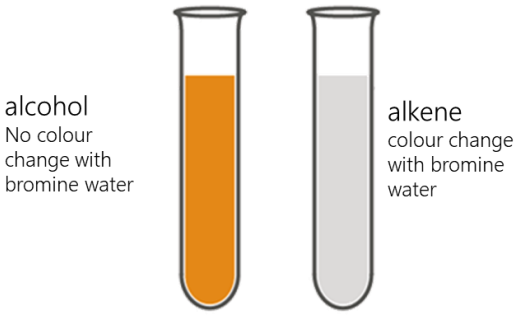
pentanal $CH_3CH_2CH_2CH_2CHO$
pentan-1-ol $CH_3CH_2CH_2CH_2CH_2OH$
pentanoyl chloride $CH_3CH_2CH_2CH_2COCl$

Develop a procedure to identify each of the three colourless liquids using only the following reagents:
• water
• Tollens' reagent
• acidified potassium dichromate, H^+ / $K_2Cr_2O_7$.

Your procedure should include:
• observations linked to the species involved
• the type of reaction occurring
• structural formulae of any organic products.

2019: 1b: Describe and explain a chemical test to distinguish the following pairs of organic molecules.

Your answer should include:
• reagents and conditions required
• observations
• the reaction type used to distinguish each pair
• structural formulae of any organic products.
(i) propan-1-ol and propene
(ii) butanal and butan-1-ol
(iii) ethanoyl chloride and ethyl pentanoate



2020: Question 1a: (ii) Describe and explain a chemical test to distinguish between compounds B and D from the table in part (i).

B	$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_3$
D	2-methylbutanal

Your answer should include:
•reagents and conditions required
• observations
•the type of reaction occurring
•structural formulae of any organic product(s).

2020: Question 2b: Three bottles, each containing a different colourless liquid, have been incorrectly labelled. The three colourless liquids are known to be:

butanoyl chloride	$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-Cl$
butanoic acid	$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-OH$
butan-2-ol	$CH_3-CH_2-\underset{\underset{OH}{\|}}{CH}-CH_3$

Develop a procedure to identify each of the three colourless liquids using only the following reagents:
• sodium carbonate solution, Na_2CO_3 • water, H_2O

• acidified potassium permanganate solution, $KMnO_4$ /H^+.

Your procedure should include: • observations • the type of reaction occurring

• structural formulae of any organic products.

Writing Excellence answers to Esterification questions

Ester Hydrolysis QUESTION

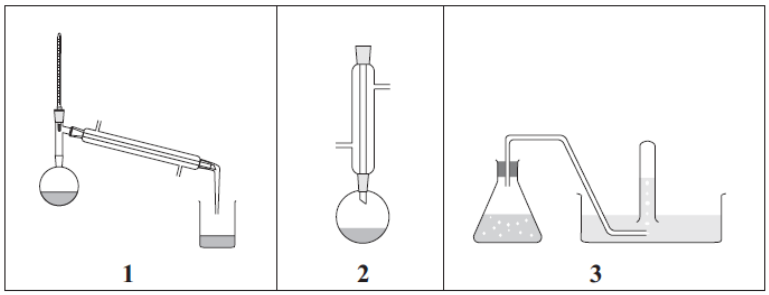
Question: Many organic synthesis reactions are heated under reflux.

(i) Draw the structural formula and name the ester formed from heating ethanol and butanoic acid under reflux in the presence of concentrated sulfuric acid.

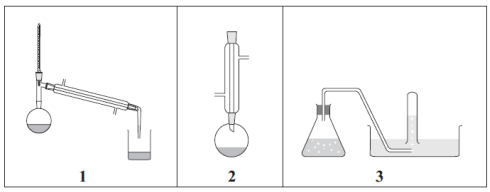
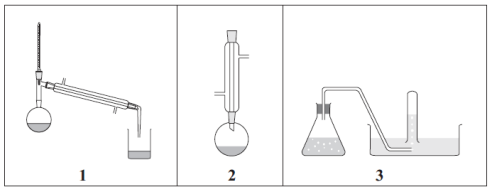
(ii) From the diagrams below, give the number of the apparatus used for heating under reflux.

(iii) Outline the advantages of heating under reflux in the preparation of the ester in part (i).

(iv) From the diagrams below, give the number of the apparatus and explain the process that could be used to purify (separate) the ester in part (i) from the reaction mixture.

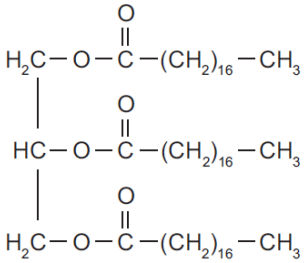


ANSWER

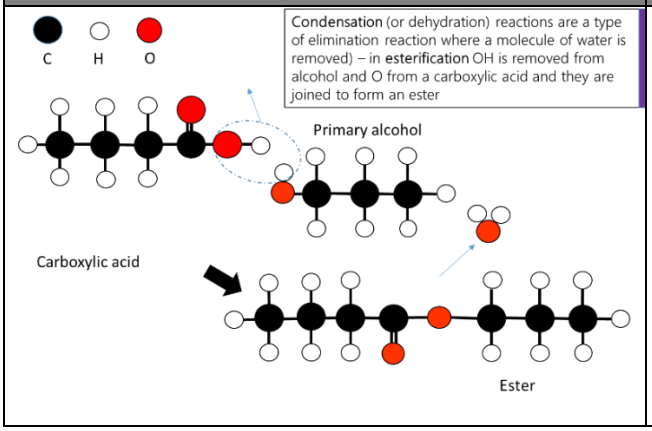
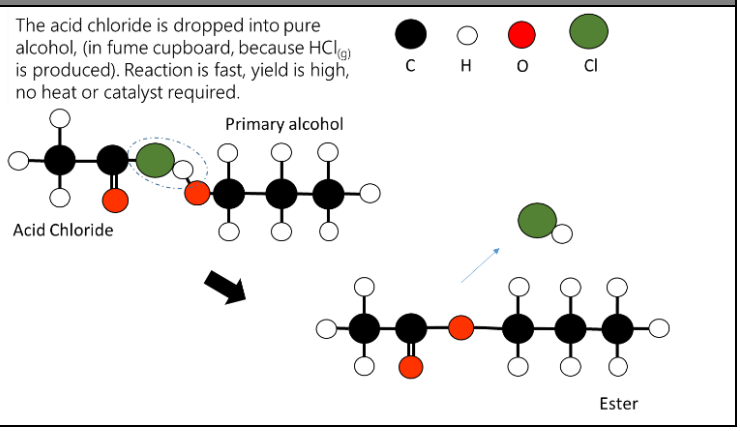
1. Draw structure and name ester formed	
2. Select correct diagram for reflux	
3. explain advantages / purpose of reflux	
4. Select correct diagram for distillation	
5. State the process (distillation), and describe process of how the ester is separated from the alcohol and carboxylic acid liquids in terms of boiling point, evaporation and condensation	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your

Writing Excellence answers to Ester Hydrolysis questions

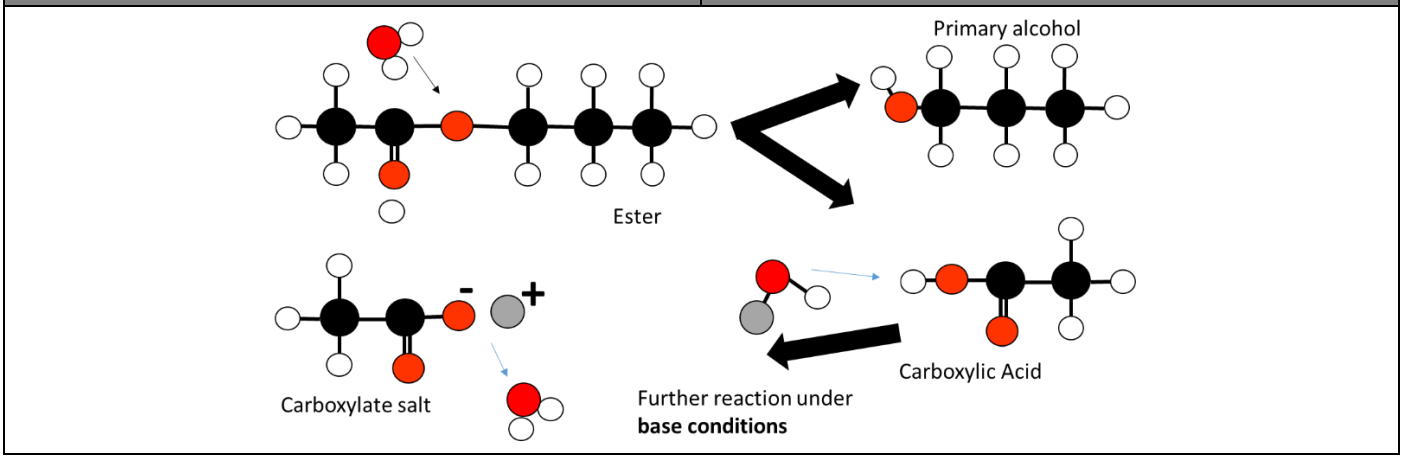
Ester Hydrolysis QUESTION		
Question: Give the structures and functional groups of the products of the reactions below. These reactions are carried out by heating in either: • dilute hydrochloric acid solution, or • dilute sodium hydroxide solution. Compare and contrast the reactions below. In your answer, you should include the type of reaction(s) taking place. 		
ANSWER		
1. Draw (condensed) the products for the reaction with dilute hydrochloric acid solution	Functional Group:	Functional Group:
2. Draw (condensed) the products for the reaction with dilute sodium hydroxide solution	Functional Group:	Functional Group:
3. explain what type of reaction occurs in both acid and base conditions and the link it occurs with		
4. discuss the products of the reaction in the acid conditions		
5. discuss the products of the reaction in the base conditions		

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your

10. Esterification reactions: alcohol + carboxylic acid → ester (conc H_2SO_4) reflux with Na_2CO_3 and anhydrous $MgSO_4$	11. Esterification reactions of acid chlorides: acid chloride + alcohol → Ester + HCl
	

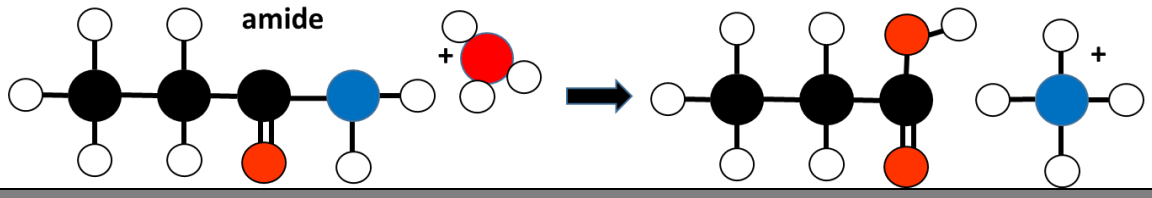
12. Hydrolysis reactions of esters:

acid: ester → alcohol + carboxylic acid	base: (NaOH) ester → alcohol + salt

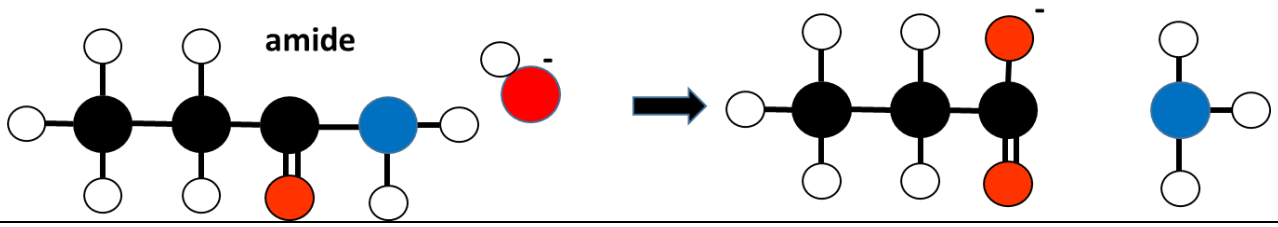


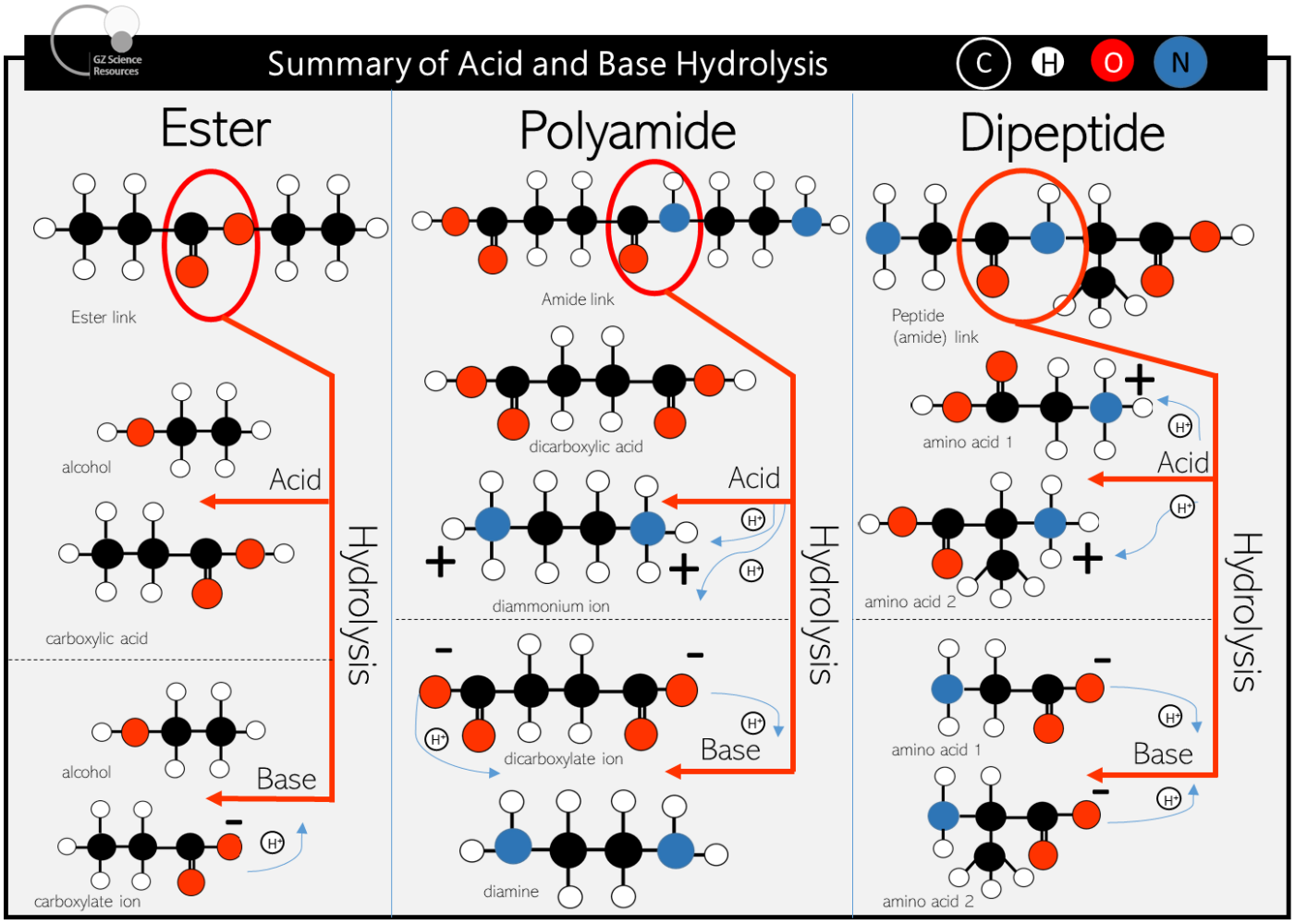
13. Hydrolysis reactions of amides:

acid: amide + H_3O^+ → carboxylic acid + NH_4^+



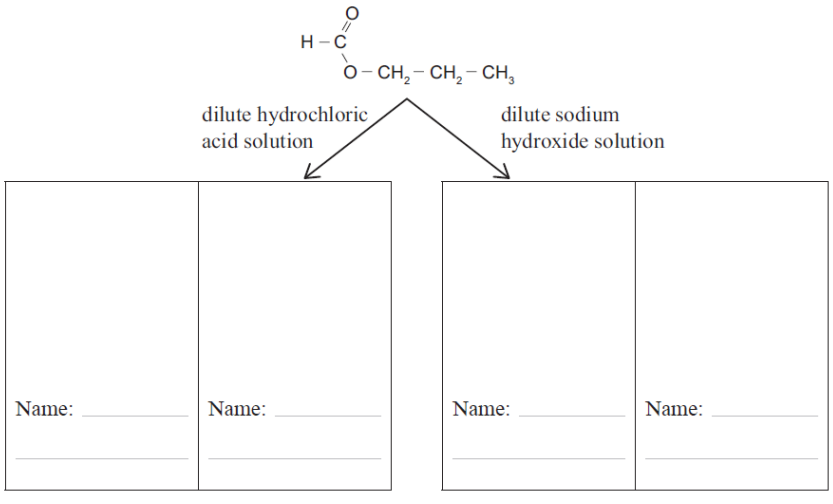
base: amide + OH^- → carboxylate ion $^+$ + NH_3





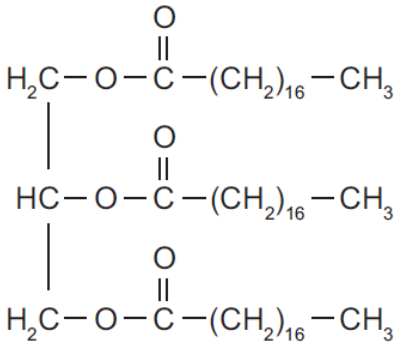
Past NCEA questions Esterification and Ester Hydrolysis reactions (Part One)

2013: 1d. 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.
Compare and contrast the reactions below. In your answer, you should include the type of reaction(s) taking place.



Past NCEA questions Esterification and Ester Hydrolysis reactions (Part Two)

2014: 1(c): (i) The triglyceride below is shown in condensed form. Circle a functional group on the diagram above and give its name

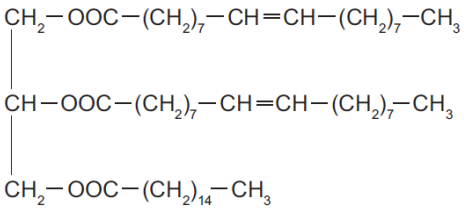


(ii) Compare and contrast the reaction of the triglyceride when it undergoes both acidic and basic hydrolysis.

In your answer you should include:

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

2015: 3(a): A triglyceride has the following structure:

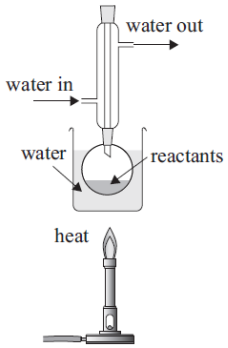


(i) Circle one of the alkene groups in the triglyceride molecule. This triglyceride is described as unsaturated.

(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.

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

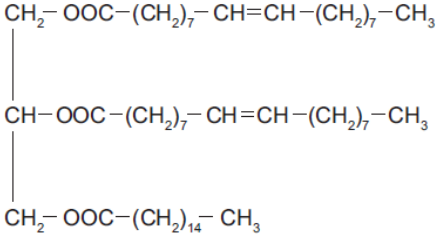
(iv) Explain why the equipment to the left is used for hydrolysis of the triglyceride.



2016: 3c A triglyceride found in olive oil has the following structure beside:

(i) Put a circle around one of the ester groups in the triglyceride molecule shown above.

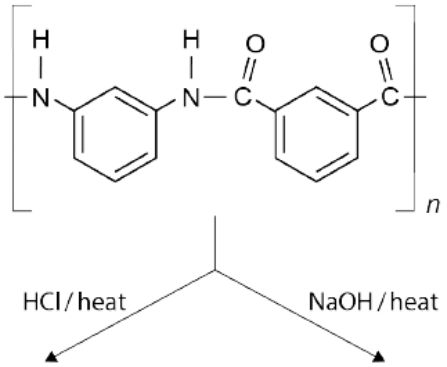
(ii) Draw the structural formulae of the products produced by the hydrolysis of this triglyceride in basic conditions, using aqueous sodium hydroxide, NaOH.



2017: 3c: Polymers such as Nomex® can be hydrolysed by either aqueous acid or base.
Show the products of the hydrolysis of Nomex® using:

(i) aqueous acid

(ii) aqueous base.



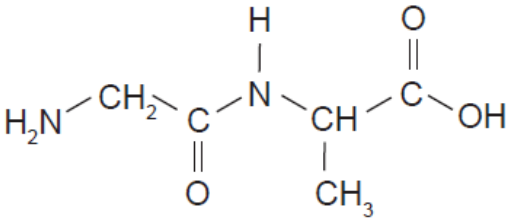
2018: 2b: Dipeptides are made from two amino acids joined by an amide (peptide) bond. The dipeptide shown below is made from glycine and alanine:

(i) Circle the amide (peptide) bond.

(ii) Compare and contrast the acidic and basic hydrolysis of the above dipeptide.

Your answer should include: • an explanation of the hydrolysis reaction

• structural formulae of the products formed when the dipeptide undergoes acidic and basic hydrolysis



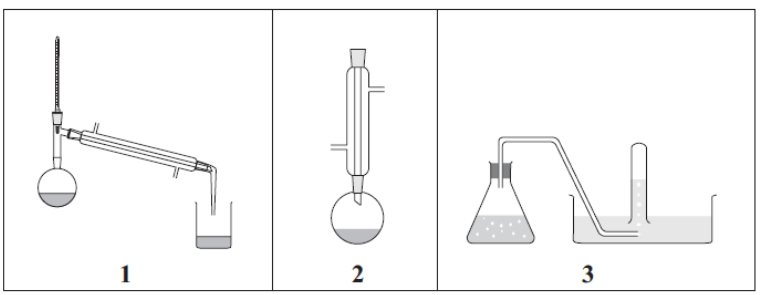
2018: 3b: Many organic synthesis reactions are heated under reflux.

(i) Draw the structural formula and name the ester formed from heating ethanol and butanoic acid under reflux in the presence of concentrated sulfuric acid.

(ii) From the diagrams below, give the number of the apparatus used for heating under reflux.

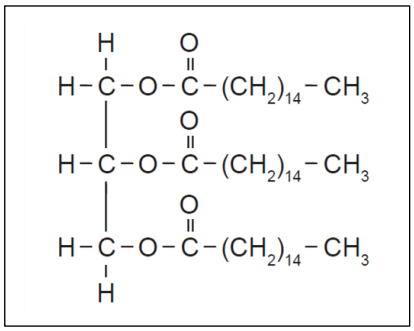
(iii) Outline the advantages of heating under reflux in the preparation of the ester in part (i).

(iv) From the diagrams below, give the number of the apparatus and explain the process that could be used to purify (separate) the ester in part (i) from the reaction mixture.



Past NCEA questions Esterification and Ester Hydrolysis reactions (Part Three)

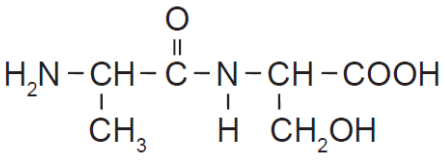
2019: 3b: Triglycerides are found in fats and oils. Beside is an example of a triglyceride.



(i) Put a circle around ONE of the ester groups in the triglyceride molecule shown above.

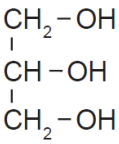
(ii) Compare and contrast the acidic and basic hydrolysis of the triglyceride molecule shown above.
In your answer you should include:
•an explanation of the hydrolysis reaction
•structural formulae of the products formed from both acidic and basic hydrolysis
•reagents and conditions required.

2020: Question 3b: (ii) Compare and contrast the acidic and basic hydrolysis of the dipeptide shown below.

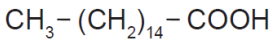


Your answer should include:
- a description of a hydrolysis reaction
- reagents and conditions required
- structural formulae of the products from BOTH acidic and basic hydrolysis.

2020: Question 3c: (i) Draw the structural formula of the triglyceride that would be formed from glycerol and the fatty acid, palmitic acid, provided below.



glycerol

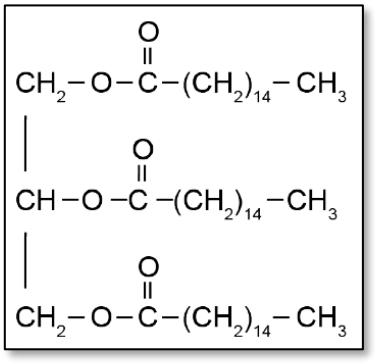


palmitic acid

Question 3c: (ii) Explain why this is a condensation reaction.

Question 3c: Below is the structural formula of the triglyceride that would be formed from glycerol and the fatty acid, palmitic acid.

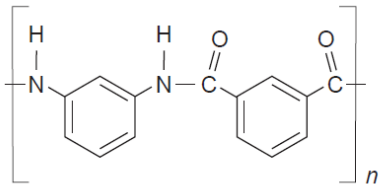
(iii) The triglyceride formed in (c)(i) can be hydrolysed by heating under reflux in either acidic or basic conditions.
Outline the advantages of heating under reflux when hydrolysing a triglyceride.



Writing Excellence answers to Polymerisation Reactions questions

Polymerisation Reactions QUESTION

Question: Nomex® is a polymer used in firefighters' suits. Nomex® is made up of two different monomers bonded together to form the polymer chain.
A small portion of the structure of Nomex® is shown below.



Note:  is a benzene ring and does not change when the monomers bond together to form the polymer.

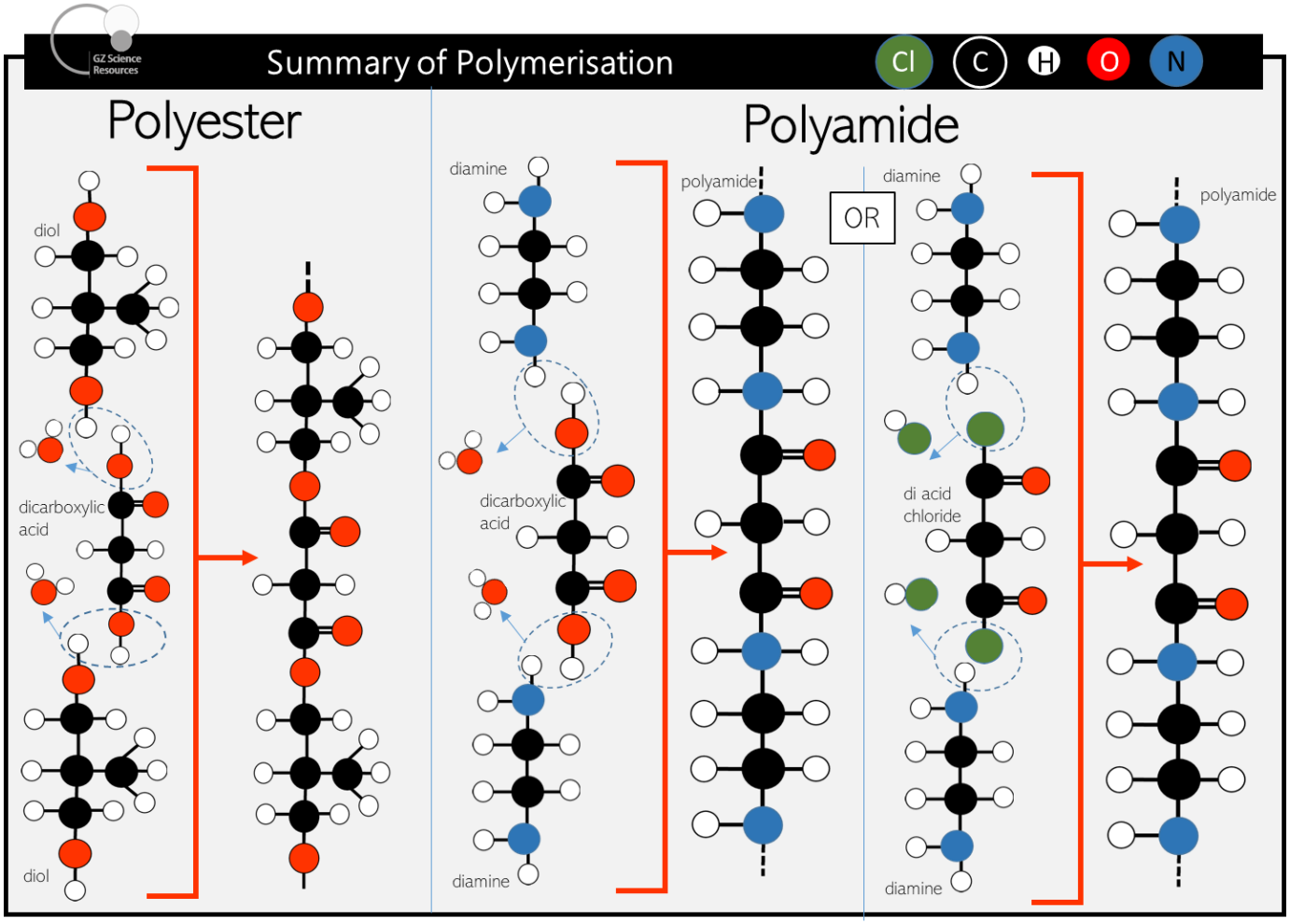
Explain the structure of the polymer, Nomex®.
In your answer, you should include:
• the name of the functional group linking the monomers
• a drawing of both monomers
• a classification of the type of polymer formed, with an explanation to justify your choice.

ANSWER

1. The name of the functional group linking the monomers. Make sure you include the name of the polymer i.e. Nomex has a ..... linkage		
2. Draw the two possible monomers	diamine	dicarboxylic acid (or di acid chloride)
3. Link type of molecule to the type of reaction that forms it and explain the products produced during the reaction (definition)		

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

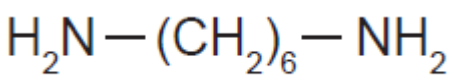
14. Condensation polymerisation:



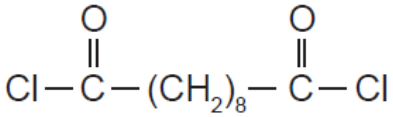
Past NCEA questions Polymerisation Reactions

2015: 2(c): A form of the polymer nylon can be made from the two monomers below.

1,6-diaminohexane



Sebacoyl chloride (decanedioyl dichloride)



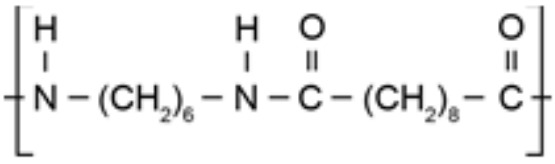
(i) draw the repeating unit of the polymer formed if these two monomers are used.

2015: 2(c): Consider the formation of this form of nylon in a laboratory.

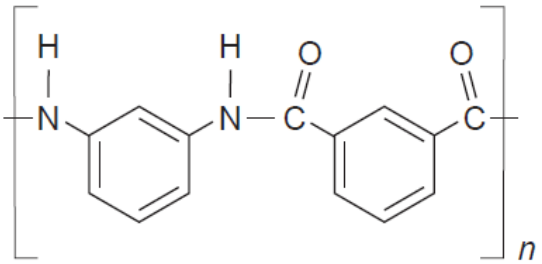
(ii) Describe the type of reaction occurring, and explain why this reaction results in a polymer.

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

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



Past NCEA questions Polymerisation Reactions



2017: 3b: Nomex® is a polymer used in firefighters' suits. Nomex® is made up of two different monomers bonded together to form the polymer chain.

A small portion of the structure of Nomex® is shown beside

Explain the structure of the polymer, Nomex®.
In your answer, you should include:
• the name of the functional group linking the monomers
• a drawing of both monomers
• a classification of the type of polymer formed, with an explanation to justify your choice.

2018: 3a: Glycolic acid can be used to make polyglycolic acid (PGA), a polyester used to make dissolvable stitches. The structure of glycolic acid is shown below:

HO – CH_2 – COOH

(i) In the box below, draw a section of the PGA polymer chain to show THREE repeating units.

(ii) Identify and explain the type of reaction occurring in the formation of PGA.

2019: 3a: Nylon 6,6 is used to make airbags. The monomers used to make nylon 6,6 are shown below:

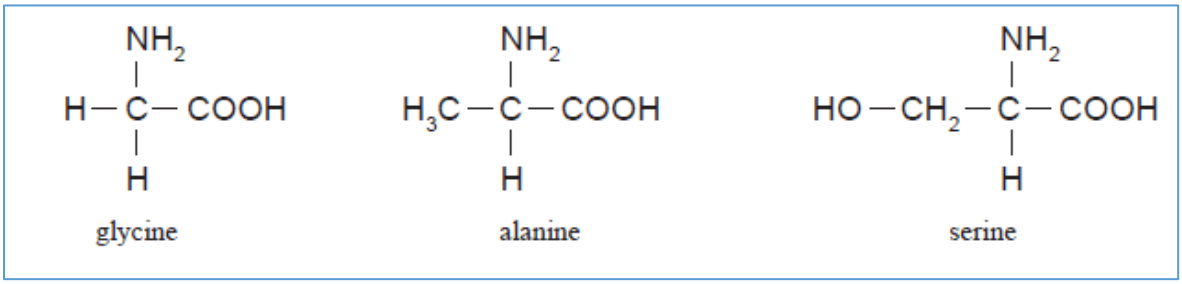
H_2N-$(CH_2)_6$-NH_2 HOOC-$(CH_2)_4$-COOH

(i) In the box below, draw a section of the nylon 6,6 polymer chain to show TWO repeating units.

(ii) Explain why nylon 6,6 is referred to as a condensation polymer.

Writing Excellence answers to Amino Acids questions

Amino Acids QUESTION
Question: 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) Name the type of reaction that occurred when the dipeptides formed in (iii) above. Explain your Answer (iii) One of these amino acids cannot form optical isomers (enantiomers). Name and explain why.

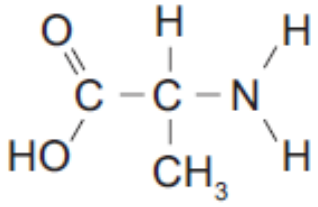


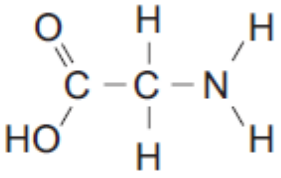
ANSWER	
1. Draw one possible dipeptide Draw the amino acids used	
2. Draw a second possible dipeptide Draw the amino acids used	
3. Give the type of reaction and explain (definition)	
4. state which amino acids cannot form an optical isomer (enantiomer)	
5. Explain why your specific molecule was selected	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

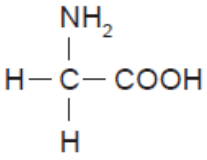
Past NCEA questions Amino Aids

2013: 2d: 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:

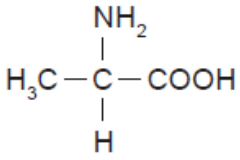




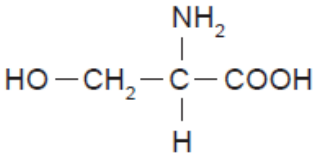
2016: 1c: (iii) Draw the two possible dipeptides formed from the amino acids glycine and alanine.



glycine



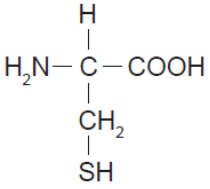
alanine



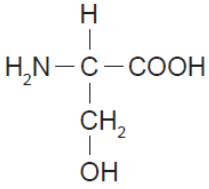
serine

2016: 1c: (iv) Name the type of reaction that occurred when the dipeptides formed in (iii) above. Explain your Answer

2017: Question 3a: Peptides are molecules that form when amino acids combine.
The following structures show the amino acids cysteine and serine



cysteine



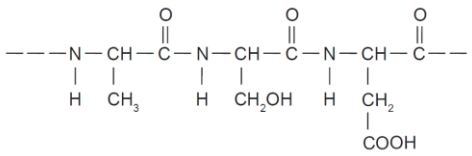
serine

(i) Show two possible dipeptides that can be formed by combining the two amino acids shown above.

(ii) Circle the amide functional group on ONE of the dipeptides drawn in part (i).

2020: Question 3a: Polypeptides are made up of amino acids.

Circle one of the peptide (amide) bonds shown in the section of the polypeptide chain below.



Question 3b: (i) Using the following amino acids, draw the TWO possible dipeptides that could be formed.

Writing Excellence answers to Reaction Scheme questions

Reaction Scheme QUESTION

Question: Complete the following reaction scheme by drawing organic structures for S1 to S7, and identifying reagents 1 to 3.

ANSWER

HINTS:
S1 will be an ester

R1 will result in acid hydrolysis with two products

R2 will cause an elimination reaction

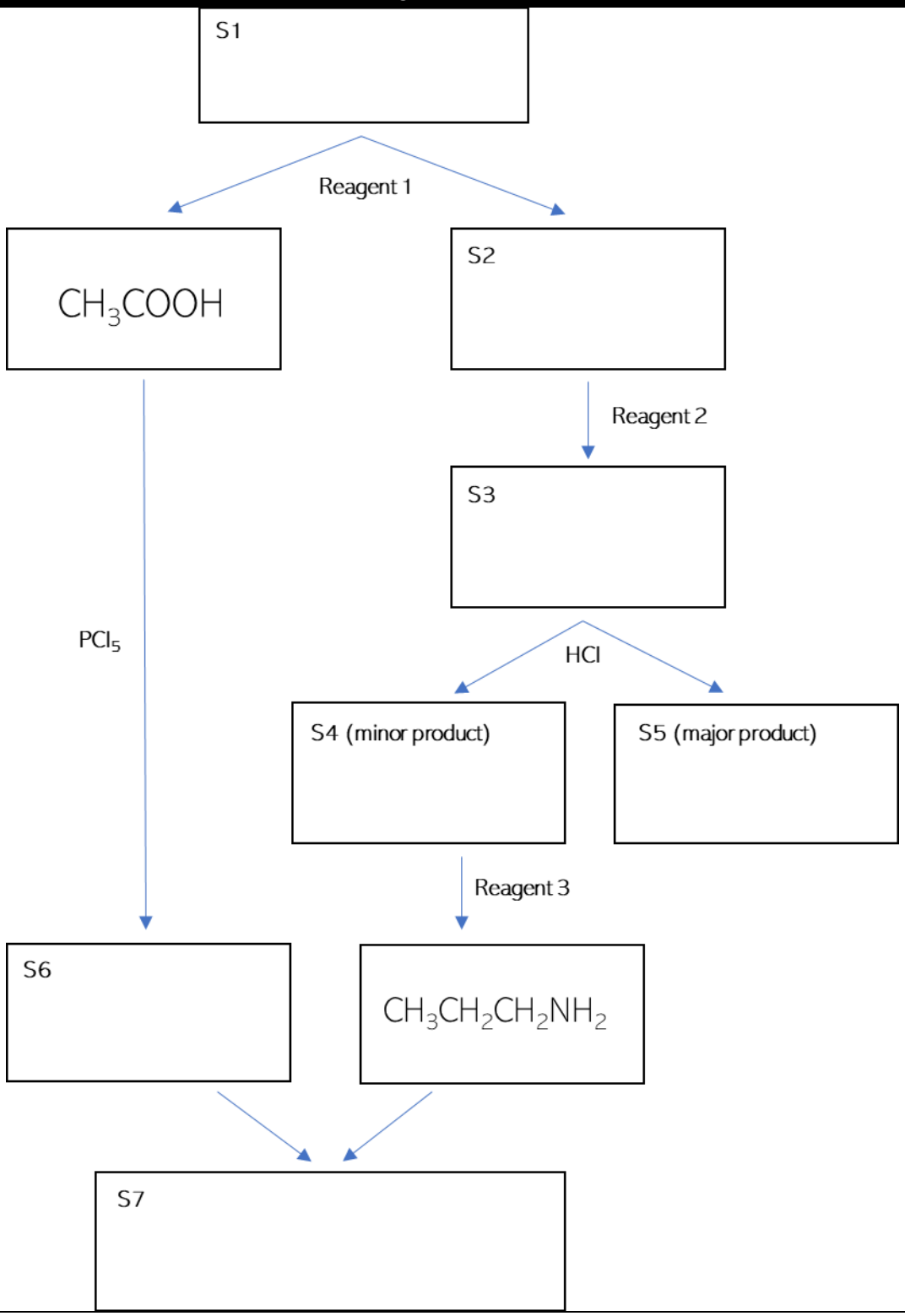
S3 will be an unsaturated substance

S4 and S5 will be the result of an addition reaction

R3 will cause a substitution reaction

S6 is the result of a substitution reaction

S7will be the product of a condensation reaction



C3.5 Reaction Scheme

Reaction Type	arrow colour
substitution	
condensation polymerisation	
oxidation	
condensation	
elimination	
hydrolysis	
addition	
acid-base	
reduction	

C H I Cl Br O N Na

Alkane

Do not need to name 2° and 3° for L3

3° Amine **2° Amine**

Slow

UV light

Turn red litmus to blue

1° Amine

H_2 (Pt) Heat

Br_2 Cl_2

Alkene

fast

HCl

NH_3 warm

Amine warm

Dibromoalkane

Br_2

Haloalkane

H_2O/H^+ heat

Conc. H_2SO_4 heat

Alc. KOH reflux

Amino Acid

Alcohol

3° alcohol 2° alcohol 1° alcohol 1° alcohol

$KOH_{(aq)}$ reflux

PCl_3, $SOCl_2$ reflux

Polymerisation
Condensation

dipeptide

polyester
di-carboxylic acid
di-alcohol

1° alcohol

2° alcohol

$Cr_2O_7^{2-}/H^+$ heat

NaBH$_4$

NO reaction to Tollens, Oxidants Benedict's

Ketone

$Cr_2O_7^{2-}/H^+$ cold

NaBH$_4$

Positive reaction to Tollens Oxidants Benedict's

Aldehyde

$Cr_2O_7^{2-}/H^+$ reflux

H_2O/H^+

$Cr_2O_7^{2-}/H^+$ reflux

MnO_4^-/H^+ can also be used as an oxidant

Plus alcohol

Conc. H_2SO_4

H_2O

Carboxylic Acid

NH_3

Carboxylate ion

H_2O

NH_4^+

heat

NH_3

Ester

$SOCl_2$ reflux

H_2O

H_3O^+

NaOH

ethanol

Violent reaction to water

Acid chloride

NH_3 or amine In ethanol

2° amide **3° amide** **1° amide** **Amide**

polyamide
di-acid chloride
di-amide

$NH_{3(alc)}$

Past NCEA questions Reaction Schemes

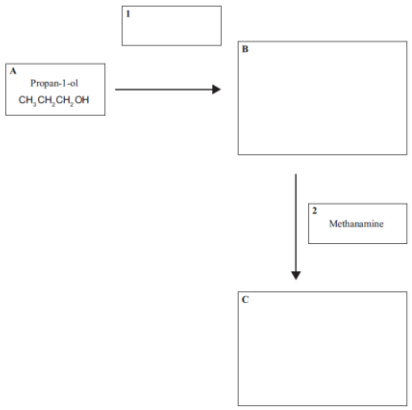
2013: 2a: For the following conversions, identify the reagent required, and state the type of reaction occurring.

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

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

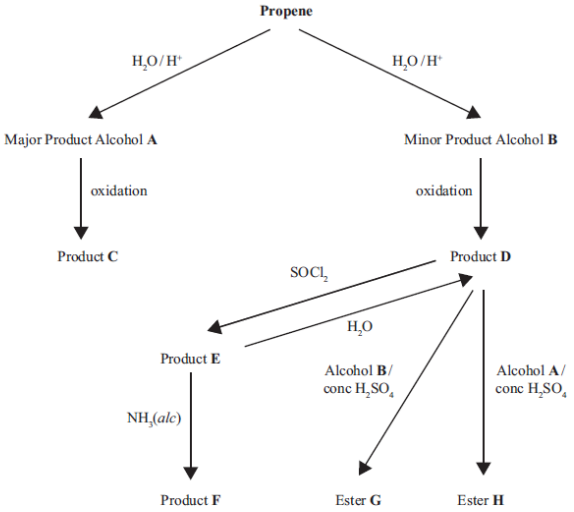
2013: 3(a): Complete the following reaction scheme by drawing the structural formulae of the organic compounds B and C, and identifying reagent 1.

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



2014: 3(a): Propene can be reacted with water in the presence of acid to form a major product (A) and a minor product (B).

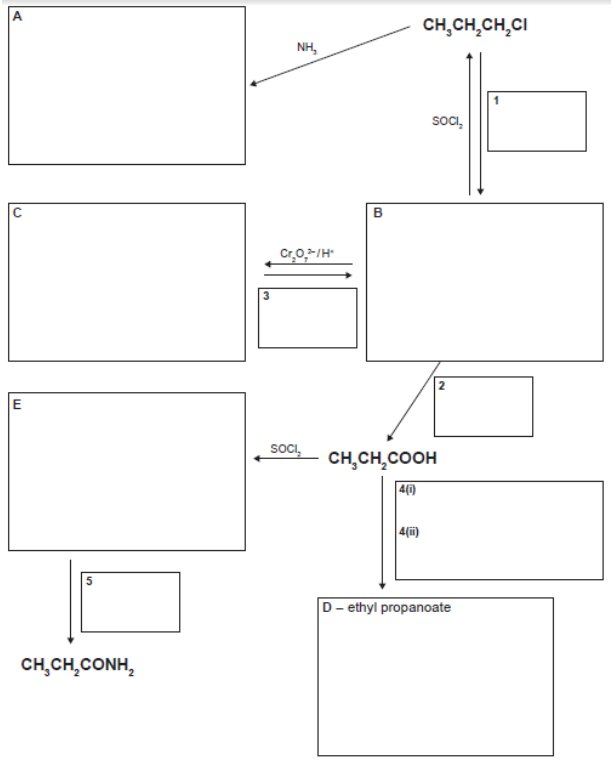
- A is oxidised to form product C.
- B is oxidised to form product D.
- When D is reacted with $SOCl_2$, it forms product E.
- When D is reacted with alcohol B, it forms an ester G.
- When D is reacted with alcohol A, it forms ester H, which is an isomer of G.
- When E is reacted with alcoholic ammonia,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



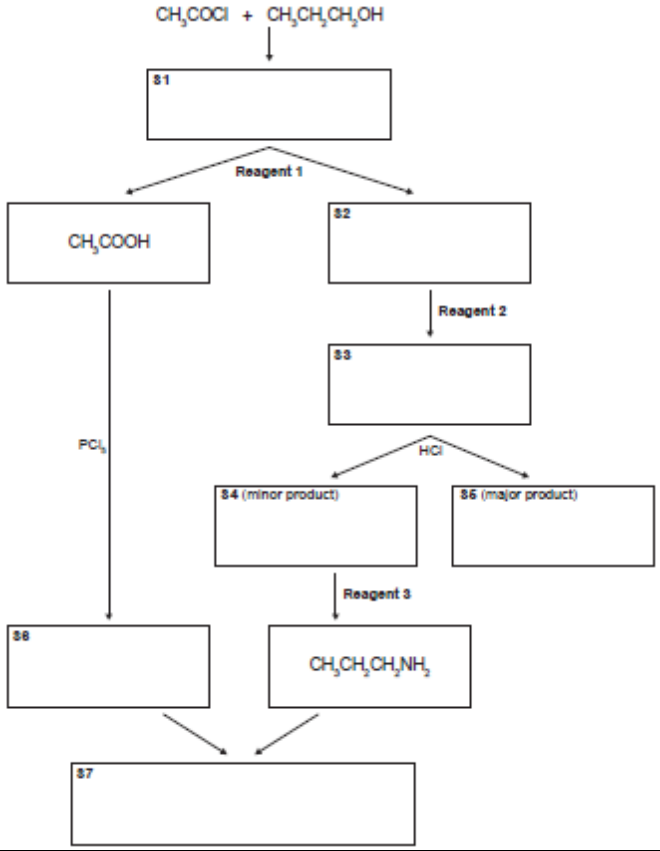
2016: 3b: Draw a reaction scheme to show the conversion of butan-1-ol to butan-2-one.

You should include any relevant reagents, conditions required, and the structures of all organic substances involved.

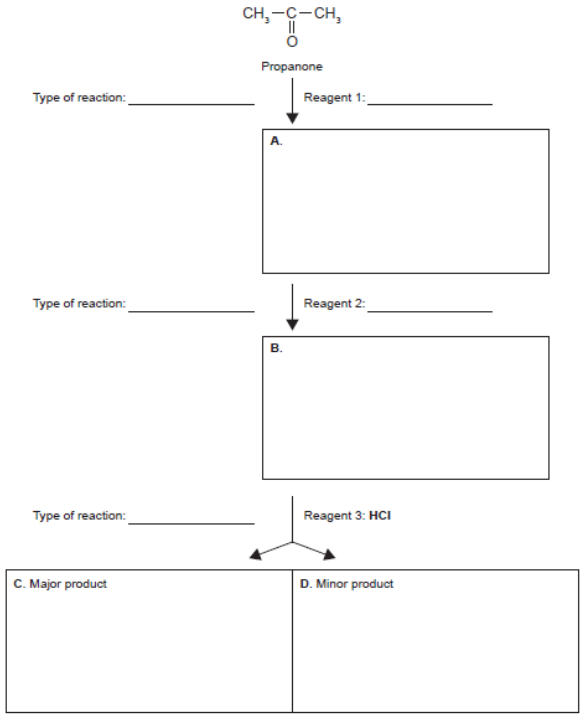
2015: 3(b): Complete the following reaction scheme by drawing the structural formulae of the organic compounds A to E, and identifying reagents 1 to 5



2016: 3a: Complete the following reaction scheme by drawing organic structures for S1 to S7, and identifying reagents 1 to 3.



2017: 1b: Complete the following reaction scheme by drawing the structural formulae of both organic compounds A and B, as well as the major and minor products C and D. Identify both reagents 1 and 2, and indicate the type of reaction occurring at each step.



2017: 2a:

Compound P and compound Q are straight-chain constitutional (structural) isomers with the molecular formula $C_5H_{12}O$.

Compound P can form optical isomers, whereas compound Q cannot.

When reacted with concentrated sulfuric acid, compound P forms two products, compounds R and S; compound Q forms only one product, compound S.

When compound Q is reacted with *Reagent 1*, it forms a chloroalkane, compound T.

Compound T reacts with concentrated NH_3 to form compound U.

Compound Q can also be oxidised to form compound V, which will turn moist blue litmus paper red.

Compound V can also be reacted with compound Q and *Reagent 2*, to form a sweet-smelling liquid, compound W.

Use the information above to identify compounds P to W, and *reagents* 1 and 2. .

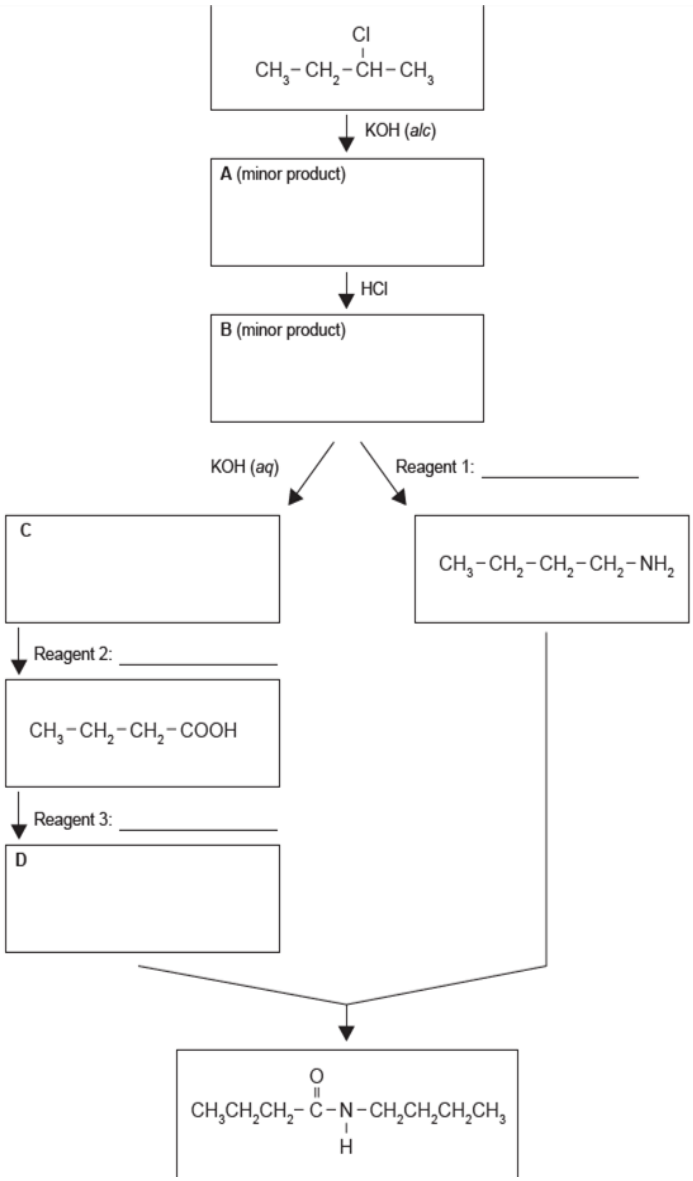
Past NCEA questions Reaction Schemes

2019: 1c: Unknown W is a straight-chain organic molecule with the molecular formula $C_4H_6OCl_2$.
Unknown W shows the following properties and reactions:

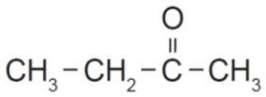
- does not exist as enantiomers (optical isomers)
- produces steamy fumes with water
- reacts with an excess of ammonia to form product X. Product X turns damp litmus blue.

Product X undergoes acidic hydrolysis to produce product Y. Bubbles are released when product Y reacts with sodium carbonate solution.
Draw the structural formulae for the organic molecules W, X, and Y

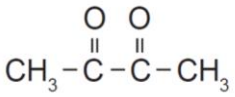
2019: 2b: Complete the following reaction scheme by drawing the structural formulae for organic products A, B, C, and D, and identifying reagents 1, 2, and 3.



2019: 3c: Devise a reaction scheme to convert butanone into butan-2,3-dione.



butanone



butan-2,3-dione

For each step include:

- the reagents and conditions
- the structural formula of the organic product after each step.

Past NCEA questions Reaction Schemes

2020: Question 1c: Unknown S is a branched chain molecule with the molecular formula $C_5H_{10}O$. It shows the following properties and reactions:

• rapidly decolourises bromine water

• exists as enantiomers (optical isomers), but does not exist as cis-trans (geometric) isomers

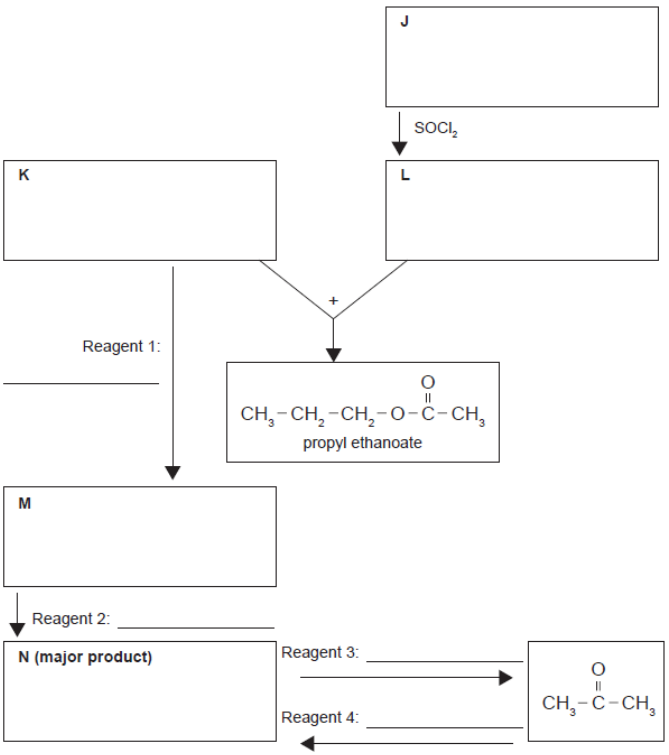
• reacts with acidified potassium dichromate solution, $Cr_2O_7^{2-}$ / H^+, to form Product T, which does not react with Benedict's reagent

• reacts with H_2O / H^+ to form two products, U and V. Product V is the major product.

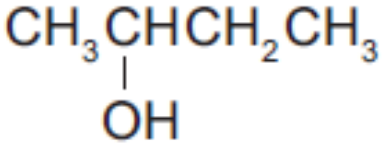
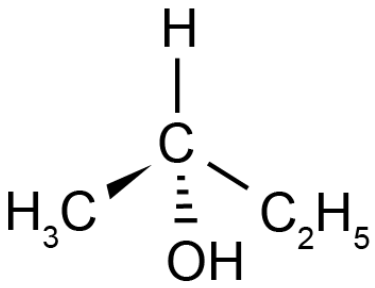
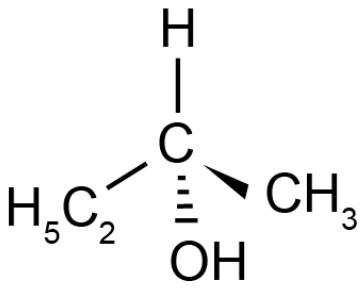
Based on the information above, draw the structural formulae of Unknown S, and Products T, U, and V.

Organic Molecule	Structural formula
S	
T	
U	
V	

2020: Question 2c: Complete the following reaction scheme by drawing the structural formulae for organic molecules J, K, L, M, N, and identifying reagents 1, 2, 3, and 4.

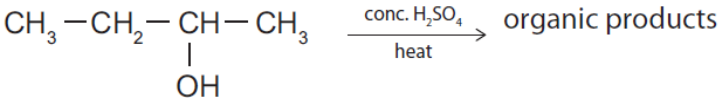
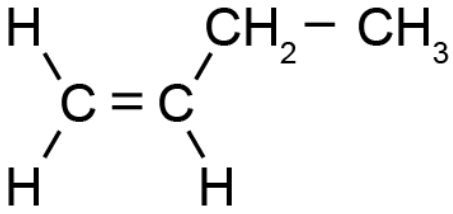
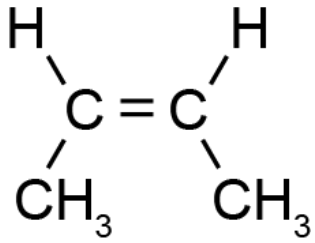
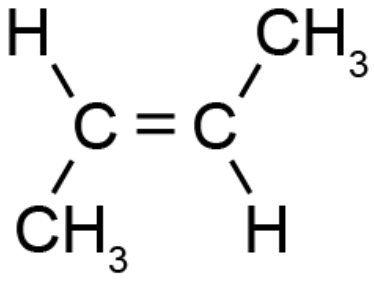


Writing Excellence answers to Optical Isomers questions

Optical Isomers QUESTION		
Question: The alcohol below can exist as two enantiomers (optical isomers). (i) Draw three-dimensional structures for the two enantiomers. (ii) Link the structure of enantiomers to a physical property that can be used to distinguish them from non-optically active molecules. 		
ANSWER		
1. Draw the two optical isomers isomers If you need to select the molecule make sure that it has: a Chiral carbon with 4 different groups attached	left 	right 
2. link the requirements of an enantiomer to the presence of four different groups joined to a C	In order for a molecule to exist as an Enantiomer it needs to have a central carbon atom, called a chiral carbon, with 4 different groups attached to it.	
3. explain the isomers have the same molecular formula but are non-superimposable mirror images	the two isomers have the same molecular formula but are non-superimposable mirror images	
4. link the requirements above to your specific molecule (D)	With the alcohol above the chiral carbon has a –OH, -H, $-CH_3$ and a $-C_2H_5$ group attached to it	
5. link different physical properties to rotating (plane) polarised light in opposite directions.	The two Enantiomers rotate (plane) polarised light in opposite directions.	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

Writing Excellence answers to Elimination Reaction – Multiple Products questions

Elimination reaction – Multiple Products QUESTION	
Question: When butan-2-ol undergoes a reaction with concentrated H_2SO_4, three possible organic products form, which are isomers of each other. (i) Draw the three isomers formed during this reaction. (ii) Which of the three isomers from part (i) will be formed in the smallest amount? 	
ANSWER	
1. Draw the minor product If you need to select the molecule make sure that it has both: a C=C double bond and 2 different groups of each C	 Name: but-1-ene
2. State reaction type and name molecule as the minor product linking to forming in the smallest amount.	This is an elimination reaction and the minor product is but-1-ene so this will form in the smallest amount. (compared to the major products)
3. Explain how the minor product is formed using Saytzeff's rule	Major and minor products will only form in unsymmetrical molecules. Saytzeff's rule states the minor product will have hydrogen atom removed from the carbon (next to the C-OH) that has the most hydrogens
4. Link to your specific molecule (i.e. groups removed, double bond formed)	because the reactant, butan-2-ol, is unsymmetrical then major and minor products will form during an elimination reaction. The –OH group is removed and a double bond forms between the 2 carbon atoms with un-bonded electrons
5. Draw the major product as cis and trans isomers	Cis  Name: cis but-2-ene Trans  Name: trans but-2-ene
6. link the presence of a double C=C bond to lack of rotation and two different groups off each of the C	For *cis* and *trans* isomers to occur a carbon-carbon double bond must be present as this prevents any rotation about this bond, and the atoms or groups of atoms attached to the two carbon atoms are therefore fixed in position. They must also have two different groups attached to each carbon (involved in the double bond).

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

Writing Excellence answers to Multiple Reactants - Substitution and Elimination

Substitution and Elimination Reactions QUESTION

Question: Chloroethane, CH_3CH_2Cl, reacts with aqueous KOH, alcoholic KOH, and with NH_3.
Compare and contrast the reactions of chloroethane with the three reagents.
In your answer you should include:
- the type of reaction occurring and the reason why it is classified as that type
- the type of functional group formed
- equations showing structural formulae for reactions occurring.

ANSWER

Reaction 1

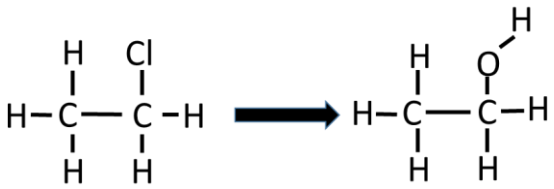
Chloroethane reacts with $KOH_{(aq)}$

Product formed - forms an alcohol, ethanol

Reaction type - in a substitution reaction; Cl is replaced by OH.

Condensed Structural Formula equation
$CH_3CH_2Cl \rightarrow CH_3CH_2OH$

Structural Formula equation



Reaction 2

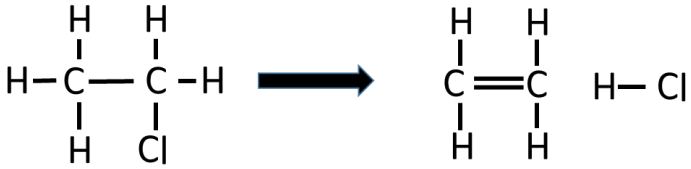
Chloroethane reacts with $KOH_{(alc)}$

Product formed - forms an alkene, ethane (plus a HCl molecule)

Reaction type - in an elimination reaction; H and Cl removed / HCl formed.

Condensed Structural Formula equation
$CH_3CH_2Cl \rightarrow CH_2 = CH_2 + HCl$

Structural Formula equation



Reaction 3

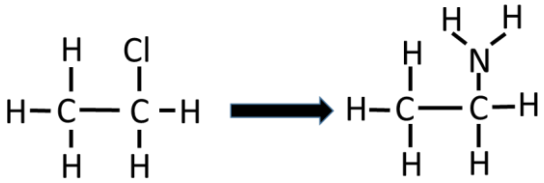
Chloroethane reacts with $NH_{3(alc)}$

Product formed - forms an amine, aminoethane

Reaction type - in a substitution reaction; Cl is replaced by NH_2

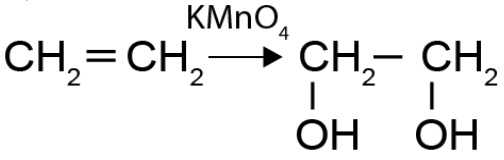
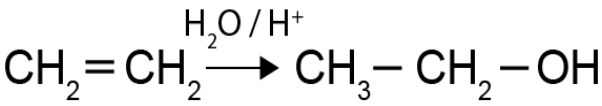
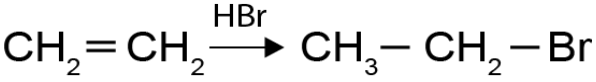
Condensed Structural Formula equation
$CH_3CH_2Cl \rightarrow CH_3CH_2NH_2$

Structural Formula equation



NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

Writing Excellence answers to Multiple Reactants - Addition Reactions questions

Addition Reactions QUESTION	
Question: Ethene, $C_2H_{4(g)}$, reacts with aqueous potassium permanganate solution, $KMnO_{4(aq)}$, dilute acid, H_2O / H^+, and hydrogen bromide, HBr. Compare and contrast the reactions of ethene gas with each of these three reagents. In your answer, you should: • describe any observations that can be made • identify, with reasons, the type of reaction ethene undergoes with each reagent • describe the functional group of the products formed • include equations showing the structural formulae for the organic compounds for each reaction.	
ANSWER	
Reaction 1 Ethene, $C_2H_{4(g)}$ *reacts with* aqueous potassium permanganate solution, **$KMnO_{4(aq)}$,**	Observations - The purple $KMnO_4$ turns colourless (or brown)
	Reaction type - This is an oxidation or addition reaction in which the double bond is broken and two –OH groups attach to each C atom of the double bond.
	Functional group of products Ethene reacts with aqueous $KMnO_4$ to form a diol, ethan-1,2-diol.
	Structural Formula equation 
Reaction 2 Ethene, $C_2H_{4(g)}$ *reacts with* dilute acid, **H_2O / H^+**	Observations - No colour changes are observed in this reaction. (colourless to colourless)
	Reaction type -This is an addition reaction as once again the double bond is broken. However, in this reaction one –OH group and one –H atom attach to each C atom of the double bond.
	Functional group of products Ethene reacts with dilute acid, H_2O / H^+, to form ethanol.
	Structural Formula equation 
Reaction 3 Ethene, $C_2H_{4(g)}$ *reacts with* hydrogen bromide, **HBr.**	Observations - Again there is no colour change observed. (colourless to colourless)
	Reaction type - This reaction is an addition reaction, as the double bond is broken and two atoms are added to each C atom of the double bond. In this reaction one H and one Br atom are added.
	Functional group of products When ethene reacts with hydrogen bromide, bromoethane is formed.
	Structural Formula equation 
Summary of the three reactions	All three reactions involve the breaking of the double bond. All three reactions involve addition (adding atoms on) Two of these reactions are addition reactions and one is an oxidation reaction. Only one of the reactions gives a colour change that is easily observed.

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Writing Excellence answers to Esterification questions

Ester Hydrolysis QUESTION

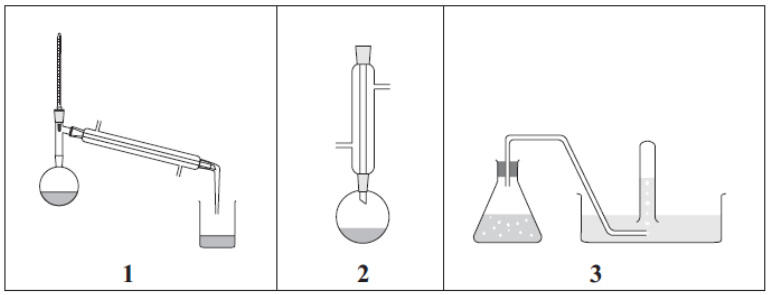
Question: Many organic synthesis reactions are heated under reflux.

(i) Draw the structural formula and name the ester formed from heating ethanol and butanoic acid under reflux in the presence of concentrated sulfuric acid.

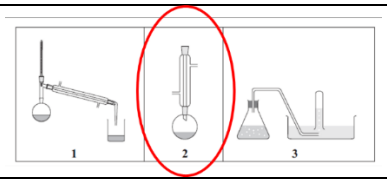
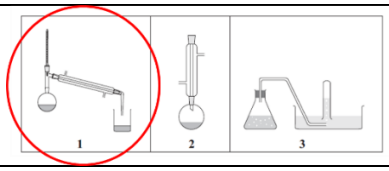
(ii) From the diagrams below, give the number of the apparatus used for heating under reflux.

(iii) Outline the advantages of heating under reflux in the preparation of the ester in part (i).

(iv) From the diagrams below, give the number of the apparatus and explain the process that could be used to purify (separate) the ester in part (i) from the reaction mixture.



ANSWER

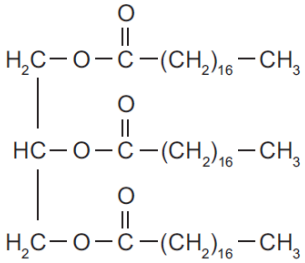
1. Draw structure and name ester formed	ethyl butanoate $CH_3–CH_2–CH_2–COO–CH_2–CH_3$
2. Select correct diagram for reflux	
3. explain advantages / purpose of reflux	Increases rate because it is able to be heated No loss of products / reactants because they are condensed back into the mixture Increases the amount of products / yield because reactants / products are prevented from escaping
4. Select correct diagram for distillation	
5. State the process (distillation), and describe process of how the ester is separated from the alcohol and carboxylic acid liquids in terms of boiling point, evaporation and condensation	Distillation could be used to purify the ester (diagram 1). The reaction mixture is heated to the boiling point of the ester which is different from both the alcohol and carboxylic acid reactants. The ester will evaporate from the mixture and enter the condenser where it is cooled back to the liquid to be collected. The ester has therefore been separated from the reaction mixture.

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your

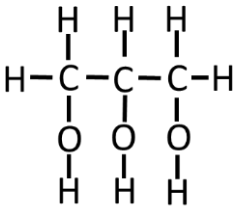
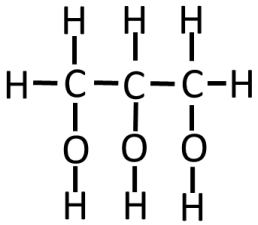
Writing Excellence answers to Ester Hydrolysis questions

Ester Hydrolysis QUESTION

Question: Give the structures and functional groups 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.
Compare and contrast the reactions below. In your answer, you should include the type of reaction(s) taking place.



ANSWER

1. Draw (condensed) the products for the reaction with dilute hydrochloric acid solution	 Functional Group: alcohol (triol)	$3\ x CH_3(CH_2)_{16}COOH$ Functional Group: carboxylic acid
2. Draw (condensed) the products for the reaction with dilute sodium hydroxide solution	 Functional Group: alcohol (triol)	$3\ x\ CH_3(CH_2)_{16}COO^-Na^+$ $(+\ 3\ x\ H_2O)$ Functional Group: Carboxylic salt
3. explain what type of reaction occurs in both acid and base conditions and the link it occurs with	The ester link is hydrolysed in both acid and basic conditions. Both produce an triol (alcohol) In base conditions a further acid-base reaction occurs	
4. discuss the products of the reaction in the acid conditions	In the acid conditions in dilute hydrochloric acid solution the hydrolysis of the triglyceride produces a triol and three long chained carboxylic acid molecules. No further reaction occurs in acid.	
5. discuss the products of the reaction in the base conditions	In the base conditions in dilute sodium hydroxide solution the hydrolysis of the triglyceride, produces a triol and then a further acid base reaction forms a three long chained carboxylic salt (sodium salt) molecules + water (products of neutralisation)	

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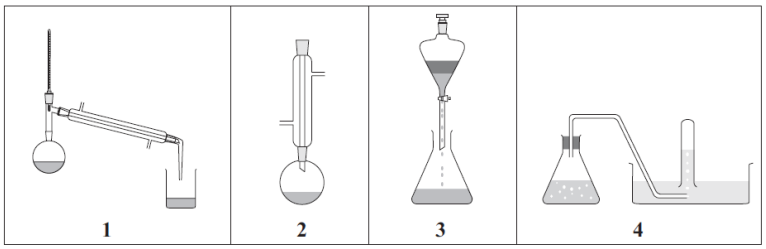
Writing Excellence answers to Oxidation Reactions of Alcohol questions

Oxidation Reactions of Alcohol QUESTION

Question: Discuss the laboratory procedures used to convert butan-1-ol into butanal, and butan-1-ol into butanoic acid.
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
Identify which piece of the equipment that a student would use to perform each process from the diagrams below.



ANSWER

1. For the conversion of butan-1-ol into butanal: Identify the laboratory procedure used and select the numbered equipment	Aldehyde (Butanal) is obtained by distillation of butan-1-ol Equipment piece 1 is used
2. give the reagent used: butan-1-ol into butanal	with acidified (potassium) dichromate / (acidified potassium) permanganate solution.
3. Explain why this laboratory procedure was required: butan-1-ol into butanal	(Distillation) is used because the aldehyde has a lower boiling point (than butan-1-ol and the carboxylic acid formed) and this will prevent it from being oxidised further. Both alcohol and the carboxylic acid have hydrogen bonding which means they have a higher boiling point than aldehyde which only has permanent dipoles (+ all have temporary dipoles and they are of similar molar mass)
4. give any observations seen: butan-1-ol into butanal	orange $Cr_2O_7^{2-}$ to green or purple MnO_4^- to colourless and the aldehyde is condensed in the condenser.
5. For the conversion of butan-1-ol into butanoic acid Identify the laboratory procedure used and select the numbered equipment	Carboxylic acid (butanoic acid) is obtained under reflux conditions Equipment piece 1 is used
6. give the reagent used: butan-1-ol into butanoic acid	with acidified (potassium) dichromate / (acidified potassium) permanganate solution.
7. Explain why this laboratory procedure was required: butan-1-ol into butanoic acid	Reflux is used so all of the reactant remains in the flask heating until it has been converted to butanoic acid. Aldehyde is an intermediate product and it will evaporate if it is not condensed and returned to the reaction flask.
8. give any observations seen: butan-1-ol into butanoic acid	orange $Cr_2O_7^{2-}$ to green or purple MnO_4^- to colourless

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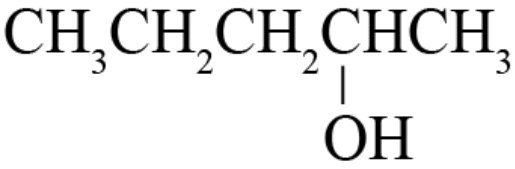
Writing Excellence answers to Redox Reactions of Ketones and Aldehydes questions

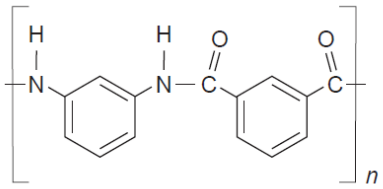
Redox Reactions of Ketones and Aldehydes QUESTION	
Question: (i) What reagent can be used to reduce aldehydes and ketones? (ii) For the reduction of pentanal and pentan-2-one, draw the structure of the organic product formed in each case. Identify the functional group of each product formed. (iii) Using Benedict's reagent (Cu^{2+}) Give a description of test observations that could be used to distinguish between pentanal and pentan-2-one. Plus any equations to show the organic products formed, if applicable.	
ANSWER	
1. Name the reagent for reduction of Aldehydes and Ketones	Sodium borohydride / $NaBH_4$
2. Draw the products for the reduction reaction of pentanal and name the functional group	$CH_3CH_2CH_2CH_2CH_2OH$ Functional Group: Pentanal will produce a primary alcohol / pentan-1-ol.
3. Draw the products for the reduction reaction of pentan-2-one and name the functional group	 Functional Group: Pentan-2-one will produce a secondary alcohol / pentan-2-ol
4. Give the expected observations of the test for pentanal Plus any equations if applicable	Pentanal will react with Benedict's reagent, with the blue solution forming a (copper mirror) / brick red precipitate. Pentanoic acid is formed. $CH_3CH_2CH_2CH_2CHO \rightarrow CH_3CH_2CH_2CH_2COOH$
5. Give the expected observations of the test for pentan-2-one Plus any equations if applicable	Pentan-2-one will not react with Benedict's reagent, with the blue solution as there is no reaction, so the blue solution stays blue

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The grey area is just to help you structure your answer and would not appear in the question.

ANSWER Writing Excellence answers to Polymerisation Reactions questions

Polymerisation Reactions QUESTION

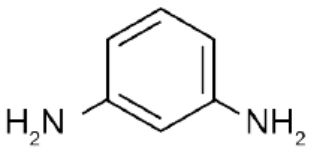
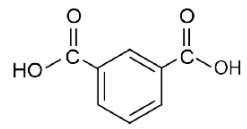
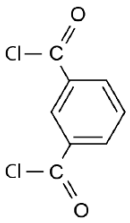
Question: Nomex® is a polymer used in firefighters' suits. Nomex® is made up of two different monomers bonded together to form the polymer chain.
A small portion of the structure of Nomex® is shown below.



Note:  is a benzene ring and does not change when the monomers bond together to form the polymer.

Explain the structure of the polymer, Nomex®.
In your answer, you should include:
• the name of the functional group linking the monomers
• a drawing of both monomers
• a classification of the type of polymer formed, with an explanation to justify your choice.

ANSWER

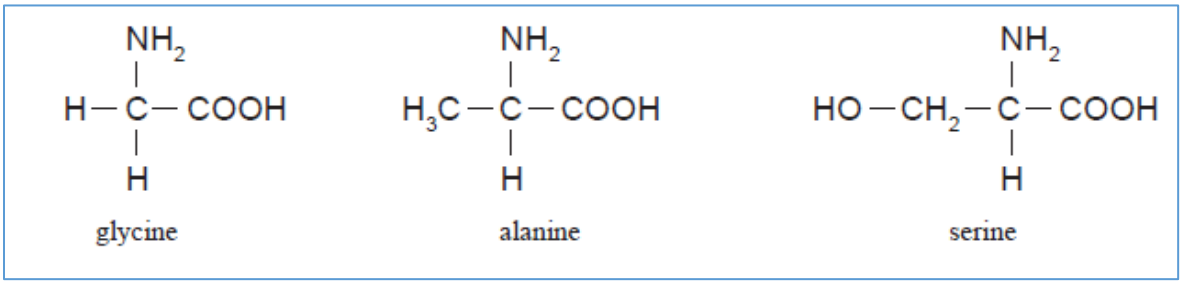
1. The name of the functional group linking the monomers. Make sure you include the name of the polymer i.e. Nomex has a ..... linkage	Nomex® is a polymer and has an amide linkage _NH-CO-	
2. Draw the two possible monomers	diamine 	dicarboxylic acid (or di acid chloride)  
3. Link type of molecule to the type of reaction that forms it and explain the products produced during the reaction (definition)	Nomex® is a condensation polymer, specifically a polyamide. It is formed from polymerisation as monomers join with amide link to form a polymer. It is condensation polymerisation because a molecule of water (or HCl) is released during the reaction.	

NOTE: The white column is how your answer would appear on your test paper so make sure you **write out complete sentences**. The shaded area is just to help you structure your answer and would not appear in the question.

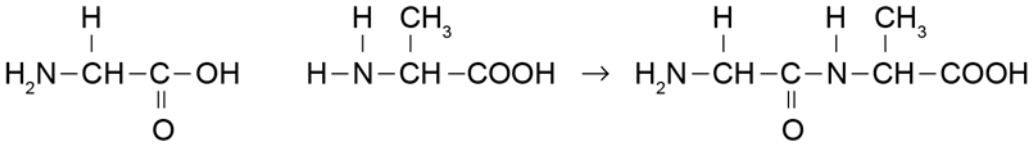
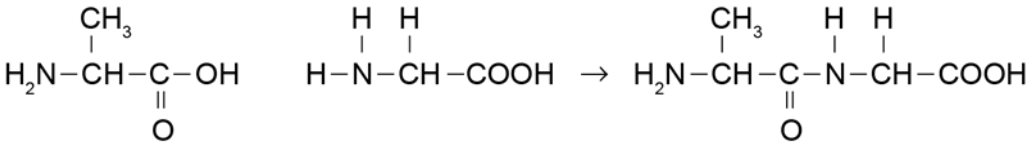
Writing Excellence answers to Amino Acids questions

Amino Acids QUESTION

Question: 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) Name the type of reaction that occurred when the dipeptides formed in (iii) above. Explain your Answer
(iii) One of these amino acids cannot form optical isomers (enantiomers). Name and explain why.



ANSWER

1. Draw one possible dipeptide Draw the amino acids used	
2. Draw a second possible dipeptide Draw the amino acids used	
3. Give the type of reaction and explain (definition)	This type of reaction is Condensation Two larger molecules are joined together with the elimination of a smaller molecule.
4. state which amino acids cannot form an optical isomer (enantiomer)	Glycine cannot form an optical isomer. (the other two, alanine and serine can)
5. Explain why your specific molecule was selected	Glycine does not have a central (chiral) carbon with 4 different groups off it – as two of the groups are the same (H). Both alanine and serine have a chiral carbon with 4 different groups attached

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Writing Excellence answers to Reaction Scheme questions

Reaction Scheme QUESTION

Question: Complete the following reaction scheme by drawing organic structures for S1 to S7, and identifying reagents 1 to 3.

ANSWER

HINTS:
S1 will be an ester

R1 will result in acid hydrolysis with two products

R2 will cause an elimination reaction

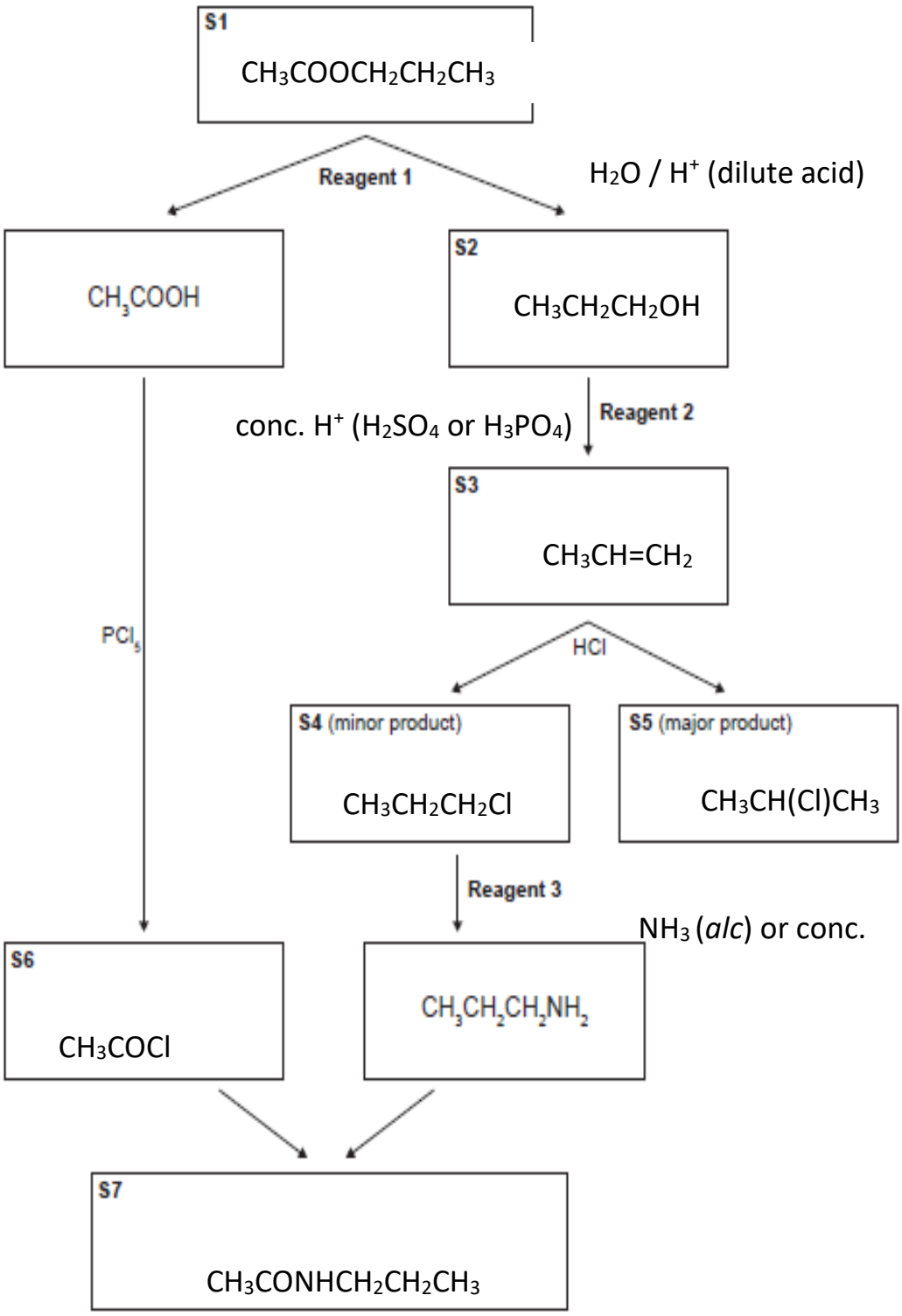
S3 will be an unsaturated substance

S4 and S5 will be the result of an addition reaction

R3 will cause a substitution reaction

S6 is the result of a substitution reaction

S7will be the product of a condensation reaction



Writing Excellence answers to Identification Tests questions

Identification Tests QUESTION	
Question: 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. Write equations if any products formed	
ANSWER	
1. state method (general)	Place 10mL of each substance in a test-tube. Slowly add 5mL of water and record observations Place another new 10mL of each substance in a test-tube. then test with dampened blue litmus paper and record observations
2. Give observations with water and litmus paper for butan-1-ol and link to functional group Write equations if any products formed	The butan-1-ol will not react with water nor change the colour of the moistened litmus paper. It will be soluble in water as it is a polar alcohol
3. Give observations with water and litmus paper for butanoic acid and link to functional group Write equations if any products formed	Carboxylic acids react with water to form carboxylic ions and hydronium ions in an acid-base reaction $CH_3CH_2CH_2COOH + H_2O \rightarrow CH_3CH_2CH_2COO^- + H_3O^+$ The butanoic acid will change the moistened blue litmus paper to red.
4. Give observations with water and litmus paper for butanoyl chloride and link to functional group Write equations if any products formed	The butanoyl chloride will react violently with the water. Acyl chlorides react with water to form carboxylic acids and hydrogen chloride in a substitution reaction $CH_3CH_2CH_2COCl + H_2O \rightarrow CH_3CH_2CH_2COOH + HCl$ The HCl fumes will change the moistened blue litmus paper to red.

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