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91165



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

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Mana Tohu Mātauranga o Aotearoa  
New Zealand Qualifications Authority

## Level 2 Chemistry 2025

### 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 margins (✂/✂/✂). 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 16**

## QUESTION ONE

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

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

Compound	Structure	Name
A	$  \begin{array}{c}  \text{NH}_2 \quad \text{H} \\    \quad   \\  \text{H} - \text{C} - \text{C} - \text{H} \\    \quad   \\  \text{H} \quad \text{H}  \end{array}  $	ethanamine
B	$  \begin{array}{c}  \text{Br} \\    \\  \text{Br} - \text{C} - \text{H} \\    \\  \text{H}  \end{array}  $	dibromomethane
C	$  \begin{array}{c}  \text{H} \quad \text{CH}_3 \quad \text{H} \\    \quad   \quad   \\  \text{H} - \text{C} - \text{C} - \text{C} - \text{C} = \text{O} \\    \quad   \quad   \quad \backslash \\  \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{OH}  \end{array}  $	3,3-dimethylbutanoic acid
D	$  \begin{array}{ccccccc}  \text{H} & \text{H} & \text{Br} & \text{H} & \text{H} & \text{H} & \\    &   &   &   &   &   & \\  \text{H} - \text{C} & - \text{C} & - \text{C} & - \text{C} & = \text{C} & - \text{C} & - \text{H} \\    &   &   & & &   & \\  \text{H} & \text{H} & \text{H} & & & \text{H} &   \end{array}  $	4-bromohex-2-ene
E	$  \begin{array}{ccccccc}  & & \text{H} & \text{H} & \text{H} & & \\  & &   &   &   & & \\  \text{H} - \text{C} & \equiv \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{H} \\  & &   &   &   & & \\  & & \text{H} & \text{H} & \text{H} & &   \end{array}  $	1-pentyne
F	$  \begin{array}{ccccccc}  & & \text{H} & \text{CH}_3 & \text{H} & & \\  & &   &   &   & & \\  \text{H} - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{H} \\    & &   &   & & & \\  \text{H} & & \text{OH} & \text{H} & & &   \end{array}  $	2-methylpropan-2-ol 2-methylpropan-2-ol

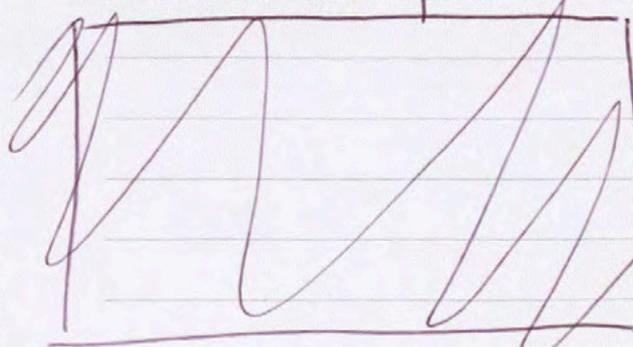
- (b) Explain how acidified dichromate solution,  $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ , can be used to distinguish between compounds G and H (below):

$\begin{array}{c} \text{Cl} \\   \\ \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{CH}_3 \\   \\ \text{CH}_3 \end{array}$	$\begin{array}{c} \text{OH} \\   \\ \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{CH}_3 \\   \\ \text{CH}_3 \end{array}$
<b>Compound G</b>	<b>Compound H</b>

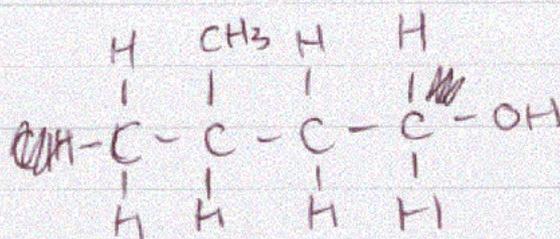
In your answer:

- identify the type of reaction occurring
- include conditions required for the reaction to occur
- describe relevant observations
- draw the product formed.

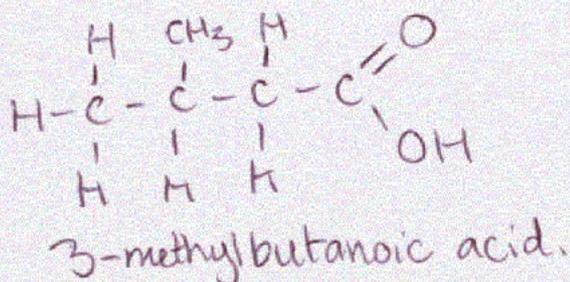
When you react Compound G with  $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ , you will find that a reaction won't occur. The orange solution will be added to Compound G and the solution will stay orange. Whereas when you react  $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$  with Compound H, you will find that the solution will turn from orange to green. This shows us the difference between the two compounds, with Compound H being an alcohol, and Compound G being a haloalkane. For Compound G there was no reaction that happened, but for Compound H an oxidation reaction happened. This means the product formed was a carboxylic acid. ~~There~~ The Compound G haloalkane just stays the same as no reaction happened.



There is more space for your answer and diagram on the next page.



Product formed:



- (c) Haloalkanes are useful starting materials used in the synthesis of many more complex molecules, including many pharmaceutical products.

Below are some constitutional (structural) isomers of chloropentane,  $\text{C}_5\text{H}_{11}\text{Cl}$ . Use these to answer parts (i) to (iii).

$  \begin{array}{c}  \text{Cl} \\    \\  \text{CH}_2-\text{CH}_2-\text{CH}-\text{CH}_3 \\    \\  \text{CH}_3  \end{array}  $	$  \begin{array}{c}  \text{CH}_3 \\    \\  \text{CH}_3-\text{CH}_2-\text{C}-\text{Cl} \\    \\  \text{CH}_3  \end{array}  $
<b>Compound G</b>	<b>Compound I</b>
$  \begin{array}{c}  \text{CH}_3 \\    \\  \text{CH}_3-\text{CH}_2-\text{CH}-\text{CH}_2-\text{Cl}  \end{array}  $	$  \begin{array}{c}  \text{Cl} \\    \\  \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\    \\  \text{CH}_3  \end{array}  $
<b>Compound J</b>	<b>Compound K</b>

- (i) Classify each of the haloalkanes as either primary, secondary, or tertiary:

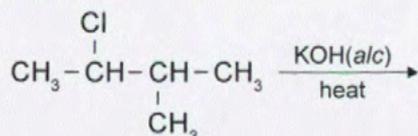
Compound G: Primary

Compound I: Tertiary

Compound J: Primary

Compound K: Secondary

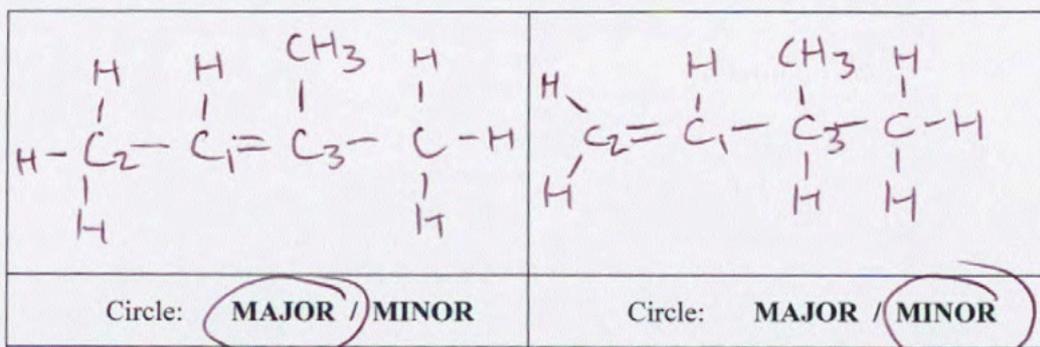
**Compound K** forms two different products when reacted with alcoholic potassium hydroxide,  $\text{KOH}(\text{alc})$ , and heat.



Alkene

Poor get Poorer = E1i

(ii) Draw both products of the reaction, and circle the correct label.



(iii) Elaborate on the reaction of **Compound K** with alcoholic potassium hydroxide,  $\text{KOH}(\text{alc})$ , and heat.

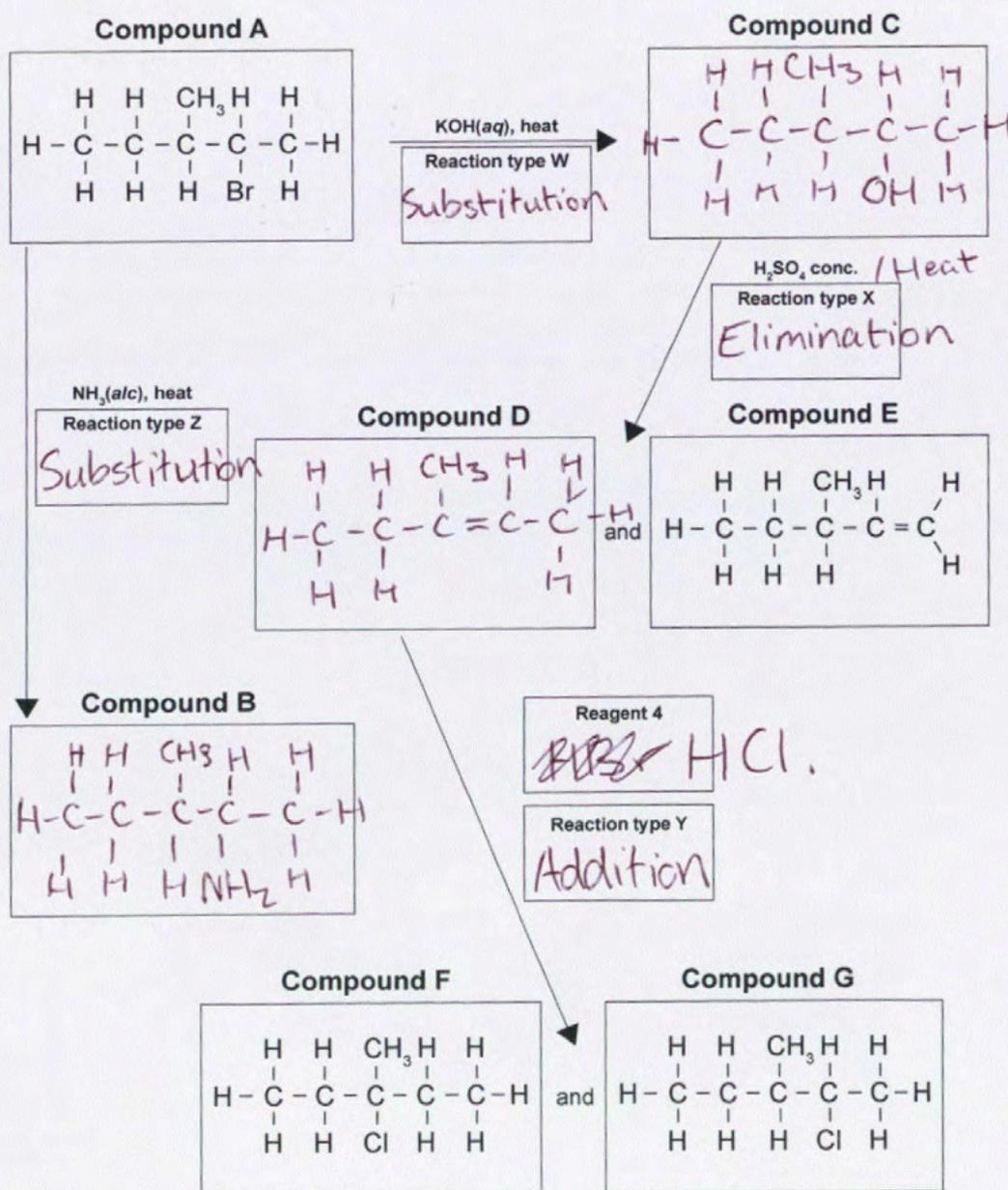
In your answer:

- explain why two different products are formed
- justify your choice of major and minor products.

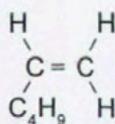
Two different major and minor products were formed due to the Elimination of the  $-\text{Cl}$  functional group and the new addition of a  $\text{C}=\text{C}$  double bond. The major product is when the double bond attaches onto the carbon with the least amount of H atoms attached to that carbon, in our case  $\text{C}_3$  has the least H atoms so  $\text{C}_1=\text{C}_3$ . The minor product is then therefore ~~then~~  $\text{C}_1=\text{C}_2$ .

## QUESTION TWO

- (a) An incomplete reaction scheme is shown below.
- Draw the structural formulae of **Compounds B, C, and D** in the labelled boxes provided.
  - Complete the **Reaction type W, X, Y, and Z** in the labelled boxes provided.
  - Complete **Reagent 4** in the labelled box provided.

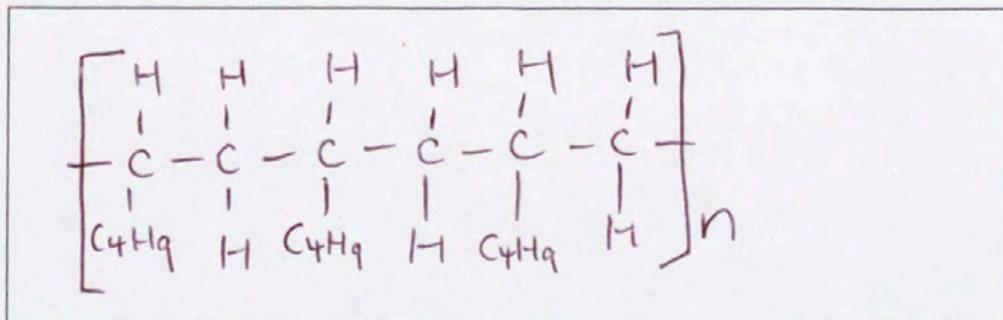


- (b) **Compound E** can be redrawn, as below, to enable it to be viewed as a monomer suitable to undergo addition polymerisation.



**Compound E**

- (i) Draw three repeating units of the polymer that would be produced using the monomer **Compound E** in the box below.



- (ii) Explain the process of addition polymerisation.

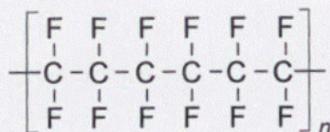
In your answer:

- identify the structure and bonding feature of **Compound E** that makes it suitable to undergo addition polymerisation
- explain how an addition polymerisation reaction occurs
- compare the relative reactivity of the monomer and the polymer.

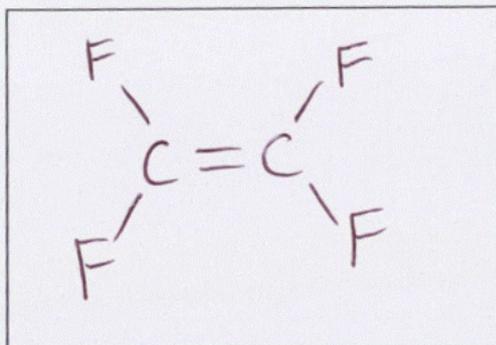
To undergo ~~addition~~ addition polymerisation you must have a monomer with a  $\text{C}=\text{C}$  double bond. Addition polymerisation occurs when you react ~~two~~ <sup>multiple</sup> double bonded monomers together to create a continuous chain. The monomer is very reactive, causing the double bond to break, and allow single bond connections with other carbon atoms. This creates a polymer using addition polymerisation. The polymer now has a very low reactivity compared to a monomer as the polymer has created a strong chain of strong bonds.

Polytetrafluoroethylene, (Teflon), is a polymer known for use in breathable, waterproof textile fabrics. Alternatives are being developed that aim to provide similar advantageous properties to Teflon with less environmental impact.

The structure of Teflon is show below.



(iii) In the box below, draw the monomer that Teflon is made from.



(iv) Teflon is also used as a non-stick coating on cooking pots and frying pans.

Identify the physical and chemical properties of Teflon that make it suitable for this use.

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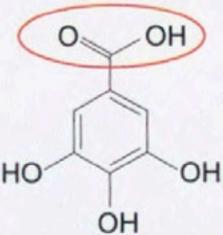
(c) Draw three straight-chain (non-branched) isomers of  $\text{C}_5\text{H}_{11}\text{Cl}$ .

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## QUESTION THREE

Pōhutukawa bark can be brewed into a tea and used in a range of rongoā (traditional medicines). as it contains organic acids, such as ellagic and gallic acids, which have antioxidant, antiseptic, and anti-nausea properties.

- (a) While extracting the pōhutukawa bark, the following compounds can be isolated.

	$\begin{array}{c} \text{NH}_2 \\   \\ \text{CH}_2 - (\text{CH}_2)_5 - \text{CH}_3 \end{array}$	$\begin{array}{c} \text{NH}_2 \\   \\ \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \end{array}$
gallic acid	1-heptanamine	1-propanamine

- (i) Name the functional group circled above.

~~Carboxylic Acid~~ Carboxylic Acid.

- (ii) Explain the procedure you could use to distinguish between 1-heptanamine and 1-propanamine solutions based solely on their physical properties.

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

In your answer:

- describe the test method
- compare the observation for each compound
- explain the test result for each compound.

The melting point, ~~between~~ and boiling point is determined by how much energy is needed to break the bonds in each compound. For 1-heptanamine, it will have a higher melting point/boiling point than 1-propanamine <sup>due</sup> to it having more C-H and C-C bonds to break. For a compound to be soluble in water it must have ~~bonds~~ attractive forces to attach to the H<sub>2</sub>O atoms, and the more bonds there are the less soluble it is. 1-propanamine is soluble in water, but 1-heptanamine is not due to having too many attractive forces to break.

Question Three continues on the next page.

- (iii) Describe how red and blue litmus paper can be used to distinguish between gallic acid and 1-heptanamine solutions.

Include observations in your answer.

When you react gallic acid with ~~the~~ blue litmus paper, it will turn red. When you react 1-heptanamine with Red Litmus Paper it will turn blue. If you used gallic acid with red litmus and 1-heptanamine with Blue ~~Litmus~~ Litmus, nothing will happen for both.

- (iv) Devise an alternative method (without using litmus) to identify the functional group circled in gallic acid.

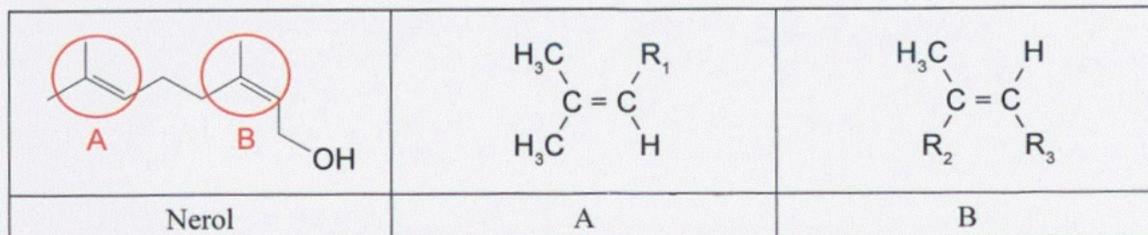
In your answer:

- state the reagent needed and the general products formed
- describe the observation, and link to the products formed.

An alternative method for finding gallic acid comes with using  $\text{Na}_2\text{CO}_3$  to react with it. When the reagent is reacted with the gallic acid, you will be able to see that ~~the~~ bubbles of  $\text{CO}_2$  will be produced, which can be seen as bubbles in a test tube. This shows that the functional group in the gallic acid is a carboxylic acid.

- (b) Pōhutukawa flowers contain many terpene compounds (volatile organic compounds) that contribute to their fragrance. An example of a terpene, nerol, is shown below.

Two functional groups (A and B) have been circled and shown to the right, where the label 'R' has been used in place of the complex remainder of the molecule. **Note that  $R_1$ ,  $R_2$ , and  $R_3$  groups are all different.**

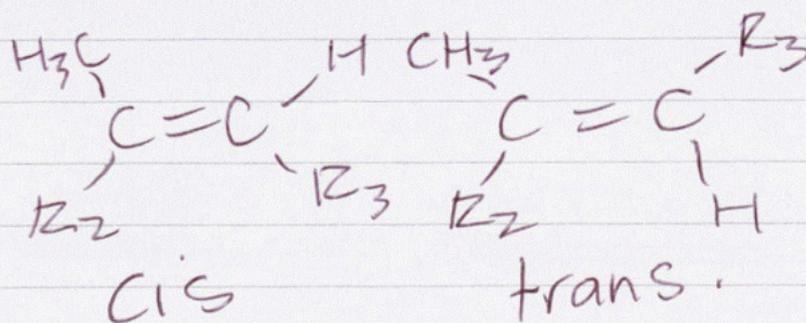


- (i) Identify which of A and B will exist as geometric isomers.

B

- (ii) Justify your choice in (b)(i) by explaining the requirements for geometric isomerism.

For geometric isomerism, you must have a cis and a trans isomer. This means you will need two complex remainders on the molecule to create the cis and the trans isomers. The cis isomer is where both  $R_2$  and  $R_3$  are on the bottom of the B, and the trans isomer is when  $R_2$  and  $R_3$  are opposite each other.



This is important.









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

QUESTION  
NUMBER

91165

## Merit

**Subject:** L2 Chemistry

**Standard:** 91165

**Total score:** 16

Q	Grade score	Marker commentary
One	M6	The candidate was awarded M6 for the following reasons: in (a) they correctly named / drew the six compounds; in (b) they correctly identified the type of reaction occurring, the observations and the product being formed, but did not identify the condition required; in (c)(ii) they correctly drew the major and minor products; in (c)(iii) they identified that there will be two products formed after an elimination reaction, and then linked this to the two different locations for the carbon-to-carbon double bond.
Two	M5	The candidate was awarded M5 for the following reasons: in (a) they correctly identified 7 from 8 structures and reaction types; in (b)(ii) they were able to explain addition polymerisation linked to the presence of the carbon-to-carbon double bond, and compared the relative reactivity of the monomer, Compound E and the corresponding polymer.
Three	M5	The candidate was awarded M5 for the following reasons: in (a)(ii) they correctly linked the melting and boiling point to the length of the carbon chain, but did not link this to the strength of the intermolecular forces; in (a)(iv) they described a correct method to identify the functional group linked to reagent, observations, and product formed.