SUPERVISOR'S USE ONLY

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91165

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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Chemistry 2024

91165 Demonstrate understanding of the properties of selected organic compounds

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the properties of selected organic compounds.	Demonstrate in-depth understanding of the properties of selected organic compounds.	Demonstrate comprehensive understanding of the properties of selected organic compounds.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table and other reference material are provided in the Resource Booklet L2–CHEMR.

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

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area will be cut off when the booklet is marked.

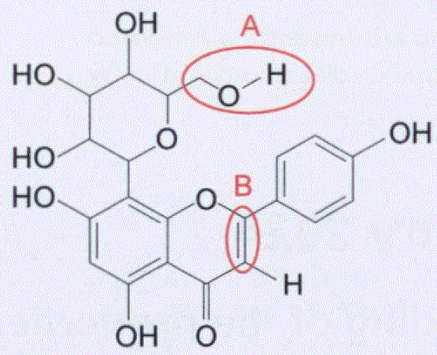
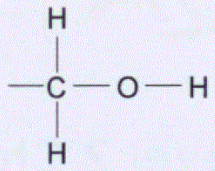
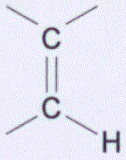
YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit TOTAL 15

QUESTION ONE

The leaves of kawakawa have been used to treat a range of conditions, including toothache and gastrointestinal upsets.

Recent research has shown medicinal effects can be attributed to many molecules in kawakawa, including vitexin, shown below.

		
Vitexin	Group A	Group B

(a) The molecule vitexin has had key functional groups, A and B, circled and shown to the right.

(i) Name the functional groups that have been circled:

A: ~~Alcohol / hydroxyl group~~ methanol B: ethene

(ii) Identification tests were conducted to show the presence of groups A and B in the molecule.

Name the reagents and any conditions required for identifying group A and group B separately.

Reagents / Conditions:

A: ~~$KMnO_4^- / H^+$~~ MnO_4^- / H^+

B: Br_2 (UV light

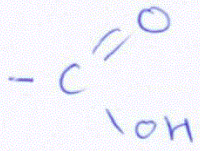
(iii) Describe the observation that would occur in a positive test for each group.

Include:

- the reaction type
- the name of the functional group of the product
- a drawing of the functional group of the product.

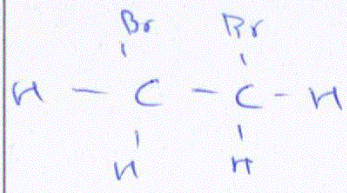
A: Oxidation. Methanol will be oxisided to form methanoic acid

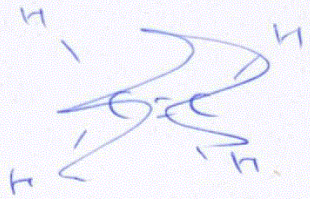
Functional group of the product:



B: Ethene will undergo a addition reaction where the ~~double~~ C=C to C=C bond is broken and 2 Br atoms are added to form 1,2-dibromoethane

Functional group of the product:





(b) Kawakawa also contains some anti-inflammatory molecules. When researchers extracted these molecules from kawakawa leaves, they had to use a range of solvents including methanol, ethanol, and hexane. All three of these solvents are colourless liquids at room temperature.

Explain the procedure you could use to distinguish between methanol, ethanol, and hexane, based solely on their physical properties.

Give reasons for the different results between solvents.

Physical properties are limited to differences in melting point, boiling point, and solubility in water.

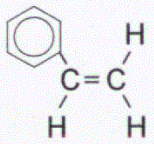
Place all compounds in water. The solution which forms 2 layers is hexane. This is because ~~hexane~~ alkanes are non-polar therefore they are insoluble in polar solvents such as water.

~~Place~~ ~~Boil the water~~ In the remaining 2 compounds, boil the water in the solutions. The solution which has a higher boiling point is the ethanol. This is because the longer the carbon chain of the alcohol, the more bonds there are to break and as a result, more heat energy is required to break the bonds thus a higher boiling point. Ethanol has a longer carbon chain than methanol ~~due to~~ thus it will be the solution with the higher boiling point. The solution with the lower boiling point is methanol due to it's shorter carbon chain.

The other 2 compounds will form 1 layer as alcohols are polar and are soluble in polar solvents such as water.

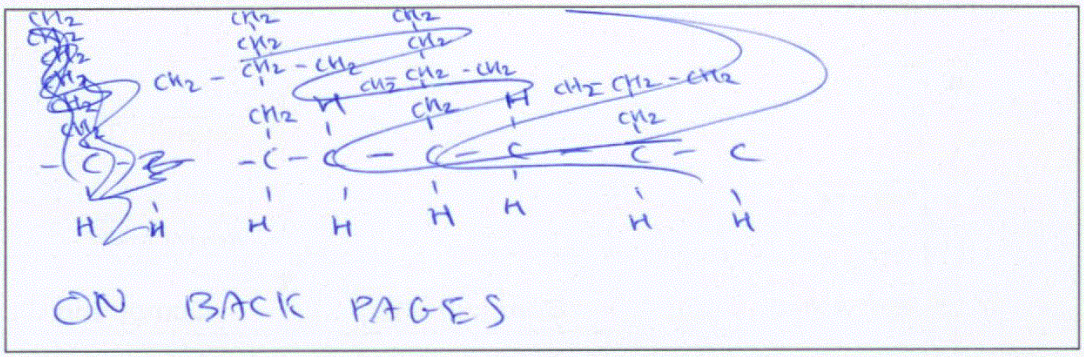
(c) Polystyrene has been used widely in the manufacture of plastic produce such as bags, plates, bowls, and cutlery. However, single-use plastics, such as these, are being phased out.

Polystyrene is an addition polymer made from the styrene monomer, shown below.



Styrene monomer

(i) In the box below, draw three repeating units of the polystyrene polymer.



(ii) Plastics are cheap and stable.

Explain why the monomer styrene is more reactive than the polymer polystyrene.

In your answer you should:

- explain the term 'addition polymerisation'
- explain the difference in structure, and link it to chemical reactivity
- relate how this difference is important for the uses of the polymer.

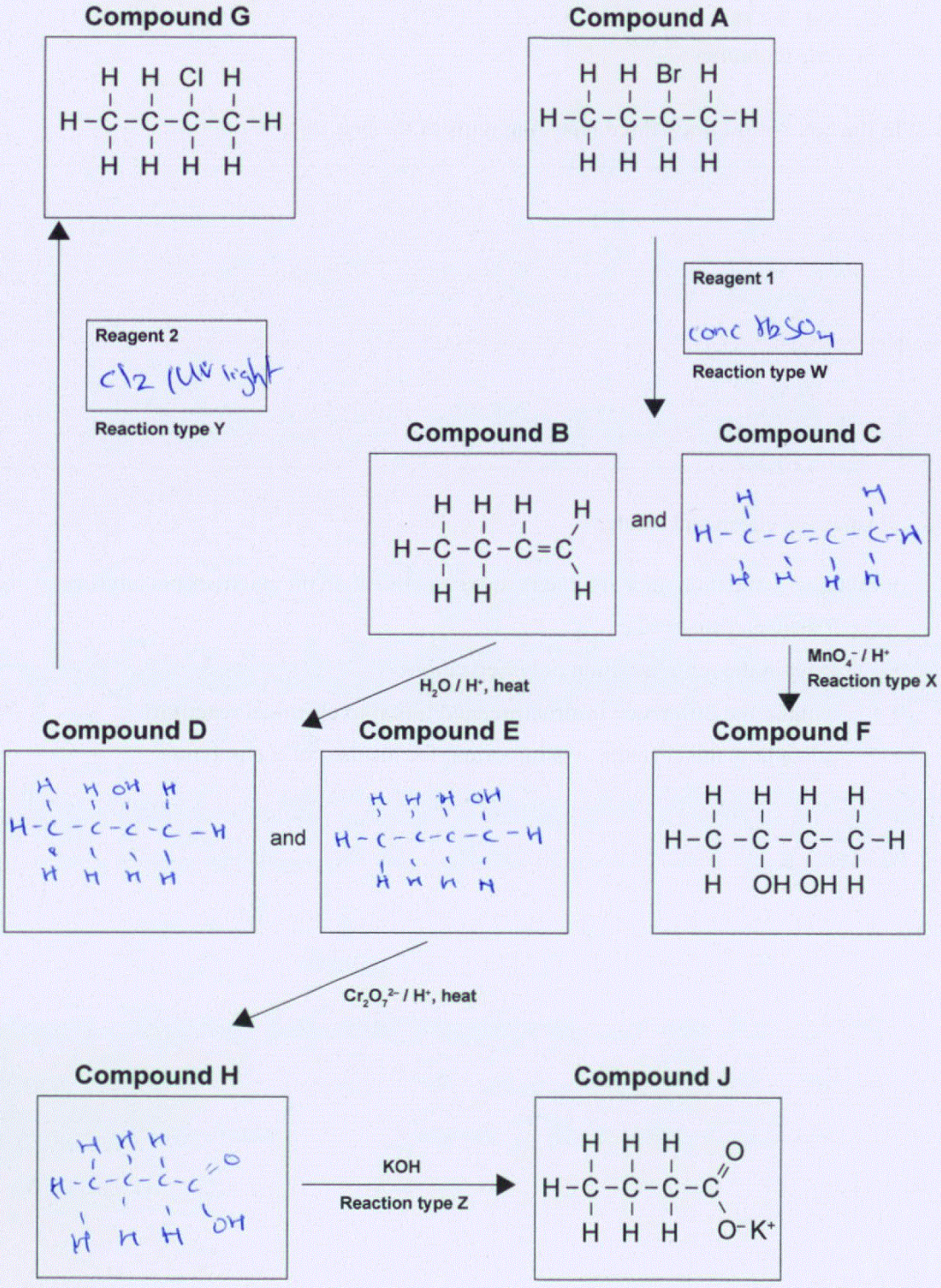
Addition polymersation is when the C=C bond is broken and therefore there is a bonding location at the end of each carbon for the monomers to link with which forms long chains of monomers known as polymers. Monomers are have C=C bonds which are unsaturated which makes them highly reactive. Polymers are made up of C-C bonds which are saturated making them have a low reactivity. Having a low reactivity for the polymer is useful as it makes it so that plastic items such as bags and plates do not react with the environment.

QUESTION TWO

(a) An incomplete reaction scheme starting with, 2-bromobutane, **Compound A**, is shown.

(i) Draw the structural formulae of **Compounds C**, **D**, **E**, and **H** in the labelled boxes provided.

(ii) Complete the **Reagents 1** and **2** in the labelled boxes provided.

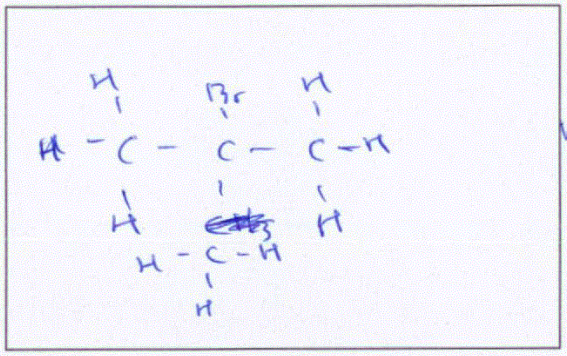


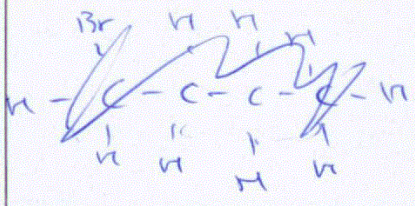
(iii) Name the **Reaction types W, X, Y,** and **Z** in the table below.

Reaction type W	~~elimination~~ elimination
Reaction type X	~~oxidation~~ addition
Reaction type Y	substitution
Reaction type Z	neutralisation

(b) The starting material **Compound A**, and one of the final products **Compound G**, are both secondary haloalkanes.

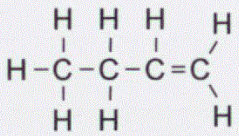
Draw the tertiary isomer of bromobutane and explain why it is classified as tertiary.



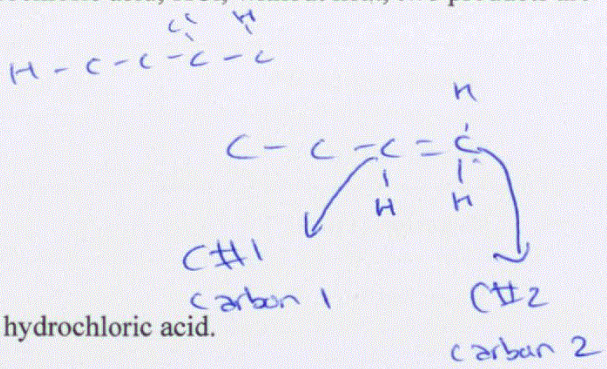


The tertiary isomer of bromobutane is tertiary because the Br atom is attached to a carbon atom which is bonded to 3 other adjacent carbon atoms.

(c) (i) When **Compound B** reacts with hydrochloric acid, HCl, without heat, two products are formed in differing amounts.



Compound B

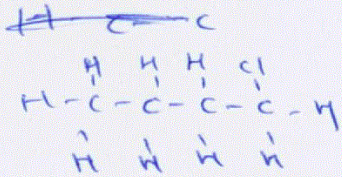


Discuss the reaction of **Compound B** with hydrochloric acid.

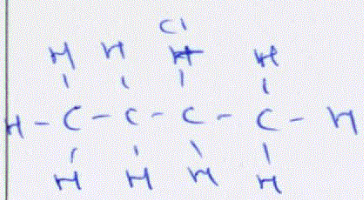
In your answer you should:

- name and explain this type of reaction
- draw the structures of both products, in the appropriate box for the major and minor products
- justify your choice of major and minor products.

This type of reaction is an addition reaction. This is because the ~~bonds are~~ C=C bond is being broken and a H and Cl atom are being added. Due to the asymmetrical shape of compound B, two different products are formed depending on the placement of the H and Cl atoms. According to markovnikov's rule, the carbon atom with the most H atoms will gain a H atom to form the major product. In this case, C#1 has 1 H atom whereas C#2 has 2 H atoms. This means that C#2 will gain the H atom and C#1 will gain the Cl atom to form 2-chlorobutane as the major product. C#1 will gain the H atom to form 1-~~b~~chlorobutane as the minor product but it will be formed in much smaller quantities.



Minor product



Major product

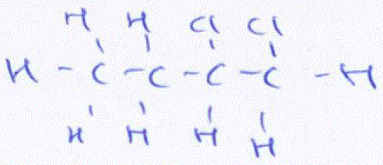
(ii) Compare the reaction of **Compound B** with chlorine, Cl_2, against the previous reaction of **Compound B** with HCl.

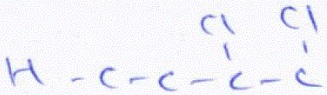
In your answer you should:

- explain why a different number of products are formed in the same type of reaction
- draw any relevant product structures.

When compound B reacts with Cl_2, an addition reaction occurs where the C=C bond is broken and 2 Cl atoms are added. Only one product forms when compound B reacts with Cl_2 as ~~no matt the plaem~~ wherever the Cl atom is placed, which can be in either carbon from the C=C bond, the product is always the same which is 1,2-dichlorobutane.

Space for drawing structures

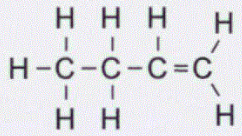
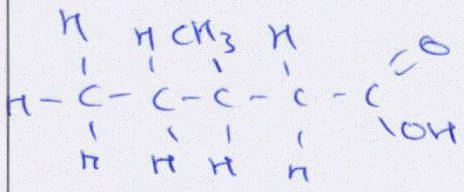
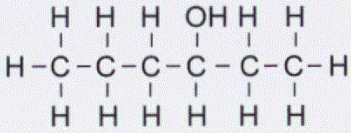
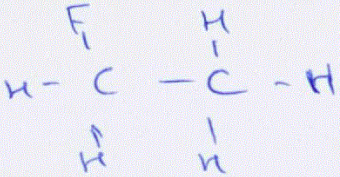




QUESTION THREE

(a) Four organic compounds are given in the table below.

Complete the table by drawing the structure or giving the IUPAC (systematic) name

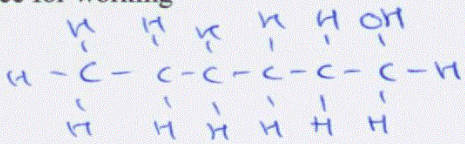
Structure	Name
 **Compound K**	~~but-1-ene~~
 **Compound L**	3-methylpentanoic acid
 **Compound M**	~~hex-3-~~ hexan-3-ol
 **Compound N**	fluoroethane

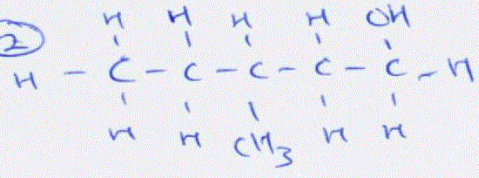
(b) **Compound M** above has the formula $C_6H_{14}O$.

Draw all of the structural isomers that are primary alcohols for this formula.

There is space below, as well as additional space at the back of this booklet, for working.

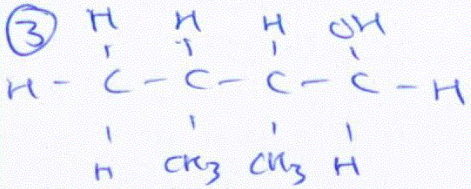
Space for working

① 

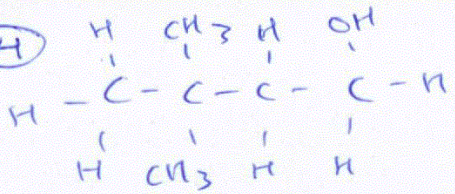
② 

Space for drawing isomers

(3)

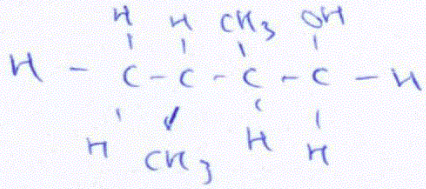


(4)

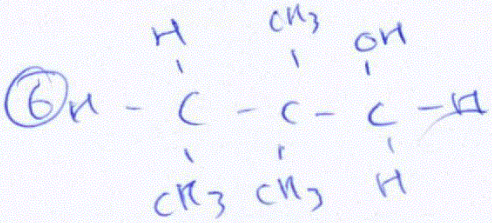


(5)

(5)

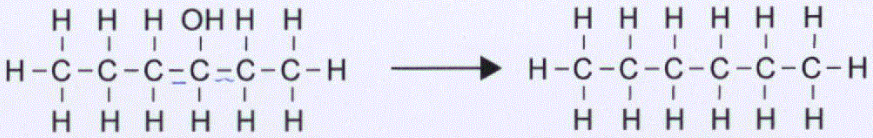


(6)



Question Three continues on the next page.

(c) (i) Describe a two-step series of reactions to convert **Compound M** into **Compound P**.



Compound M **Compound P**

Step 1 starts with **Compound M**:

Reaction type: elimination

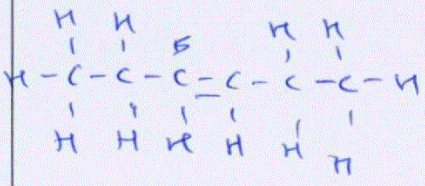
Reagents and any conditions: ~~alcoholic~~ KOH (alc)

Products' functional group: C=C

Draw the structure of ALL products.

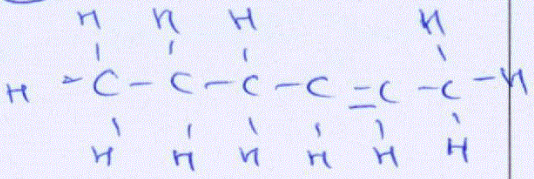
~~Major~~

(1)



~~Minor~~

(2)



Step 2 ends with **Compound P**:

Reaction type: ~~E~~ addition

Reagents and any conditions: ~~Pt~~ H_2 / Pt

~~Reagent → H_2 Pt~~

(ii) The reaction in Step 1 produces two isomers with the same functional group in equal quantities.

Explain why there is no major or minor product of the hydrocarbon produced.

In your answer you should explain:

- the type of reaction
- what determines major and minor products
- why the products are equal in this situation.

The type of reaction is elimination. The major and minor products are determined by which carbon atom and the H atom is taken from that C atom has less H atoms attached to it. However, both the carbons neighbouring the C atom with the OH functional group have 2H atoms. This means that neither of the carbon atoms is more likely to lose a H atom and as a result, the products are equal in amounts this reaction for compound M.

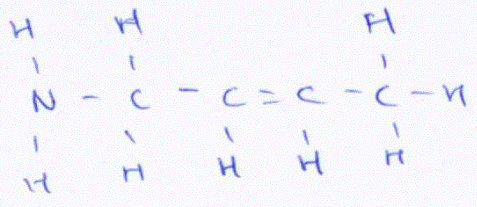
(d) **Compounds Q** and **R** below each contain a carbon to carbon double bond, but only one of them can form geometric isomers.

$H_2N-CH_2-CH=CH-CH_3$ **Compound Q**

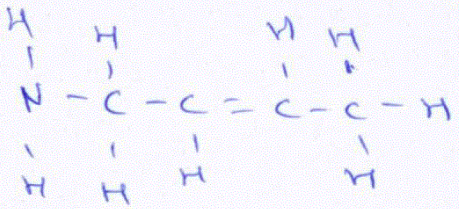
$H_2N-CH_2-CH_2-CH=CH_2$ **Compound R**

(i) Which compound forms geometric isomers? Compound Q

(ii) Draw the *cis* and *trans* geometric isomers that it forms in the boxes provided, and select the correct label.



Circle the correct isomer: ***cis*** ***trans***



Circle the correct isomer: ***cis*** ***trans***

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

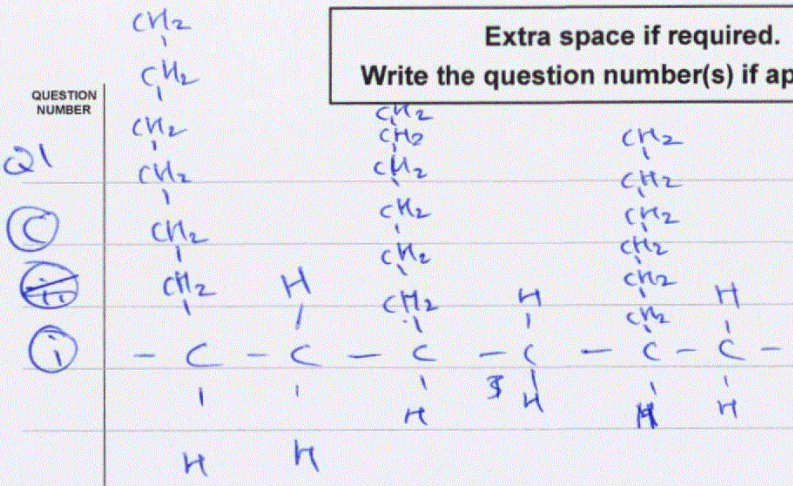
QUESTION NUMBER

Q1

(c)

(i)

(i)



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Write the question number(s) if applicable.

QUESTION NUMBER

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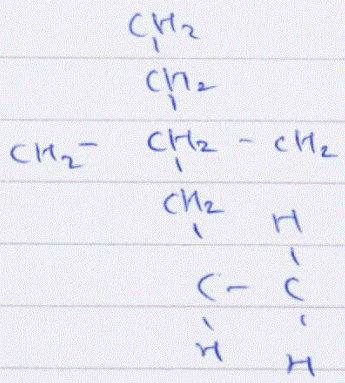
QUESTION NUMBER



Merit

Subject: Chemistry

Standard: 91165

Total score: 15

Q	Grade score	Marker commentary
One	M5	The candidate was awarded M5 for the following reasons: in (b) they were able to link the functional group to the solubility to the observation for one of the groups or alternatively, they were able to link the BP of ethanol to the increased carbon chain; in (c) (ii) they were able to explain how multiple monomers break their C=C to link together into a chain but were unable to link the reactivity of the monomer/polymer to the specific example in the question.
Two	M5	The candidate was awarded M5 for the following reasons: in (a) they were able to identify 8 correct structures/reaction types; in (b) they correct drew the isomer and explained why it was tertiary; in (c) (i) they were able to explain why it was an addition reaction and how to determine the major/minor products; in (c) (ii) they were able to explain why only one product was formed when Cl2 was added but were unable to explain what was different with the previous example.
Three	M5	The candidate was awarded M5 for the following reasons: in (a) they were able to name/draw all four compounds; in (b) they were able to draw 5 primary alcohol isomers; in (c) (i) they were able to identify 5/6 pieces of information; in (c) (ii) they were able to explain why the products formed in equal amounts but were unable to explain why it was an elimination reaction.