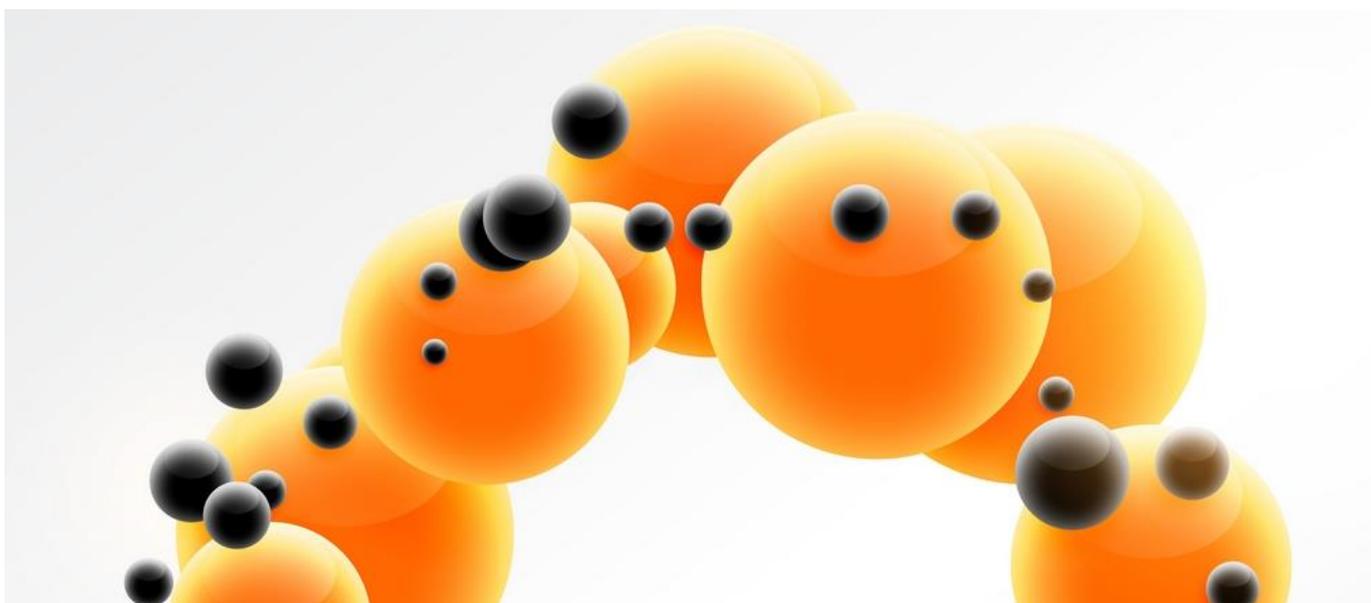


Demonstrate understanding of the properties of selected organic compounds

WORKBOOK

Working to Excellence & NCEA Questions



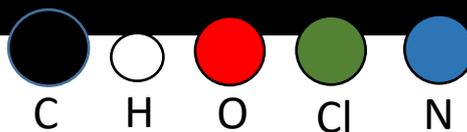
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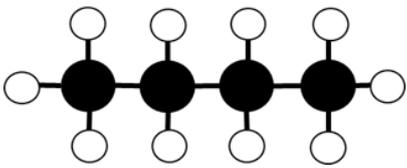
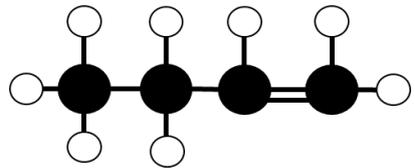
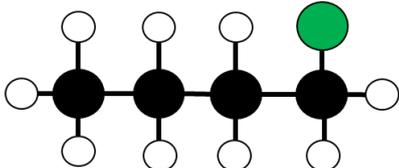
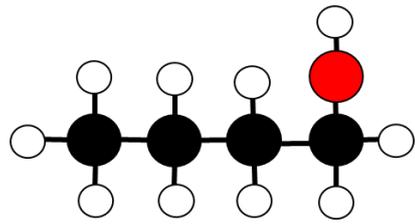
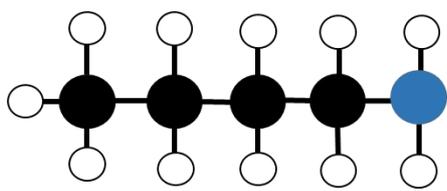
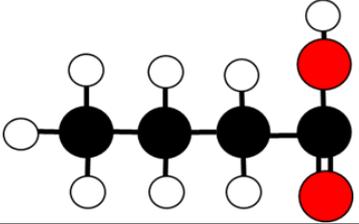
All NCEA answers
can be found on
C2.5 ppt



Summary Notes



1. Functional groups – Naming and properties: Alkanes, alkenes, alkynes, haloalkanes (primary, secondary, tertiary), alcohol, amines, carboxylic acids

<h2>Alkanes</h2> <ol style="list-style-type: none"> 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 <p>Non-polar - insoluble. BP and MP increase with chain length</p> 	<h2>Alkenes</h2> <ol style="list-style-type: none"> 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. <p>Non-polar - insoluble. BP and MP increase with chain length</p> 	<h2>Haloalkanes</h2> <p>Halogen named as a branch Bromine – bromo Chlorine – chloro Fluorine – fluoro Iodine-iodo</p> <p>primary (1°) – bonded to a C that is bonded to only 1 other C secondary (2°) – bonded to a C that is bonded to 2 other C tertiary (3°) – bonded to a C that is bonded to 3 other C Polar with only slight solubility in small chained molecules</p> 
<h2>Alcohols</h2> <ol style="list-style-type: none"> 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 <p>Polar – soluble in water Higher BP and MP than alkanes and alkenes</p> 	<h2>Amines</h2> <ol style="list-style-type: none"> 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 (NH₂) 4. Location /Name of branch 5. Amino- 6. Prefix of long chain 7. -ane <p>Weak base – turns red litmus blue</p> 	<h2>Carboxylic acids</h2> <ol style="list-style-type: none"> 1. Longest –C chain with -COOH 2. Identify branches 3. No. 1 C is the C in -COOH 4. Location of branches 5. Name branch 6. Prefix 7. -anoic acid <p>Weak acid – turns blue litmus red</p> 



Past NCEA questions Names and Structural Formula (ONE)

2013: Question 1d: Complete the following table to show the structural formula and IUPAC (systematic) name for each compound.

Structural formula	IUPAC (systematic) name
	pentanoic acid
	3-methylbut-1-ene
$\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$	
$\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{OH} \\ \\ \text{Cl} \end{array}$	
$\begin{array}{c} \text{CH}_2\text{CHCH}_2\text{CH}_2\text{CH}_3 \\ \\ \text{CH}_3\text{CH}_3 \end{array}$	

Question 1b: Identify two molecules from the table in (a) that are constitutional (structural) isomers of each other.

Justify your choice.

2013: Question: 1a: (i) The structures of some organic compounds containing chlorine are shown below. Write the letter of the molecule that is a secondary chloroalkane. (ii) Describe why you chose the molecule

A $\begin{array}{c} \text{Cl} \\ \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$	B $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
C $\text{CH}_3\text{CH}_2\text{CHCCl}_2$	D $\text{CH}_3\text{CH}_2\text{CHCHCl}$
E $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$	F $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$

2014: Question: 1a: Draw a primary, a secondary, and a tertiary alcohol for the molecule $\text{C}_5\text{H}_{11}\text{OH}$.

Primary	
Secondary	
Tertiary	

2014: Question: 2a: Complete the following table to show the structural formula and IUPAC (systematic) name for each compound.

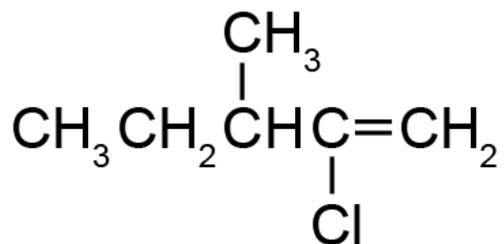
Structural formula	IUPAC (systematic) name
	But-1-yne
	2,2-dichloropentan-1-ol
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}_2$	
$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}-\text{CH}_2-\text{C}-\text{OH} \\ \quad \quad \quad \\ \text{CH}_3 \quad \quad \quad \text{O} \end{array}$	
$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}=\text{C}-\text{CH}_2-\text{CH}_3 \\ \quad \quad \\ \text{Cl} \quad \quad \text{Cl} \end{array}$	



Past NCEA questions Names and Structural Formula (TWO)

2015: Question: 1a: (ii) The organic compound, 4-chloro-3-methylpent-4-ene has been named incorrectly.

- Draw the implied structure and explain why it is named incorrectly.
- Give the correct IUPAC name for this structure



2015: Question: 1b: (ii) Draw THREE other constitutional (structural) isomers of $\text{C}_4\text{H}_{10}\text{O}$.

Structural formula	IUPAC (systematic) name
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\underset{\text{ }}{\text{CH}}-\text{CH}_3$	
	3-methylpentanoic acid
	but-1-yne
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\underset{\text{H}}{\underset{\text{H}}{\text{N}}}$	

2016: Question: 1a: (ii) Draw and name the THREE constitutional (structural) isomers of the organic compound C_5H_{12} .

2015: Question: 1b: (i) Butan-1-ol has the molecular formula $\text{C}_4\text{H}_{10}\text{O}$. Its structural formula is: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$. Define the term constitutional (structural) isomer.

2015: Question: 1b: (ii) Draw THREE other constitutional (structural) isomers of $\text{C}_4\text{H}_{10}\text{O}$.

2016: Question: 1a: (i) Complete the following table.

Structural formula	IUPAC (systematic) name
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\underset{\text{ }}{\text{CH}}-\text{CH}_3$	
	3-methylpentanoic acid
	but-1-yne
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\underset{\text{H}}{\underset{\text{H}}{\text{N}}}$	

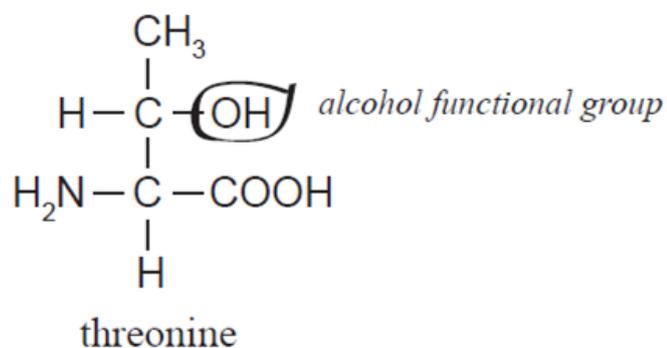
2016: Question: 1b: (i) Classify the following haloalkanes as primary, secondary or tertiary.

	Haloalkane	Classification
A	$\text{CH}_3-\text{CH}_2-\underset{\text{Cl}}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	
B	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\underset{\text{Cl}}{\overset{\text{CH}_3}{\text{CH}}}-\text{CH}_2-\text{CH}_3$	
C	$\text{CH}_3-\text{CH}_2-\underset{\text{Cl}}{\text{CH}}-\underset{\text{Cl}}{\overset{\text{CH}_3}{\text{CH}}}-\text{CH}_2-\text{CH}_3$	



Past NCEA questions Names and Structural Formula (THREE)

2017: Question: 2a: The structure of a molecule of an organic compound, threonine, is shown below.



An alcohol functional group has been identified in the threonine molecule above.

- (i) Circle and name two other functional groups on the threonine molecule above.
- (ii) Classify the alcohol functional group as primary, secondary, or tertiary.
- (iii) Explain how you classified the alcohol group.

2017: Question: 2c: (i) Draw four alkene isomers for the organic compound C_4H_8 in a table below.

--

2018: Question: 1b: Draw structural formulae for primary, secondary, and tertiary chloroalkane molecules that are constitutional (structural) isomers with the molecular formula $\text{C}_4\text{H}_9\text{Cl}$.

2017: Question: 2b: Name the organic compounds in the table below

Compound	IUPAC (systematic) name
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{C}\equiv\text{CH}$	
$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \\ \quad \\ \text{Br} \quad \text{CH}_3 \end{array}$	
$\begin{array}{c} \text{OH} \quad \text{CH}_3 \\ \quad \\ \text{CH}_3-\text{CH}_2-\text{CH}-\text{C}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	

2018: Question: 1a: Complete the following table.

Compound	IUPAC (systematic) name
$\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	
$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\ \quad \\ \text{CH}_3 \quad \text{OH} \end{array}$	
	2-hydroxypropanoic acid



2019: Question: 1a: Complete the following table

Compound	IUPAC (systematic name)
$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad // \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{OH} \end{array}$	
	propan-2-amine
$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{Cl} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	
	2,3-dimethylbutane

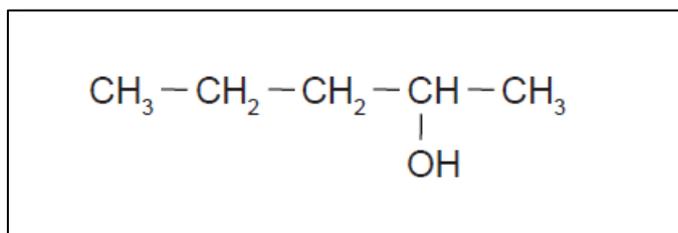
2019: Question: 1b: Draw four structural (constitutional) isomers of C₄H₁₀O that are alcohols. Classify the alcohols as either primary, secondary or tertiary.

1.	2.
Type of alcohol:	Type of alcohol:
3.	4.
Type of alcohol:	Type of alcohol:

2020: Question: 1a: Complete the following table

Compound	IUPAC (systematic name)
	butan-2-amine
$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}-\text{CH}_3 \\ \\ \text{OH} \end{array}$	
$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \end{array}$	
	iodoethane

2020: Question: 1b: Classify the alcohol in the table above as primary, secondary, or tertiary, and explain your choice.





Writing Excellence answers to Cis-Trans Isomers questions

Cis-Trans Isomers QUESTION

Question: Molecule D can exist as geometric (*cis* and *trans*) isomers, with both isomers having the same molecular formula.

Draw the geometric (*cis* and *trans*) isomers for molecule D in the boxes below. Justify why molecule D can exist as geometric (*cis* and *trans*) isomers.

Your answer should include:

- an explanation of the requirements for *cis* and *trans* isomers
- reference to the structure of molecule D.

A	$\begin{array}{c} \text{Cl} \\ \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$	B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
C	$\text{CH}_3\text{CH}_2\text{CHClCl}_2$	D	$\text{CH}_3\text{CH}_2\text{CHCHCl}$
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$	F	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$

ANSWER

1. Draw the *cis* and *trans* isomers

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

Cis

Trans

Name:

Name:

2. link the presence of a double C=C bond to lack of rotation

3. link the requirement of two different groups of each of the C on the double

4. link the requirements above to your specific molecule (D)

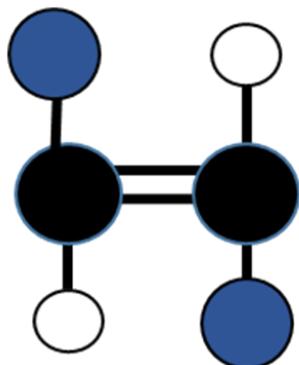
5. Explain how two geometric isomers can have the same molecular formula

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.

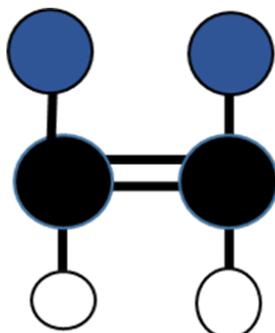


2. Isomers: cis/trans

Trans ethene



Cis ethene



The double bond prevents the carbons on either end rotating like single bonds do, therefore, the groups attached to the carbons remain "fixed" on their respective sides

Past NCEA questions Cis-Trans Isomers (ONE)

2013: Question 1c: Molecule D can exist as geometric (*cis* and *trans*) isomers.

Draw the geometric (*cis* and *trans*) isomers for molecule D in the boxes below. Justify why molecule D can exist as geometric (*cis* and *trans*) isomers.

Your answer should include:

- an explanation of the requirements for *cis* and *trans* isomers
- reference to the structure of molecule D.

A	$\begin{array}{c} \text{Cl} \\ \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$	B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
C	$\text{CH}_3\text{CH}_2\text{CHCl}_2$	D	$\text{CH}_3\text{CH}_2\text{CHCHCl}$
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$	F	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$

2014: Question: 2b: The structures of three organic compounds are shown below. Explain why compound A can exist as geometric (*cis* and *trans*) isomers, but compounds B and C cannot.

In your answer you should: (i) draw the geometric (*cis* and *trans*) isomers of compound A

Compound A	$\text{CH}_3 - \text{CH}_2 - \text{CH} = \text{CH} - \text{CH}_3$
Compound B	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH} = \text{CH}_2$
Compound C	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$



Past NCEA questions Cis-Trans Isomers (TWO)

2014: Question: 2b: (ii) explain the requirements for geometric (*cis* and *trans*) isomers by referring to compounds A, B, and C above

2015: Question: 2a: (ii) Explain why 1,1-dichloroethene cannot exist as a *cis-trans* isomer.

2015: Question: 2a: (iii) A structural isomer of 1,1-dichloroethene can exist as *cis-trans* isomers. Draw and name the *cis-trans* isomers.

2016: Question: 1c: Some alkenes are able to form *cis* and *trans* (geometric) isomers.

(i) Complete the names of structures A and B in the table below.

A	B
_____ 1,2-dibromoethene	_____ 1,2-dibromoethene

2016: Question: 1c: (ii) Elaborate on the structure of the organic compound 1,2-dibromoethene to explain why it is able to form *cis* and *trans* (geometric) isomers.

2017: Question: 2c: (ii) Identify the compounds that are *cis* and *trans* (geometric) isomers from the table. Justify your choices, and explain why only these two compounds are *cis* and *trans* (geometric) isomers.

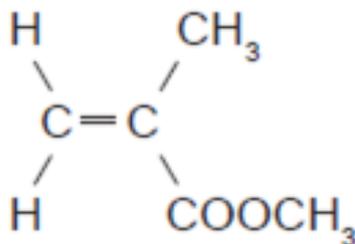
1. 	2.
3. 	4.

	cis	trans
Number		



Past NCEA questions Cis-Trans Isomers (TWO)

2018: Question: 1c: (ii) Justify whether or not the monomer used to produce Perspex[®] is a geometric (cis-trans) isomer by explaining the features required for this type of isomerism



2019: Question: 1c: Refer to the compounds in the table below to answer parts (i) to (ii).

A	$\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$
B	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$

- (i) Draw and name the two geometric (*cis-trans*) isomers of compound A.
- (ii) Explain why compound A exists as geometric (*cis-trans*) isomers while compound B does not.

2020: Question: 2b: The C_4H_8 (butene) molecule can display different forms of isomerism.

A	B	C
$\text{CH}_2 = \text{CHCH}_2\text{CH}_3$		

- (i) Circle the form of isomerism that exists between molecules A and B.
constitutional / structural geometric
- (ii) Circle the form of isomerism that exists between molecules B and C.
constitutional / structural geometric
- (iii) Compare and contrast the two forms of isomerism. In your answer, you should: explain the requirements for each form of isomerism and refer to molecules A, B, and C.



Writing Excellence answers to Physical Properties of Organic Compounds questions

Solubility - Physical Properties of Organic Compounds QUESTION

Question: Explain why two layers form in Reaction One. Hexane reacts with bromine water

ANSWER

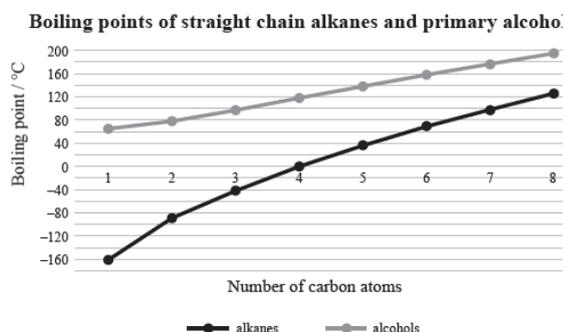
1. Identify the functional group of your substance (hexane) and name the product formed.

2. link observation (layers forming) to the polarity of the substance

3. identify the polarity of the bromine water and link to the substances being immiscible (forming 2 layers)

Melting point - Physical Properties of Organic Compounds QUESTION

Question: Identify the trends shown on the graph. Identify which alkanes will be gases at room temperature (20°C) according to the graph beside.



ANSWER

1. link the boiling point trend to number of carbons in both groups (when explaining trends on a line graph always relate one variable to the other)

2. Identify which alkanes (number of carbons) are gases at room temp. (will have boiling point below 20°C)

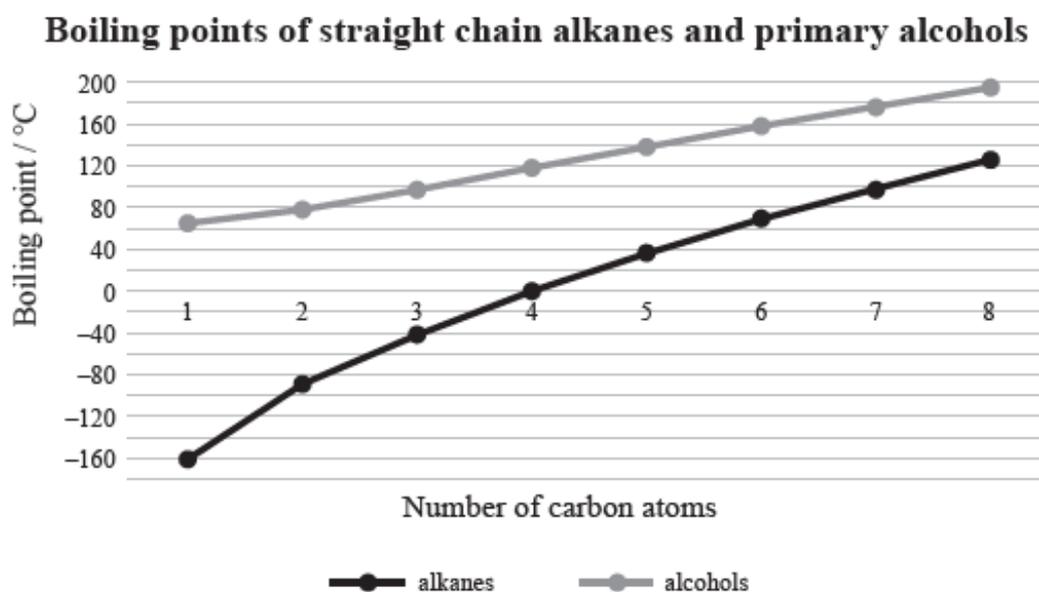
NOTE: The white column is how your answer would appear on your test paper so make sure you write out complete sentences. The grey area is just to help you structure your answer and would not appear in the question.



Past NCEA questions Physical Properties of Organic Compounds

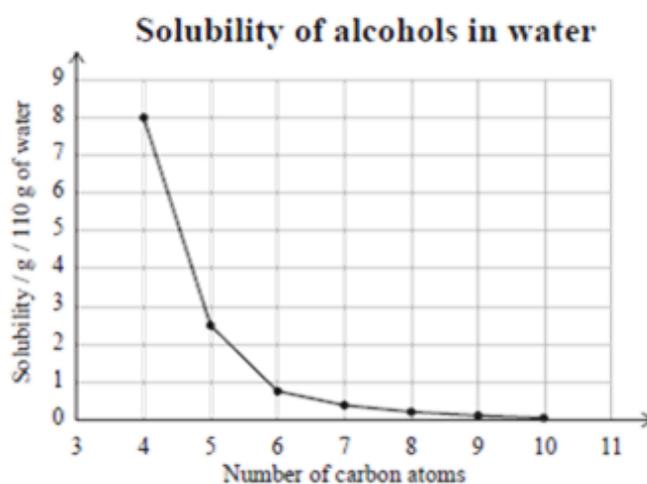
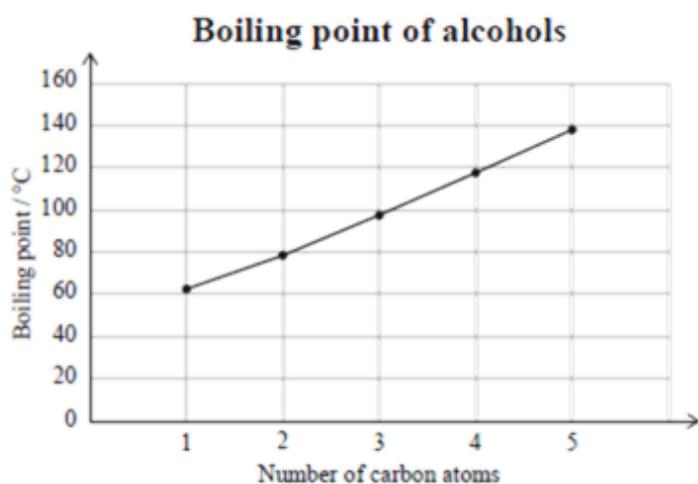
2014: Question 1c: Explain why two layers form in Reaction One. Hexane reacts with bromine water

2016: Question 2a (i): Identify the trends shown on the graph



2016: Question 2a (ii) Identify which alkanes will be gases at room temperature (20°C) according to the graph above.

2018: Question: 3a: The graphs below show trends in two physical properties of alcohols. Identify the trends shown on the graphs below





Writing Excellence answers to Haloalkane Reactions questions

Haloalkane Reactions QUESTION

Question: Chloroethane, $\text{CH}_3\text{CH}_2\text{Cl}$, 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 $\text{KOH}_{(\text{aq})}$	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 2 Chloroethane reacts with $\text{KOH}_{(\text{alc})}$	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 3 Chloroethane reacts with $\text{NH}_3_{(\text{alc})}$	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 grey area is just to help you structure your answer and would not appear in the question.



Writing Excellence answers to Alcohol Reactions questions

Alcohol Reactions QUESTION

Question: Butan-1-ol can react separately with each of PCl_5 , $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$, and concentrated H_2SO_4 . Elaborate on the reactions of butan-1-ol with each of the three reagents.

For each reaction, your answer should include:

- the type of reaction occurring and the reason why it is classified as that type
- the name of the functional group formed in each product
- the structural formula of the organic product.

ANSWER

Reaction 1 Butan-1-ol reacts with PCl_5	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 2 Butan-1-ol reacts with $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$	Product formed
	Reaction type
	Condensed Structural Formula equation
	Structural Formula equation
Reaction 3 Butan-1-ol reacts with concentrated H_2SO_4	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 grey area is just to help you structure your answer and would not appear in the question.



Writing Excellence answers to Alkene Reactions questions

Alkene 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:

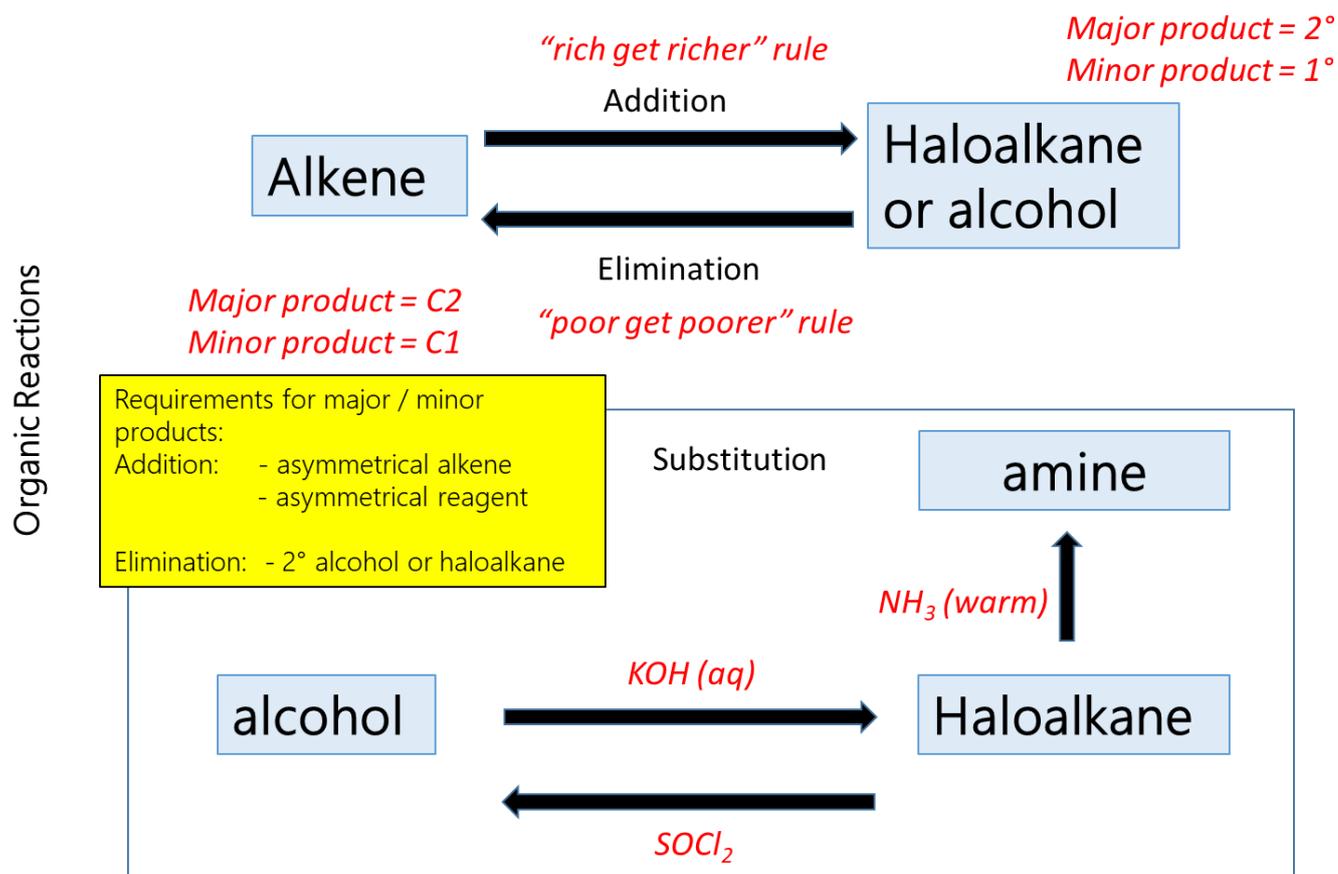
- describe any observations that can be made
- identify, with reasons, the type of reaction ethene undergoes with each reagent
- describe the functional group of the products formed
- include equations showing the structural formulae for the organic compounds for each reaction.

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	



Summary of Addition, Elimination and Substitution



Past NCEA questions Comparing Reactions (ONE)

2012: Question 2d: Chloroethane, $\text{CH}_3\text{CH}_2\text{Cl}$, 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.

2013: Question 3a: Butan-1-ol can react separately with each of PCl_5 , $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$, and concentrated H_2SO_4 .

Elaborate on the reactions of butan-1-ol with each of the three reagents.

For each reaction, your answer should include:

- the type of reaction occurring and the reason why it is classified as that type
- the name of the functional group formed in each product
- the structural formula of the organic product.



Past NCEA questions Comparing Reactions (TWO)

2014: Question: 1c: The reactions shown below are all classified as being the same type of reaction. Compare and contrast these reactions.

In your answer you should:

- state whether any conditions are required
- describe the type of reaction occurring and explain why all three reactions are classified as this type of reaction
- explain why two layers form in Reaction One.

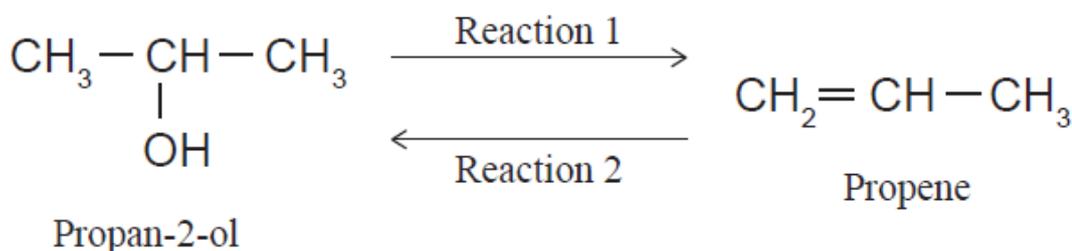
Reaction One	hexane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$, reacts with bromine water, $\text{Br}_2(\text{aq})$
Reaction Two	hexan-1-ol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$, reacts with PCl_3
Reaction Three	1-chlorohexane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$, reacts with conc NH_3 (alc)

2015: Question: 2b: In Reaction 1, propan-2-ol can be converted to propene.

In Reaction 2, propene can be converted back to propan-2-ol.

Analyse BOTH of these reactions by:

- describing the reagents and conditions needed for each reaction to occur
- identifying each type of reaction and explaining your choice
- explaining why Reaction 1 forms only a single organic product, but Reaction 2 forms a mixture of organic products.



2015: Question: 3b: Ethene, $\text{C}_2\text{H}_4(\text{g})$, reacts with aqueous potassium permanganate solution, $\text{KMnO}_4(\text{aq})$, dilute acid, $\text{H}_2\text{O} / \text{H}^+$, 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.



Past NCEA questions Comparing Reactions (THREE)

2016: Question 2c: Ethane gas, $C_2H_6(g)$, and ethene gas, $C_2H_4(g)$, will both react with bromine water, $Br_{2(aq)}$. Compare and contrast these two reactions.

In your answer you should refer to:

- any conditions required
- the observations made
- the types of reactions occurring
- structural formulae of the organic products formed.

2018: Question: 3b: Reacting 2-chloropropane with potassium hydroxide, KOH, can produce different products due to different reactions occurring.

(i) Elaborate on the reactions of 2-chloropropane with potassium hydroxide, KOH.

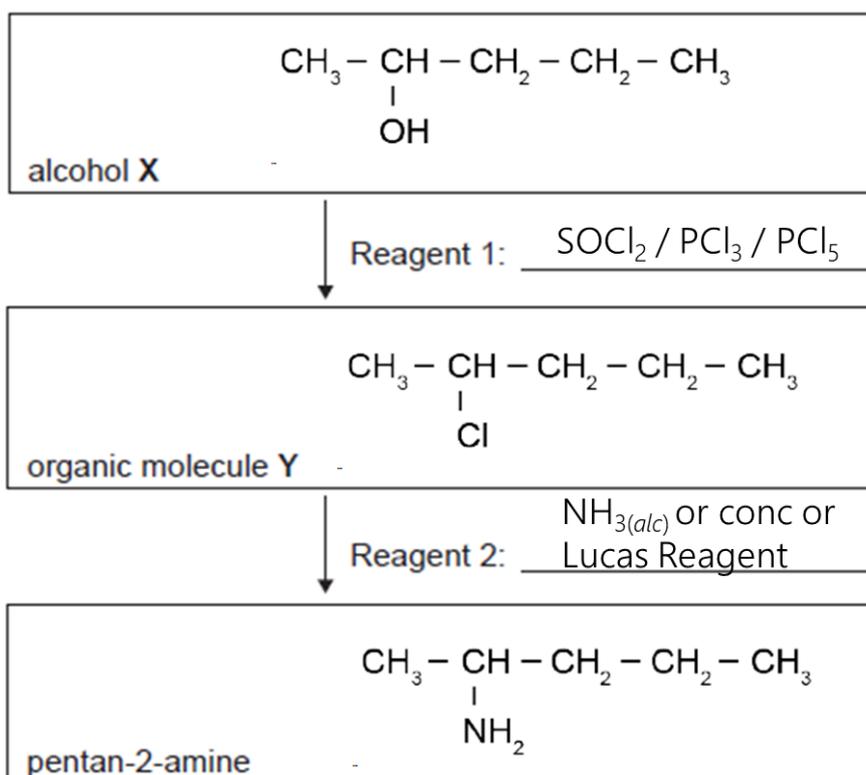
In your answer you should:

- identify the conditions of the reagent KOH
- explain the types of reaction that occur with the reagent in each condition
- draw structural formulae of the organic products.

2018: Question: 2c: (ii) Elaborate on the reactions in the scheme below.

In your answer you should identify:

- any conditions needed for each step of the conversion
- the names of alcohol X and organic molecule Y
- the type of reaction that is occurring for each step of the conversion.





Past NCEA questions Comparing Reactions (FOUR)

2020: Question: 1c: Depending upon the conditions in which it is used, sulfuric acid, H_2SO_4 , can enable the two reactions below to occur.

alcohol \rightarrow alkene

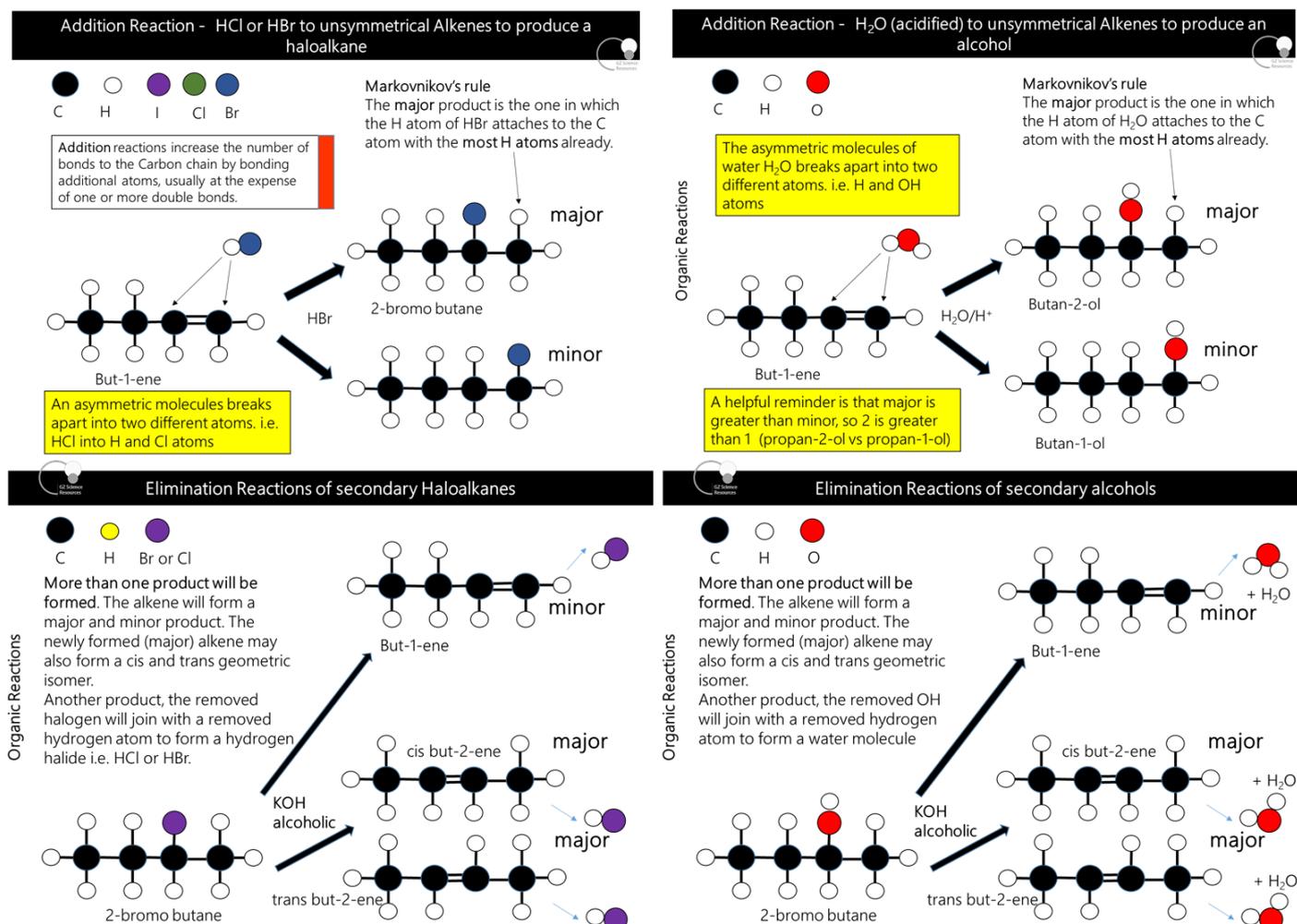
alkene \rightarrow alcohol

(i) In the boxes below, draw the structural formula for a molecule containing two carbon atoms that could be used in the reactions above.

(ii) Elaborate on how sulfuric acid is used in the conversion of both an alcohol to an alkene, and an alkene to an alcohol.

In your answer you should:

- state the conditions required for each reaction
- state the type of reaction occurring in each case, and justify your choices.





Writing Excellence answers to Major and Minor products questions

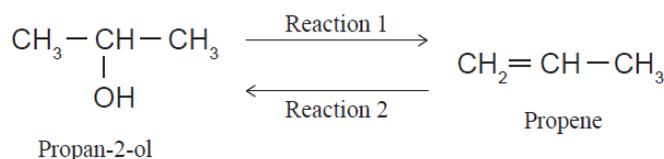
Major and Minor Products QUESTION

Question: In Reaction 1, propan-2-ol can be converted to propene.

In Reaction 2, propene can be converted back to propan-2-ol.

Analyse BOTH of these reactions by:

- describing the reagents and conditions needed for each reaction to occur
- identifying each type of reaction and explaining your choice
- explaining why Reaction 1 forms only a single organic product, but Reaction 2 forms a mixture of organic products.



ANSWER

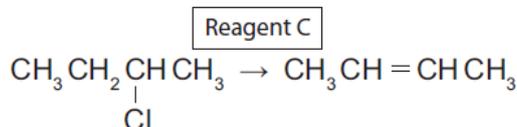
1. Reaction 1 Propan – 2-ol forms propene	Reagent and conditions	
	Reaction type	
	Structural Formula	
2. Reaction 2 Propene forms propanol Label each structure with name and whether it is major or minor	Reagent type and conditions	
	Reaction type	
	Structural Formula	
	Product type: Name:	Product type: Name:
3. Explain why <u>reaction one</u> forms only one product linked to symmetry		
4. State Markovnikov's rule AND Explain the reason <u>reaction two</u> produces two products linked to Markovnikov's rule and asymmetry, including which is major and which is minor.		

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.

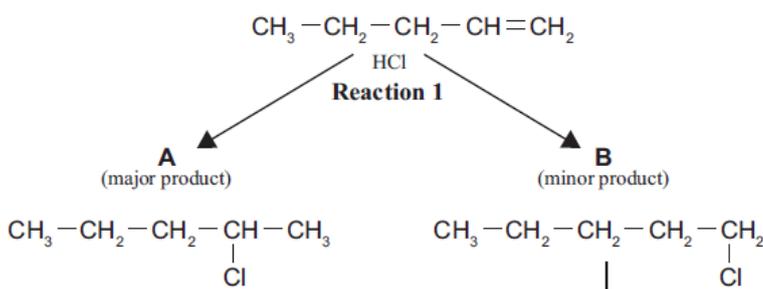


Past NCEA questions Major and Minor Products

2013: Question 3a: For the following reaction: describe if the product formed is major or minor. Explain your answer.



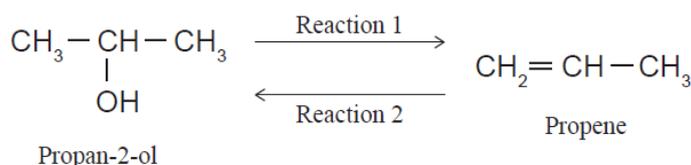
2014: Question: 3a: (ii) Explain why compound A is the major product for Reaction 1



2015: Question: 2b: In Reaction 1, propan-2-ol can be converted to propene.

In Reaction 2, propene can be converted back to propan-2-ol. Analyse BOTH of these reactions by:

- describing the reagents and conditions needed for each reaction to occur
- identifying each type of reaction and explaining your choice
- explaining why Reaction 1 forms only a single organic product, but Reaction 2 forms a mixture of organic products.



2016: Question 3c: The reaction between propene, $\text{C}_3\text{H}_6(\text{g})$, and hydrogen chloride, $\text{HCl}(\text{g})$, produces a mixture of products.

(ii) Elaborate on the reaction that occurs between propene and hydrogen chloride.

2017: Question 1b: (iii) 2-bromo-3-methylbutane also reacts with conc. $\text{KOH}_{(\text{alc})}$. However, in this reaction TWO organic products are formed, a major and a minor product. Give an account of the chemical processes that occur in this reaction. In your answer you should:

- write an equation for this reaction showing the organic compounds
- name the type of reaction occurring
- explain how the products form
- explain which product you would expect to be the minor product.



Past NCEA questions Major and Minor Products

2018: Question: 1d: When but-1-ene is reacted to form bromobutane, C_4H_9Br , two organic products are formed.

Analyse this reaction by:

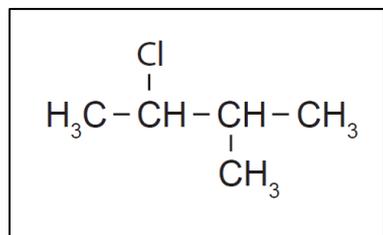
- stating the reagent required
- identifying the type of reaction and justifying your choice
- explaining why there is a mixture of organic products.

2019: Question: 2b: Explain how you identified the major and minor products (C: 2-bromopropane

D: 1-bromopropane) in the reaction of propene with hydrogen bromide solution, $HBr_{(aq)}$.

2019: Question: 2c: Compare and contrast the reaction that forms compound B (propan-2-ol OR propan-1-ol) to the reverse reaction that forms propene, C_3H_6 , from compound B (propan-2-ol OR propan-1-ol).

2020: Question: 3a: When 3-methyl-2-chlorobutane, shown below, is reacted with $KOH_{(alc)}$ and heated, a mixture of products are formed.



(i) Draw the two products from this reaction.

Major product:	Minor product:

(ii) Give an account of the chemical process that occurs in this reaction.

In your answer you should:

- state the type of reaction and explain your choice
 - explain why two products form, and justify how you decided which are the major and minor products.
- swer by drawing structural formulae for but-1-ene and the organic products.



Writing Excellence answers to Acid-Base Reactions questions

Acid-Base Reactions QUESTION

Question: Question 3c: Compounds B (CH_3COOH) and E ($\text{CH}_3\text{CH}_2\text{NH}_2$) react together.

(i) Write a balanced equation for the reaction that occurs between compounds B and E.

(ii) Identify the type of reaction that occurs between compounds B and E.

Justify your answer.

ANSWER

	Acid (carboxylic acid)	Base (amine)
1. Draw the structural formula of the acid and base Identify which hydrogen ion will be donated in the acid (-COOH end) and which part of the base will accept the hydrogen ion (-NH ₂ end)		
2. Write a balanced equation		
3. Name the type of reaction		
4. Explain what occurs in the reaction generally		
5. Explain in detail what occurs in the acid – and the product formed		
5. Explain in detail what occurs in the base – and the product 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. Acid Base Reactions

Acid-Base reactions in carboxylic acid

Carboxylic acids act as a weak acid by partially dissociating and neutralising bases:
For example
 $\text{RCOOH} + \text{NaOH} \rightarrow \text{RCOONa} + \text{H}_2\text{O}$

Organic Reactions

butanoic acid + NaOH → Sodium butanoate + H₂O

acid + base → salt + water

Acid - Base reactions in Amines

C H O Cl

With water - Amines behave like ammonia due to a lone pair of e- proton acceptors (i.e. bases)
Like ammonia itself, water soluble amines form alkaline solutions. They react with water by proton transfer to form OH⁻ ions. This means aqueous solutions of amines turn litmus blue.
 $\text{RNH}_2 + \text{H}_2\text{O} \rightarrow \text{RNH}_3^+ + \text{OH}^-$

Acid/Base Reactions

With an acid - Amines also react with acids to form salts.
 $\text{CH}_3\text{NH}_2 + \text{HCl} \rightarrow \text{CH}_3\text{NH}_3^+ \text{Cl}^-$
aminomethane methyl ammonium chloride

This reaction can occur in solution, or in the air as vapours given off solutions of both chemicals meet and combine to form a smoke. This smoke is made of the salt in solid form.

Past NCEA questions Acid and Base reactions

2014: Question: 2c: Sodium carbonate, hydrochloric acid, and sulfuric acid are each added to separate samples of three organic compounds. Compare and contrast the reactions that do occur between these organic compounds, and the reagents in the table above. In your answer you should:

- give the structure of the organic products (i) and (ii)
- describe the different types of reactions occurring, and give reasons why they are classified as that type
- identify any specific conditions that are required for the reactions to occur.

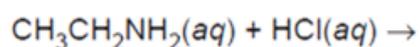
Reagent	Organic compound		
	$\text{CH}_3-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{NH}_2$	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{OH}$
Na_2CO_3	(i)	no reaction	no reaction
HCl	no reaction	(ii)	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{Cl}$
H_2SO_4	no reaction	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{NH}_3^+$	$\text{CH}_3-\text{CH}=\text{CH}_2$



Past NCEA questions Acid and Base reactions

2016: Question 2b: Solutions of amines are described as bases, and solutions of carboxylic acids are described as acids.

(i) Complete the balanced equation for the reaction between solutions of ethanamine, $\text{CH}_3\text{CH}_2\text{NH}_2(aq)$ and hydrochloric acid, $\text{HCl}(aq)$.



(ii) Explain the statement 'carboxylic acids have acidic properties'. Refer to the reaction between ethanoic acid, $\text{CH}_3\text{COOH}(aq)$, and water, $\text{H}_2\text{O}(l)$ in your answer.

2017: Question 3b: Describe a simple test that will distinguish between solutions of the final organic compounds B (CH_3COOH) and E ($\text{CH}_3\text{CH}_2\text{NH}_2$).

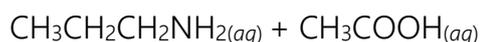
2017: Question 3c: Compounds B (CH_3COOH) and E ($\text{CH}_3\text{CH}_2\text{NH}_2$) react together.

(i) Write a balanced equation for the reaction that occurs between compounds B and E.

(ii) Identify the type of reaction that occurs between compounds B and E.

Justify your answer.

2018: Question: 2a (ii): Give the structural formula and name for the product of the reaction between propan-1-amine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, and ethanoic acid, CH_3COOH to form a salt.





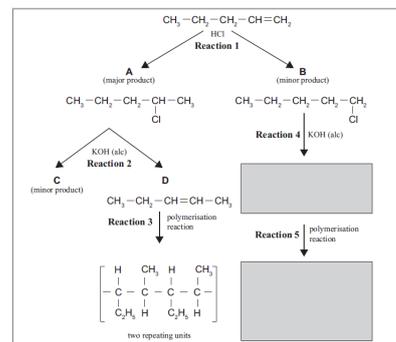
Writing Excellence answers to Polymers questions

Polymers QUESTION

Question: Draw TWO repeating units of the polymer formed in Reaction 1. Explain why the formation of the polymer from its monomer is classified as an addition polymerisation reaction.

Compare and contrast the polymer formed in Reaction 5 to the polymer formed in Reaction 3.

In your answer you should explain why the polymers formed in these two reactions are different.



ANSWER

	monomer	polymer
1. Identify the monomer, then draw the polymer (identify C 1 and C2 in monomer either side of the double bond then draw a chain of C (4 for 2 repeating units) and add on groups of each one removing double bond)		
2. explain the definition of addition polymerisation		
3. molecule 1 (reaction 5) – describe the 2 groups of each end of the double bonded carbons		
4. molecule 2 (reaction 3) – describe the 2 groups of each end of the double bonded carbons		
5. Explain that molecule 1 and 2 are structural isomers but have the same molecular formula		

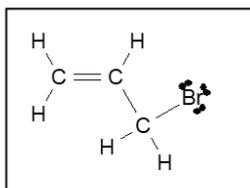
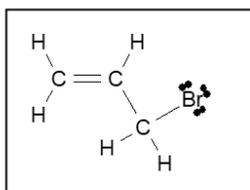
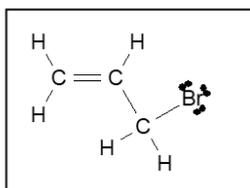


Monomers - smallest repeating unit with a double bond

Polymers – long chains of monomers joined with single bonds

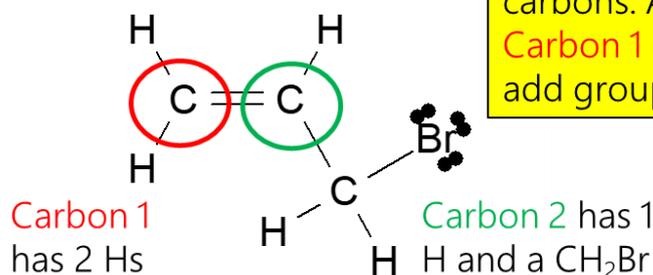
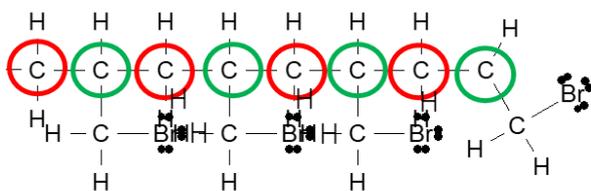
Polymerisation – breaking of the double bond of each monomer and joining together with single bonds

MONOMERS



polymerisation

POLYMER



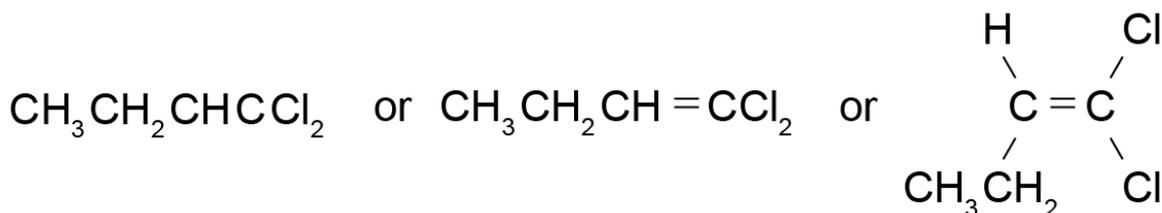
Draw a line of single bonded carbons. Add groups on Carbon 1 (alternate Cs) then add groups on carbon 2

Past NCEA questions Polymers (ONE)

2013: Question: 2a: (i) The molecule tetrafluoroethene, shown below, is the monomer for the polymer commonly known as Teflon. $\text{CF}_2=\text{CF}_2$

□ Draw TWO repeating units of the polymer formed.

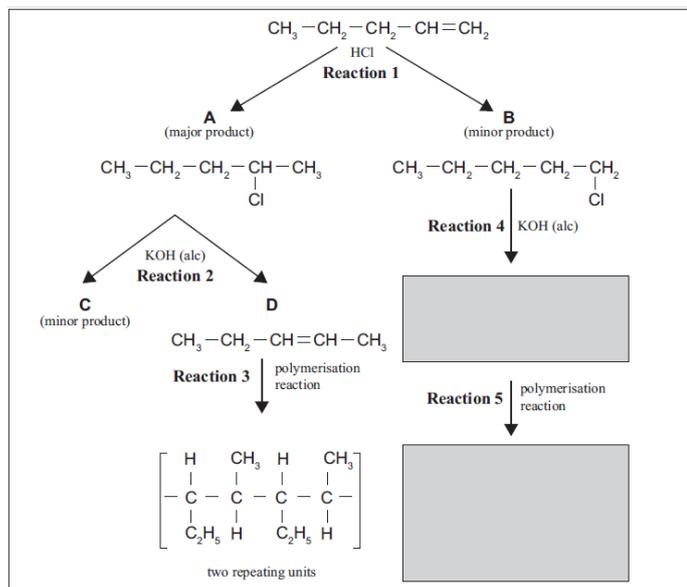
2013: Question: 2a: (ii) The following diagram shows three repeating sections of another polymer. Draw the structural formula of the monomer molecule used to make this polymer.



2014: Question: 3c: (i) Draw TWO repeating units of the polymer formed in Reaction 5.



Past NCEA questions Polymers (ONE)



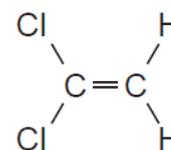
2014: Question: 3c: (ii) Compare and contrast the polymer formed in Reaction 5 to the polymer formed in Reaction 3.

In your answer you should explain why the polymers formed in these two reactions are different.

2014: Question: 3c: (ii) Compare and contrast the polymer formed in Reaction 5 to the polymer formed in Reaction 3. In your answer you should explain why the polymers formed in these two reactions are different.

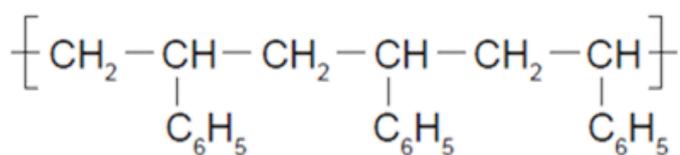
2015: Question: 2a: (i) Cling Wrap is a polymer that can be made from the monomer 1,1-dichloroethene.

□ Draw THREE repeating units of the polymer formed.



2016: Question 3b: Polystyrene is a polymer with the structure:

1,1-dichloroethene

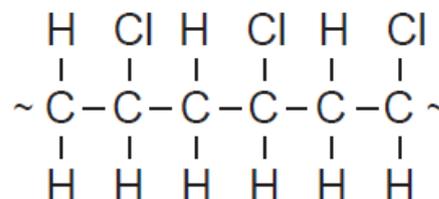


(i) Draw the monomer used to make the polymer polystyrene.

2016: Question 3b: (ii) Explain why the formation of polystyrene from its monomer is classified as an addition polymerisation reaction.

2017: Question 1a: Polyvinyl chloride (polychloroethene) is often used to make artificial leather. This can then be used to cover chairs, cover car seats, and make clothing. A section of a polyvinyl chloride molecule is shown below.

(i) Draw the monomer from which the polymer polyvinyl chloride would be made.





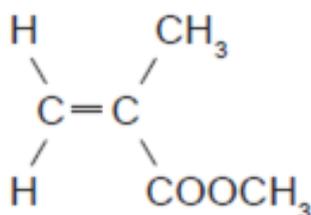
Past NCEA questions Polymers (TWO)

2017: Question 1a: (ii) Explain the difference in the structures and chemical reactivity of the monomer and polymer, and why the difference is important for the uses of the polymer.

2017: Question 1a (iii): Making polyvinyl chloride (polychloroethene) from its monomer is called 'addition polymerisation'.

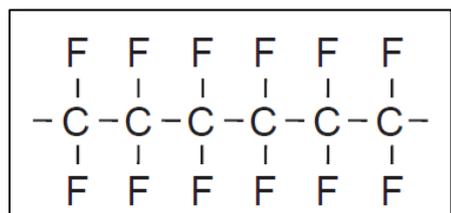
Explain the term 'addition polymerisation' using polyvinyl chloride as an example. Include an equation in your answer.

2018: Question: 1c: Perspex® is a polymer used as an alternative to glass as it is transparent, lightweight, and shatter resistant. It can be made from the monomer shown below.



(i) draw THREE repeating units of the polymer formed.

2020: Question: 2a: A section of the Teflon polymer chain is shown below. Teflon is best known for its use in coating non-stick frying pans and other cookware.



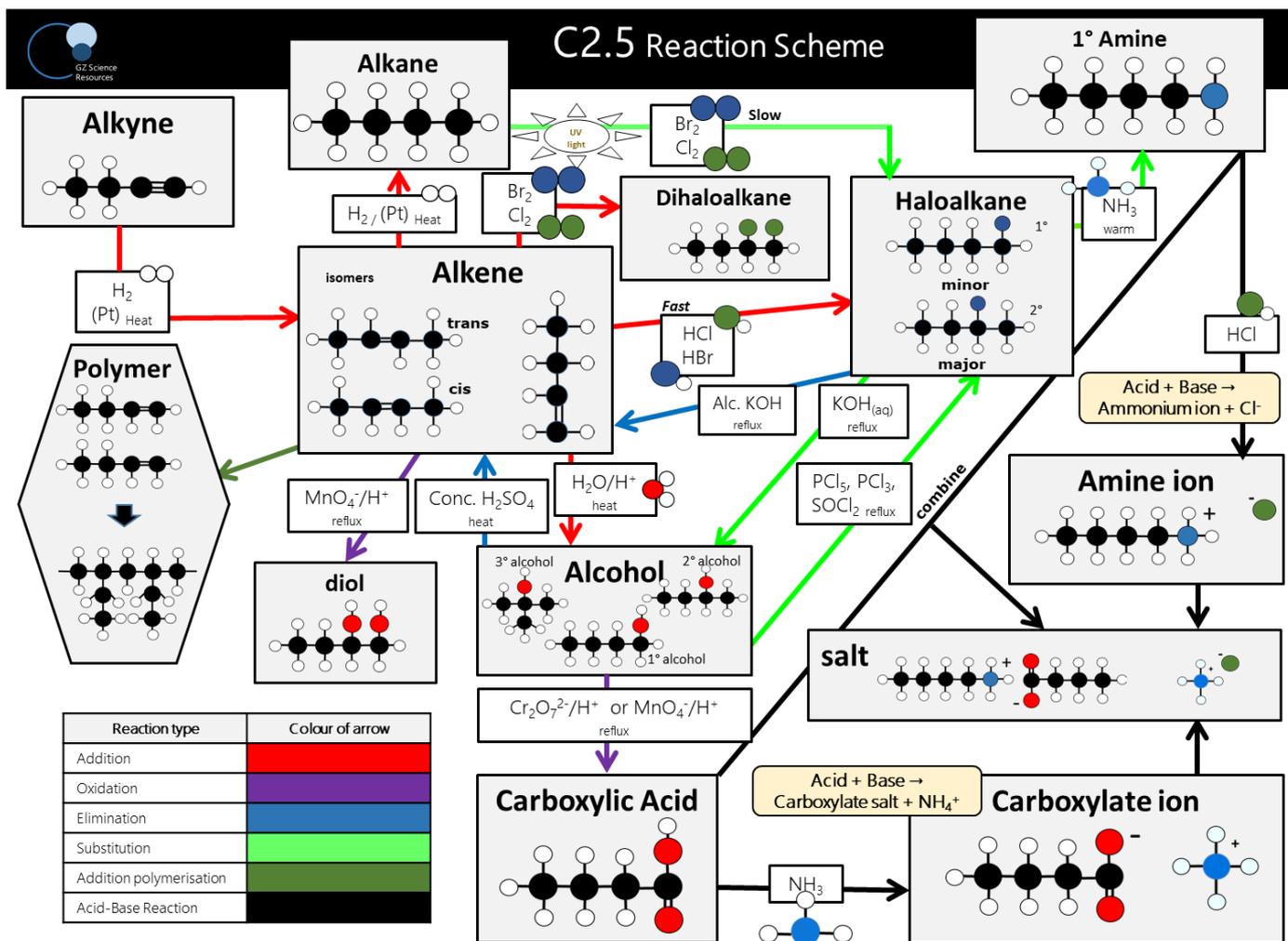
(i) draw and name the structure of the monomer used to make this polymer.

(ii) The chemical reactivity of the monomer and polymer are different.

Analyse this difference.

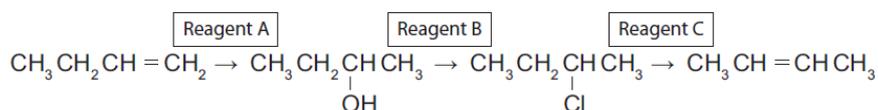
In your answer you should:

- link the structure of the monomer and polymer to its reactivity
- explain the importance of this difference for Teflon's use as a polymer.



Past NCEA questions Reaction Schemes (ONE)

2013: Question 3a: The flow diagram below shows a reaction scheme for the conversion of but-1-ene into but-2-ene.



Use the reaction scheme above to complete the following table to show:

- the formula of each reagent, including any necessary conditions
- the type of reaction occurring.

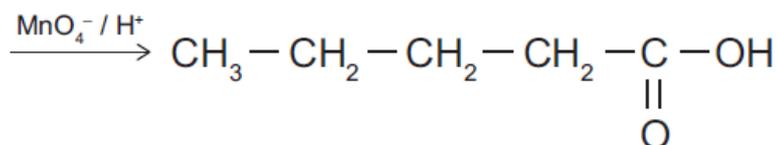
Reagent	Formula of reagent / conditions	Type of reaction
A		
B		
C		



Past NCEA questions Reaction Schemes (TWO)

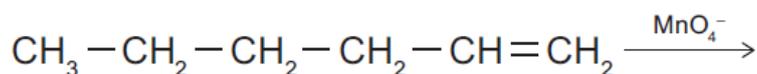
2014: Question: 1b: (i) When primary alcohols are oxidised by acidified permanganate, $\text{MnO}_4^- / \text{H}^+$, they form carboxylic acids.

Draw the primary alcohol that was oxidised to form the carboxylic acid shown

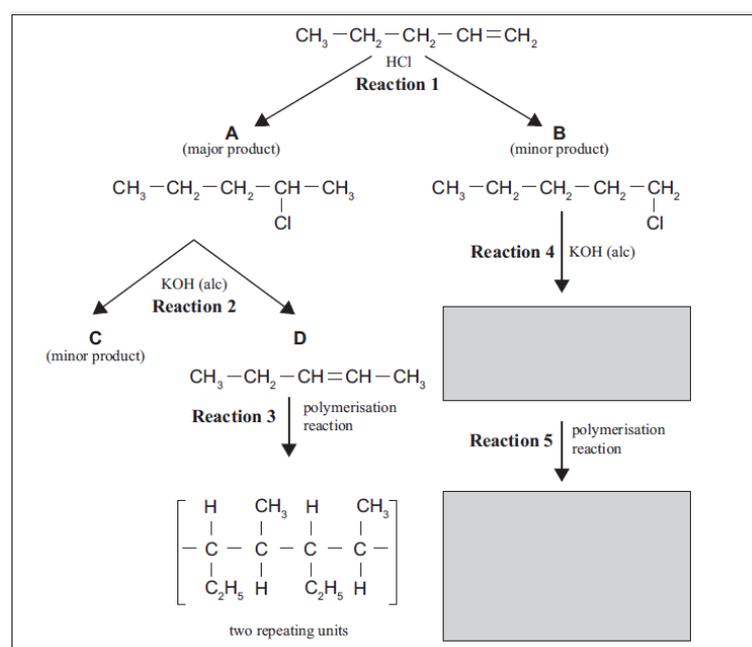


2014: Question: 1b: (ii) Permanganate ion, MnO_4^- , can be used to oxidise alkenes.

Draw the product of the following reaction



2014: Question: 3a: (i) Explain why Reaction 1 from the reaction scheme, shown again below, is classified as an addition reaction.



2014: Question: 3b: (i) Explain why Reaction 2 from the reaction scheme is classified as an elimination reaction.

2014: Question: 3b: (ii) Reaction 4 is also an elimination reaction.

Draw the structural formula of the product formed

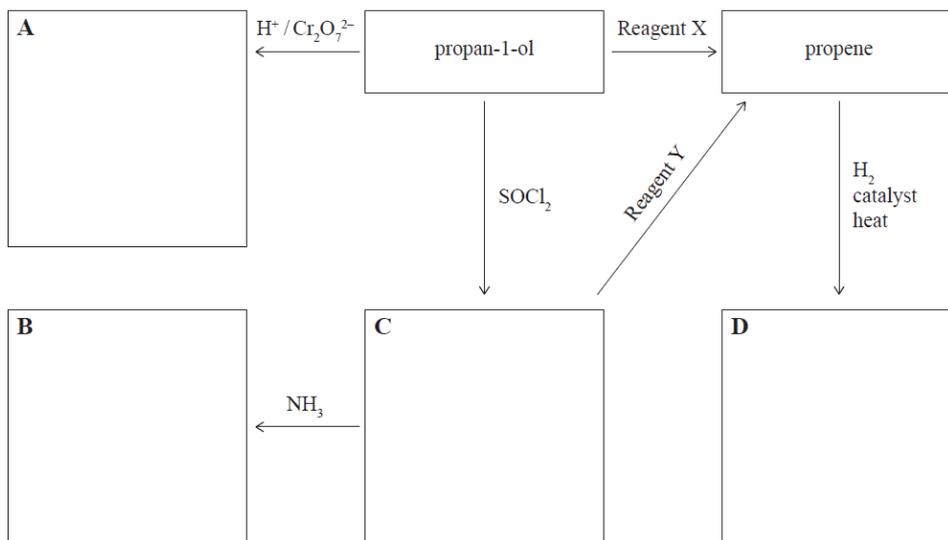


Past NCEA questions Reaction Schemes (THREE)

2015: Question: 3a: (i) Complete the scheme above by drawing the structural formulae of the organic compounds A to D.

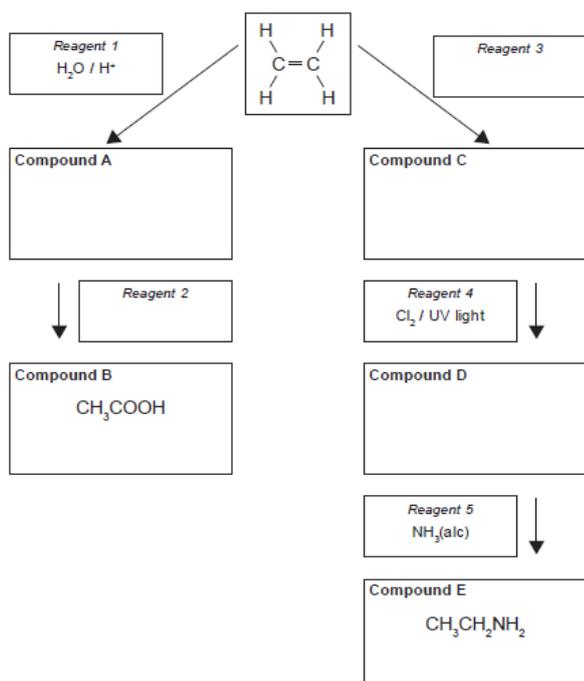
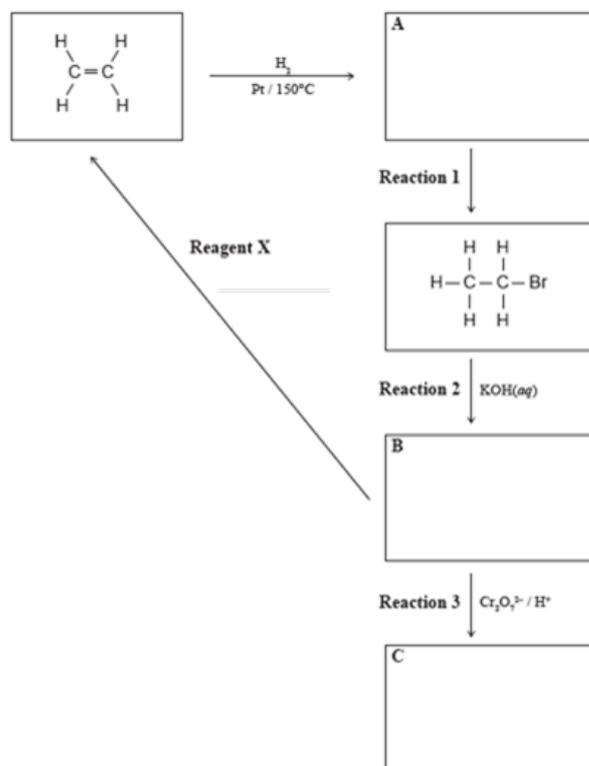
(ii) Circle the functional group of each of the organic compounds A, B, and C that you have drawn.

(iii) Identify reagents X and Y.



2016: Question 3a (i): Complete the following chart to the right by drawing the structural formulae for the organic compounds A, B, and C and identifying reagent X. →

(ii): Identify the type of organic reaction occurring in each of Reactions 1, 2, and 3.



2017: Question 3a: (i) Complete the following reaction scheme to the left by drawing the structural formulae for the organic compounds A, C, and D, and identifying reagents 2 and 3.

2017: Question 3a: (ii) Identify the types of reactions that occur to produce compounds A, B, C, D, and E:



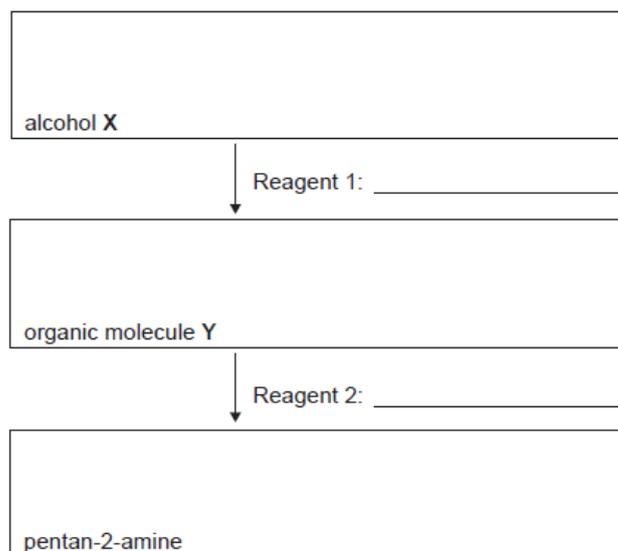
Past NCEA questions Reaction Schemes (FOUR)

2018: Question: 2c: Many organic reactions take more than one step in order to convert from one organic molecule to another.

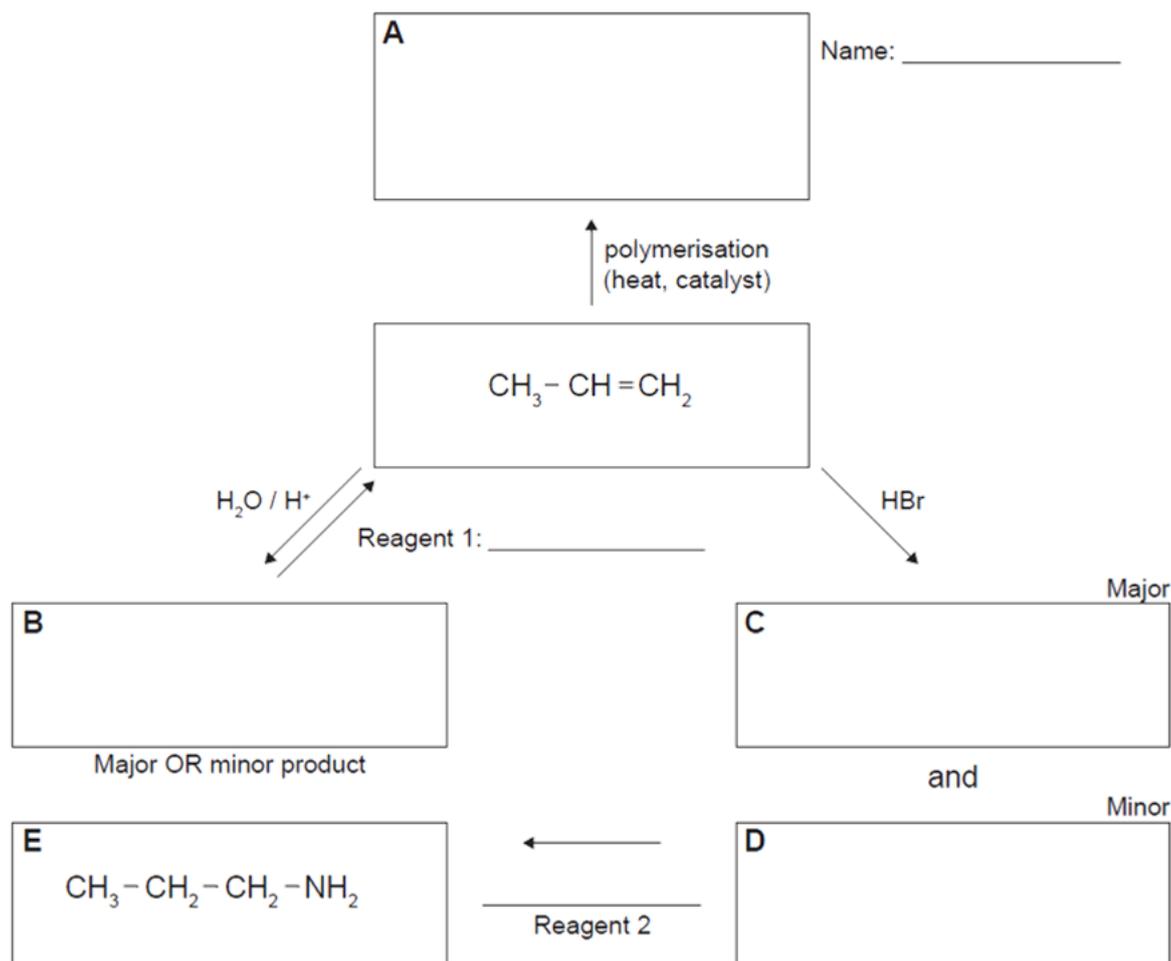
Two steps are required to produce pentan-2-amine from an alcohol.

Use the information given to analyse the reactions.

(i) Draw the structural formulae of the compounds, and name the reagents involved in the process.



2019: Question: 2a: Complete the following reaction scheme for propene, C_3H_6 , by drawing the structural formulae for the organic compounds A to D, naming compound A and identifying Reagents 1 and 2, including any conditions.

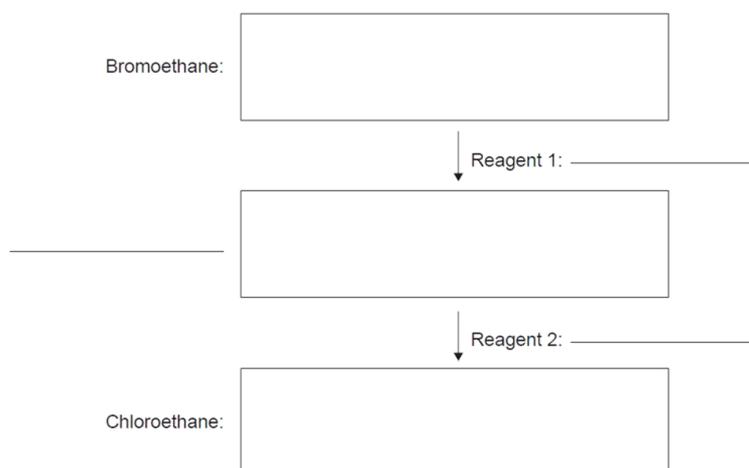




Past NCEA questions Reaction Schemes (FIVE)

2019: Question: 3b: The conversion of bromoethane to chloroethane requires two steps, with alcohol as an intermediate product.

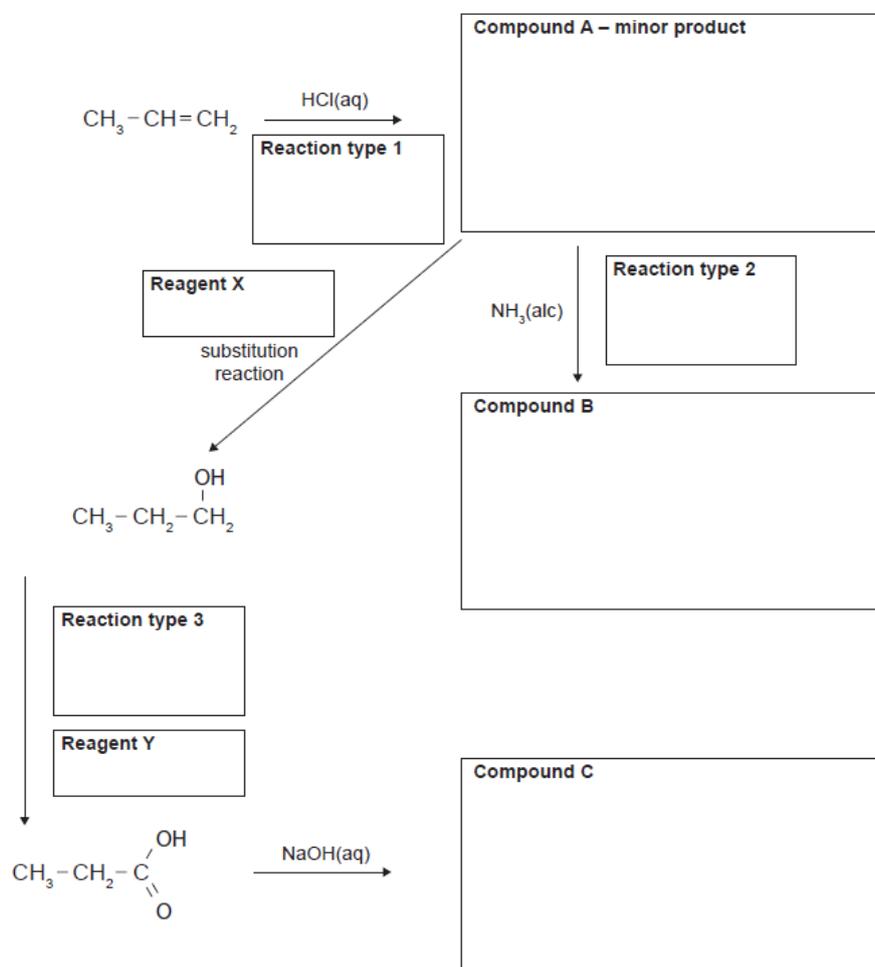
(i) Use this information to complete the reaction scheme below by drawing the structural formulae of each organic molecule and naming the intermediate alcohol and the reagents required.



(ii) Elaborate on the reaction scheme for this conversion. In your answer, you should identify:

- any conditions needed for each step of the conversion
- the type of reaction occurring for each step of the conversion.

2020: Question: 1d: Complete the following reaction scheme by drawing the structural formulae for the organic compounds A, B and C, identifying reagents X and Y, and reaction types 1, 2, and 3.





Writing Excellence answers to Identifying Unknowns questions

Identifying Unknowns QUESTION

Question: Question: 1c:

Four separate colourless organic liquids are known to be: • ethanol • ethanoic acid • hex-2-ene • 1-aminohexane

Write a procedure to identify each of these organic liquids using only the reagents listed below.

• acidified dichromate solution, $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+_{(aq)}$ • bromine water, $\text{Br}_{2(aq)}$ • sodium carbonate solution, $\text{Na}_2\text{CO}_{3(aq)}$.

In your answer, you should:

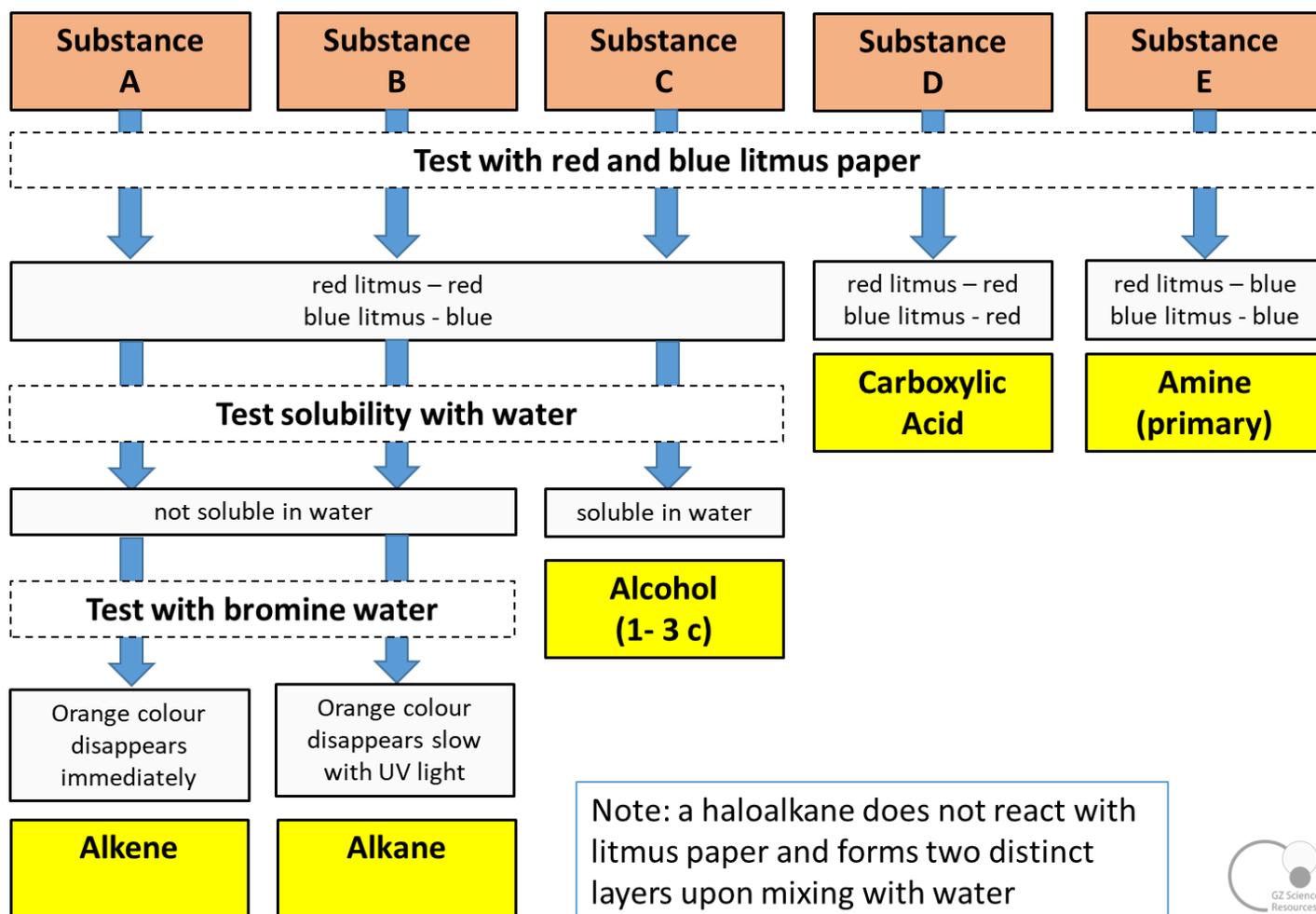
- identify the test reagents used
- describe any observations that would be made
- identify the type of reaction that occurs
- identify the organic product of any reaction.

You do not need to include equations in your answer.

ANSWER

Step 1	Test reagents used
	Observations
	Type of reaction that occurs
	Organic product of any reaction
Step 2	Test reagents used
	Observations
	Type of reaction that occurs
	Organic product of any reaction
Step 3.	Test reagents used
	Observations
	Type of reaction that occurs
	Organic product of any reaction
Step 4.	Test reagents used
	Observations
	Type of reaction that occurs
	Organic product of any reaction

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.



Past NCEA questions Identifying Unknowns

2013: Question 2b: Five separate colourless organic liquids are known to be:

pentan-1-ol ethanol pent-1-ene pentane ethanamine.

Write a valid method to show how each of these liquids can be identified using only water, litmus paper, and bromine water, $\text{Br}_{2(aq)}$. Your method should allow another student to identify these liquids, and include:

the reagent used and any observations made.

2015: Question 1c: Four separate colourless organic liquids are known to be:

• ethanol • ethanoic acid • hex-2-ene • hexan-1-amine (1-aminohexane).

Write a procedure to identify each of these organic liquids using only the reagents listed below.

• acidified dichromate solution, $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+_{(aq)}$ • bromine water, $\text{Br}_{2(aq)}$ • sodium carbonate solution, $\text{Na}_2\text{CO}_{3(aq)}$.

In your answer, you should: • identify the test reagents used • describe any observations that would be made

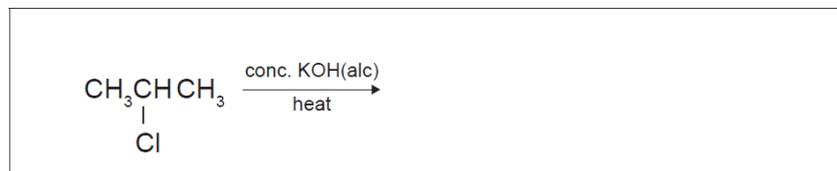
• identify the type of reaction that occurs • identify the organic product of any reaction.

You do not need to include equations in your answer.



Past NCEA questions Identifying Unknowns

2017: Question 1b: A chemistry class was learning about the chemistry of haloalkanes. They were researching the effect of heat and concentrated potassium hydroxide in ethanol, conc. KOH(alc), on the haloalkane 2-chloropropane. (i) Draw the organic product formed in the following reaction.



2017: Question 1b: (ii) Explain how the functional group of the organic product drawn above could be identified.

2018: Question: 2a: Two bottles of different colourless organic liquids are unlabelled. They are known to be propan-1-amine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, and ethanoic acid, CH_3COOH .

(i) Explain how you could identify these two liquids using only solid sodium hydrogen carbonate, $\text{NaHCO}_3(\text{s})$.

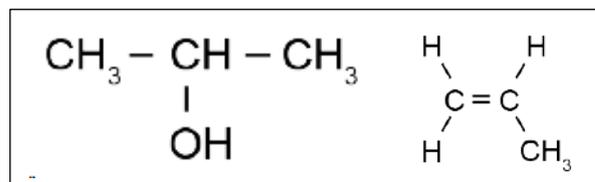
2018: Question: 2b: Three more unlabelled bottles of colourless organic liquids are known to contain hexane, hex-1-ene, and ethanol. Write a procedure to identify each of these liquids using only bromine water, $\text{Br}_2(\text{aq})$, and water, H_2O . In your answer you should explain any observations that would be made.

You do not need to include equations in your answer.

2018: Question: 3b: (ii) Elaborate on chemical tests that could be used to identify the functional groups of the organic products formed in part (i).

In your answer, you should:

- identify chemicals and conditions required
- describe any observations
- state the type of reaction occurring
- explain why potassium permanganate solution, $\text{KMnO}_4(\text{aq})$, cannot be used to distinguish between these organic products.



2019: Question: 1c: (iii) Explain how acidified potassium permanganate solution, $\text{KMnO}_4 / \text{H}^+(\text{aq})$, can be used to distinguish between compounds A and B.

A	$\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$
B	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$

In your answer you should:

- identify the type of reaction
- describe any relevant observations.



Past NCEA questions Identifying Unknowns

2019: Question: 1c: (iv) Compounds A and B will both react with bromine water, $\text{Br}_{2(aq)}$.

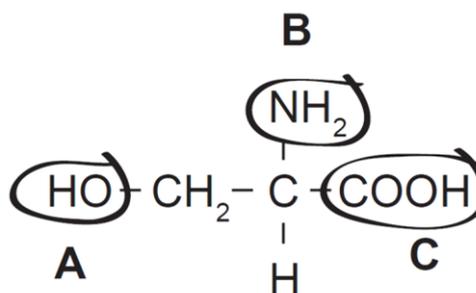
A	$\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$
B	$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$

Compare and contrast these reactions by referring to the conditions required, the observations, the products formed, and the type of reaction.

2019: Question: 3a (i): Each circled functional group is found in different organic molecules commonly used in school laboratories:

Using the list below, choose a reagent and describe the observations that could identify each of these functional groups.

- red litmus paper • blue litmus paper
- bromine water, $\text{Br}_{2(aq)}$
- acidified dichromate solution, $\text{H}^+ / \text{Cr}_2\text{O}_7^{2-}(aq)$



	Functional Group	Chemical test	Observations
A			
B			
C			

(ii): Describe an alternative method to distinguish between functional groups B and C.

Identify the reagent needed, the expected observations, and explain the type of reaction occurring.

2020: Question: 3b (i) The labels have fallen off bottles of three colourless liquids. They are known to be ethanol, hexene, and propanoic acid. Explain how you would identify the liquids, using a solution of sodium hydrogen carbonate, $\text{NaHCO}_3(aq)$, and your knowledge of the physical and chemical properties of the compounds. In your answer you should: state any observations

- link your observations to chemical or physical properties of the organic molecule
- write chemical equations for any reactions that occur, including the structural formula of organic products.

(ii) Explain how you could use an alternative reagent to do a chemical test that would allow you to distinguish between hexene and propanoic acid. In your answer you should:

- identify a reagent
- state the observations that would allow you to distinguish the compounds
- identify any reaction type occurring.



Writing Excellence answers to Cis-Trans Isomers questions

Cis-Trans Isomers QUESTION

Question: Molecule D can exist as geometric (*cis* and *trans*) isomers, with both isomers having the same molecular formula.

Draw the geometric (*cis* and *trans*) isomers for molecule D in the boxes below. Justify why molecule D can exist as geometric (*cis* and *trans*) isomers.

Your answer should include:

- an explanation of the requirements for *cis* and *trans* isomers
- reference to the structure of molecule D.

A	$\begin{array}{c} \text{Cl} \\ \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$	B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
C	$\text{CH}_3\text{CH}_2\text{CHCl}_2$	D	$\text{CH}_3\text{CH}_2\text{CHCHCl}$
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$	F	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$

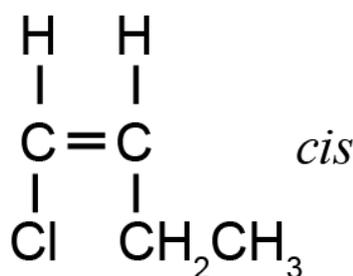
ANSWER

1. Draw the *cis* and *trans* isomers

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

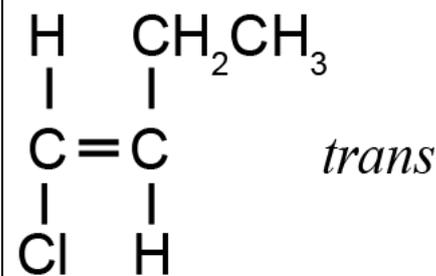
(name of molecules not normally required as part of the question)

Cis



Name: cis 1-chlorobut-1-ene

Trans



Name: trans 1-chlorobut-1-ene

2. link the presence of a double C=C bond to lack of rotation

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.

3. link the requirement of two different groups of each of the C on the double

They must also have two different groups attached to each carbon (involved in the double bond).

4. link the requirements above to your specific molecule (D)

This molecule has a carbon-carbon double bond. One carbon of the double bond is attached to a hydrogen atom and an ethyl group. The other is attached to a hydrogen atom and a chlorine atom.

5. Explain how two geometric isomers can have the same molecular formula

When these two requirements are met, the two haloalkenes can have the same molecular formula and the same sequence of atoms in the formula, but a different arrangement in space (a different 3D formula), hence they are *cis* and *trans* isomers.

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 Physical Properties questions

Solubility - Physical Properties of Organic Compounds QUESTION

Question: Explain why two layers form in Reaction One. Hexane reacts with bromine water

ANSWER

1. Identify the functional group of your substance (hexane) and name the product formed.

Hexane is an alkane, with single bonded carbons. When reacting with bromine water it will form a haloalkane (bromohexane) during a substitution reaction

2. link observation (layers forming) to the polarity of the substance

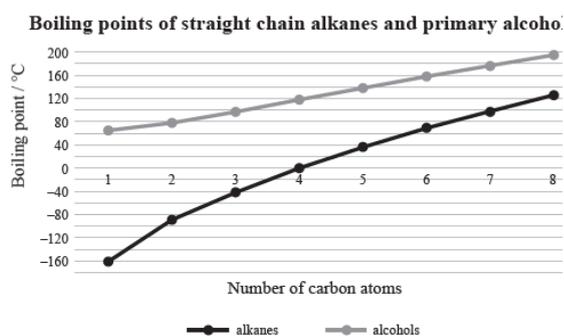
Two layers form in Reaction One as hexane is non-polar and the product (bromohexane) is effectively also non-polar.

3. identify the polarity of the bromine water and link to the substances being immiscible (forming 2 layers)

The water from the bromine water is polar and therefore the non-polar organic reactant and product will not dissolve in the water; because of this, two layers form as this polar and non-polar layer do not mix.

Melting point - Physical Properties of Organic Compounds QUESTION

Question: Identify the trends shown on the graph. Identify which alkanes will be gases at room temperature (20°C) according to the graph beside.



ANSWER

1. link the boiling point trend to number of carbons in both groups (when explaining trends on a line graph always relate one variable to the other)

The boiling points of both alkanes and alcohols increase as the number of C atoms increases. The boiling points of alcohols are always higher than the alkanes (with the same number of C atoms).

2. Identify which alkanes (number of carbons) are gases at room temp. (will have boiling point below 20°C)

Alkanes with 1, 2, 3, and 4 C atoms (methane, ethane, propane, and butane) will be gases at room temperature.



Writing Excellence answers to Haloalkane reactions questions

Haloalkane reactions QUESTION

Question: Chloroethane, $\text{CH}_3\text{CH}_2\text{Cl}$, 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

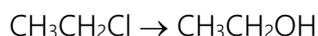
Reaction 1

Chloroethane reacts with $\text{KOH}_{(\text{aq})}$

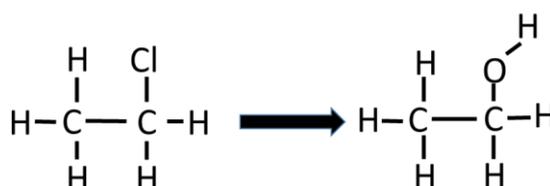
Product formed - forms an alcohol, ethanol

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

Condensed Structural Formula equation



Structural Formula equation



Reaction 2

Chloroethane reacts with $\text{KOH}_{(\text{alc})}$

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



Structural Formula equation



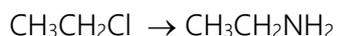
Reaction 3

Chloroethane reacts with $\text{NH}_3_{(\text{alc})}$

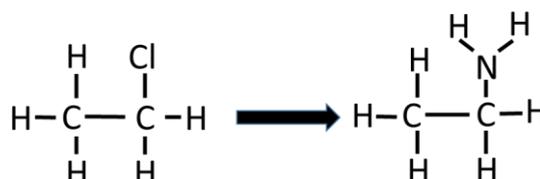
Product formed - forms an amine, aminoethane

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

Condensed Structural Formula equation



Structural Formula equation





Writing Excellence answers to Alcohol Reactions questions

Alcohol Reactions QUESTION

Question: Butan-1-ol can react separately with each of PCl_5 , $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$, and concentrated H_2SO_4 . Elaborate on the reactions of butan-1-ol with each of the three reagents.

For each reaction, your answer should include:

- the type of reaction occurring and the reason why it is classified as that type
- the name of the functional group formed in each product
- the structural formula of the organic product.

ANSWER

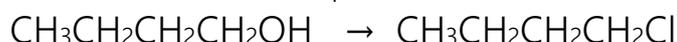
Reaction 1

Butan-1-ol reacts with PCl_5

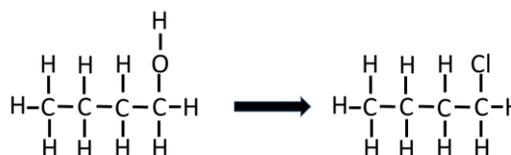
Product formed – The functional group in the product is a chloro group / chloroalkane (haloalkane) 1-chlorobutane

Reaction type - Reaction with PCl_5 is a substitution reaction. The hydroxyl group ($-\text{OH}$) is replaced by a chloro group ($-\text{Cl}$).

Condensed Structural Formula equation



Structural Formula equation



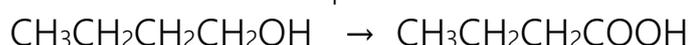
Reaction 2

Butan-1-ol reacts with $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$

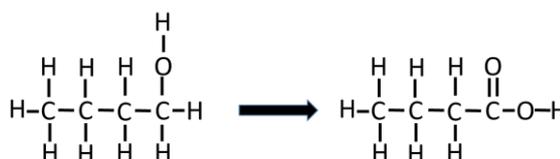
Product formed - The functional group in the product is carboxylic acid. butanoic acid

Reaction type – Reaction with acidified dichromate is oxidation as the alcohol is oxidised to a carboxylic acid.

Condensed Structural Formula equation



Structural Formula equation



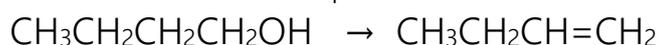
Reaction 3

Butan-1-ol reacts with concentrated H_2SO_4

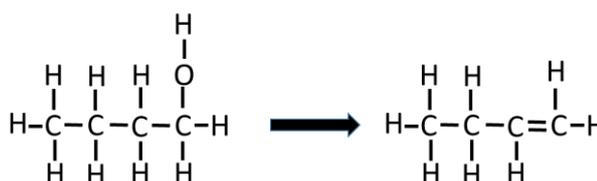
Product formed - The functional group in the product is a (carbon-to-carbon) double bond / alkene. But-1-ene

Reaction type - Reaction with concentrated H_2SO_4 is an elimination reaction. A hydrogen atom and the $-\text{OH}$ group on (adjacent) carbon atoms are removed forming a (carbon-to-carbon) double bond.

Condensed Structural Formula equation



Structural Formula equation





Writing Excellence answers to Alkene Reactions questions

Alkene 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 $CH_2 = CH_2 \xrightarrow{KMnO_4} \begin{array}{c} CH_2 - CH_2 \\ \quad \\ OH \quad OH \end{array}$
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 $CH_2 = CH_2 \xrightarrow{H_2O / H^+} CH_3 - CH_2 - OH$
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 $CH_2 = CH_2 \xrightarrow{HBr} CH_3 - CH_2 - Br$
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.



Writing Excellence answers to Major and Minor products questions

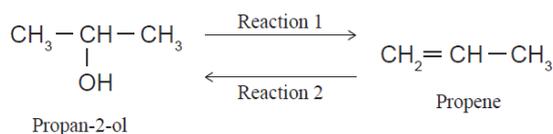
Major and Minor Products QUESTION

Question: In Reaction 1, propan-2-ol can be converted to propene.

In Reaction 2, propene can be converted back to propan-2-ol.

Analyse BOTH of these reactions by:

- describing the reagents and conditions needed for each reaction to occur
- identifying each type of reaction and explaining your choice
- explaining why Reaction 1 forms only a single organic product, but Reaction 2 forms a mixture of organic products.



ANSWER

1. Reaction 1 Propan – 2-ol forms propene	Reagent and conditions -To convert propan-2-ol to propene, add concentrated sulfuric acid (which is a dehydrating agent).	
	Reaction type - It is an elimination reaction because OH and H are removed from adjacent carbon atoms and a double bond is created to form an alkene.	
	Structural Formula $\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{C}-\text{C}=\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	
2. Reaction 2 Propene forms propanol Label each structure with name and whether it is major or minor	Reagent type and conditions - To convert propene to propan-2-ol, add dilute (sulfuric) acid.	
	Reaction type - This is an addition reaction because the double bond is broken forming a C-C (single) bond, allowing H and OH from water to bond to the C atoms that were double bonded together.	
	Structural Formula $\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$ Product type: Major Name: Propan-2-ol	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \quad \\ \quad \quad \quad \text{H} \end{array}$ Product type: Minor Name: Propan-1-ol
3. Explain why <u>reaction one</u> forms only one product linked to symmetry	Reaction 1 forms only one product because the carbon atom from which the H is removed (C1 or C3) does not affect the structure of the product as propan-2-ol is symmetrical.	
4. State Markovnikov's rule AND Explain the reason <u>reaction two</u> produces two products linked to Markovnikov's rule and asymmetry, including which is major and which is minor.	Reaction 2 produces two products because an asymmetric reagent (H-OH) adds onto an asymmetric alkene (CH ₃ CH=CH ₂). There are two carbons that the H or OH can bond with (C1 and C2), so there are two possible combinations. We can predict which will be the major product by using <u>Markovnikov's rule</u> , which states that the carbon with the most hydrogens gains more hydrogens. This means that most of the time, C1 will get another hydrogen while C2 will get the OH in this reaction. Propan-2-ol will be the major product and propan-1-ol the minor product.	



Writing Excellence answers to Acid-Base Reactions questions

Acid-Base Reactions QUESTION

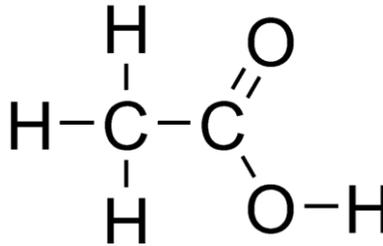
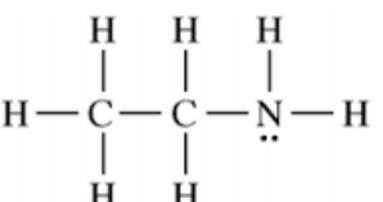
Question: Question 3c: Compounds B (CH_3COOH) and E ($\text{CH}_3\text{CH}_2\text{NH}_2$) react together.

(i) Write a balanced equation for the reaction that occurs between compounds B and E.

(ii) Identify the type of reaction that occurs between compounds B and E.

Justify your answer.

ANSWER

<p>1. Draw the structural formula of the acid and base</p> <p>Identify which hydrogen ion will be donated in the acid ($-\text{COOH}$ end) and which part of the base will accept the hydrogen ion ($-\text{NH}_2$ end)</p>	<p>Acid (carboxylic acid)</p> 	<p>Base (amine)</p> 
<p>2. Write a balanced equation</p>	$\text{CH}_3\text{COOH}_{(aq)} + \text{CH}_3\text{CH}_2\text{NH}_{2(aq)} \rightarrow \text{CH}_3\text{COO}^-_{(aq)} + \text{CH}_3\text{CH}_2\text{NH}_3^+_{(aq)}$	
<p>3. Name the type of reaction</p>	<p>The reaction between B and E is an acid-base (neutralisation) reaction.</p>	
<p>4. Explain what occurs in the reaction generally</p>	<p>Acid-base reactions involve a proton / H^+ transfer.</p>	
<p>5. Explain in detail what occurs in the acid – and the product formed</p>	<p>Protons / H^+, are released from the carboxylic acid functional group, $-\text{COOH}$, resulting in a salt forming containing the $-\text{COO}-$ group.</p>	
<p>5. Explain in detail what occurs in the base – and the product formed</p>	<p>The proton / H^+ is accepted by the amine functional group, $-\text{NH}_2$, this forms a salt containing the $-\text{NH}_3^+$ group.</p>	



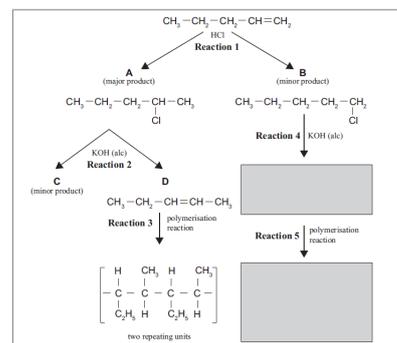
Writing Excellence answers to Polymers questions

Polymers QUESTION

Question: Draw TWO repeating units of the polymer formed in Reaction 1. Explain why the formation of the polymer from its monomer is classified as an addition polymerisation reaction.

Compare and contrast the polymer formed in Reaction 5 to the polymer formed in Reaction 3.

In your answer you should explain why the polymers formed in these two reactions are different.

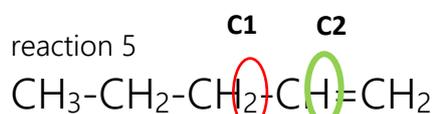


ANSWER

1. Identify the monomer, then draw the polymer

(identify C 1 and C2 in monomer either side of the double bond then draw a chain of C (4 for 2 repeating units) and add on groups of each one removing double bond)

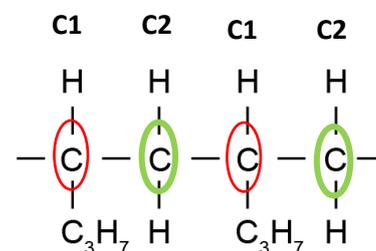
monomer



reaction 3



polymer



2. explain the definition of addition polymerisation

Since the monomer for this reaction is an alkene, when polymerisation occurs, the double bond in each alkene molecule is broken, freeing up a bonding space on each of the C atoms that was part of the double bond. This allows the monomers to join together by forming covalent bonds to make the polymer.

Since double bonds in the alkene are being broken and molecules added into the freed up bonding spaces to make the monomer, this is an addition reaction.

Polymerisation reactions occur when many monomers are chemically joined.

3. molecule 1 (reaction 5) – describe the 2 groups of each end of the double bonded carbons

In Reaction 3, the polymer formed will have a carbon with one hydrogen and a methyl group, and a carbon with one hydrogen and an ethyl group, as its repeating unit, due to the double bond being on the C2 position.

4. molecule 2 (reaction 3) – describe the 2 groups of each end of the double bonded carbons

In Reaction 5, since the double bond is in a different position (the C1 position), the polymer formed will have as its repeating unit a carbon atom with 2 hydrogen atoms attached, and a carbon atom with one hydrogen attached and a propyl group attached.

5. Explain that molecule 1 and 2 are structural isomers but have the same molecular formula

The molecular formulae of the two repeating units of both polymers are the same, but the structural formulae are different. (States repeating units are structural isomers.)



Writing Excellence answers to Identifying Unknowns questions

Identifying Unknowns QUESTION

Question: Question: 1c:

Four separate colourless organic liquids are known to be: • ethanol • ethanoic acid • hex-2-ene • 1-aminohexane. Write a procedure to identify each of these organic liquids using only the reagents listed below.

• acidified dichromate solution, $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+_{(aq)}$ • bromine water, $\text{Br}_{2(aq)}$ • sodium carbonate solution, $\text{Na}_2\text{CO}_{3(aq)}$.

In your answer, you should:

• identify the test reagents used • describe any observations that would be made • identify the type of reaction that occurs • identify the organic product of any reaction.

You do not need to include equations in your answer.

ANSWER

Step 1	Test reagents used – start with $\text{Cr}_2\text{O}_7^{2-} / \text{H}^+$ adding a bit to each sample
	Observations - which will turn from orange to green with ethanol No change for the other 3 samples
	Type of reaction that occurs - oxidation
	Organic product of any reaction - ethanol is oxidised to ethanoic acid.
Step 2	Test reagents used - add sodium carbonate solution, $\text{Na}_2\text{CO}_{3(aq)}$ to the remaining 3 samples
	Observations - Bubbles of gas will be produced in the ethanoic acid sample No change for the other 2 samples
	Type of reaction that occurs – acid-base reaction
	Organic product of any reaction – in the acid-base reaction Sodium ethanoate / ethanoate ion is formed.
Step 3.	Test reagents used – add bromine water, $\text{Br}_{2(aq)}$ to the remaining 2 samples
	Observations - the bromine water, which turns from red / brown to colourless straightaway in the hex-2-ene sample No change for the other sample (for substitution in an alkane this reaction will be seen slowly with UV light as a catalyst)
	Type of reaction that occurs – addition reaction
	Organic product of any reaction – in the addition reaction It will form 2,3-dibromohexane is formed
Step 4.	Test reagents used - Hexan-1-amine will be the chemical left over that will not react with any of the given reagents.
	Observations (in other questions red litmus paper can be used – which will turn blue for an amine)
	Type of reaction that occurs
	Organic product of any reaction