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91165



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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.

Excellence

TOTAL 22

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{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} - \text{C} - \text{NH}_2 \\ \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} $	1,1-dibromomethane 1,1-dibromomethane
C	$ \begin{array}{c} \text{CH}_3 \\ \\ \text{H} - \text{C} - \text{C} - \text{C} - \text{C} = \text{O} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{OH} \\ \text{CH}_3 \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} & \text{H} & \end{array} $	4-bromo hex-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{H} \\ & & & & & & \\ & \text{H} & \text{OH} & \text{H} & & & \end{array} $	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):

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

In your answer:

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

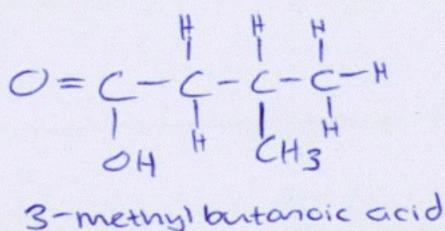
Compound G is a haloalkane with the functional group -Cl . It does not react with $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ which is an oxidant, so no reaction occurs and no colour change is observed.

Compound H is a primary alcohol which can be oxidised by the oxidant $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ in an oxidation reaction. The solution can be heated for the oxidation to occur. When oxidised, the colour of the solution will turn from the orange of the $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ to green, indicating that the reaction has taken place. A carboxylic acid is formed.

This differentiates Compound G and H because G will remain colourless while H changes colour to green.

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).

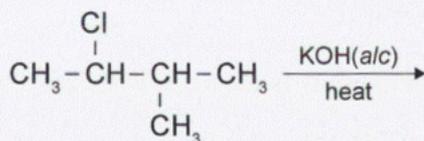
$ \begin{array}{cccc} \text{Cl} & & & \\ & & & \\ \text{CH}_2 - \text{CH}_2 - \text{CH} - \text{CH}_3 \\ \\ \text{CH}_3 \end{array} $	$ \begin{array}{cccc} & & \text{CH}_3 & \\ & & & \\ \text{CH}_3 - \text{CH}_2 - \text{C} - \text{Cl} \\ \\ \text{CH}_3 \end{array} $
Compound G	Compound I
$ \begin{array}{cccc} & & \text{CH}_3 & \\ & & & \\ \text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{Cl} \end{array} $	$ \begin{array}{cccc} & & \text{Cl} & \\ & & & \\ \text{CH}_3 - \text{CH} - \text{CH} - \text{CH}_3 \\ \\ \text{CH}_3 \end{array} $
Compound J	Compound K

- (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.



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

Circle: MAJOR / MINOR	Circle: MAJOR / MINOR

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

In your answer:

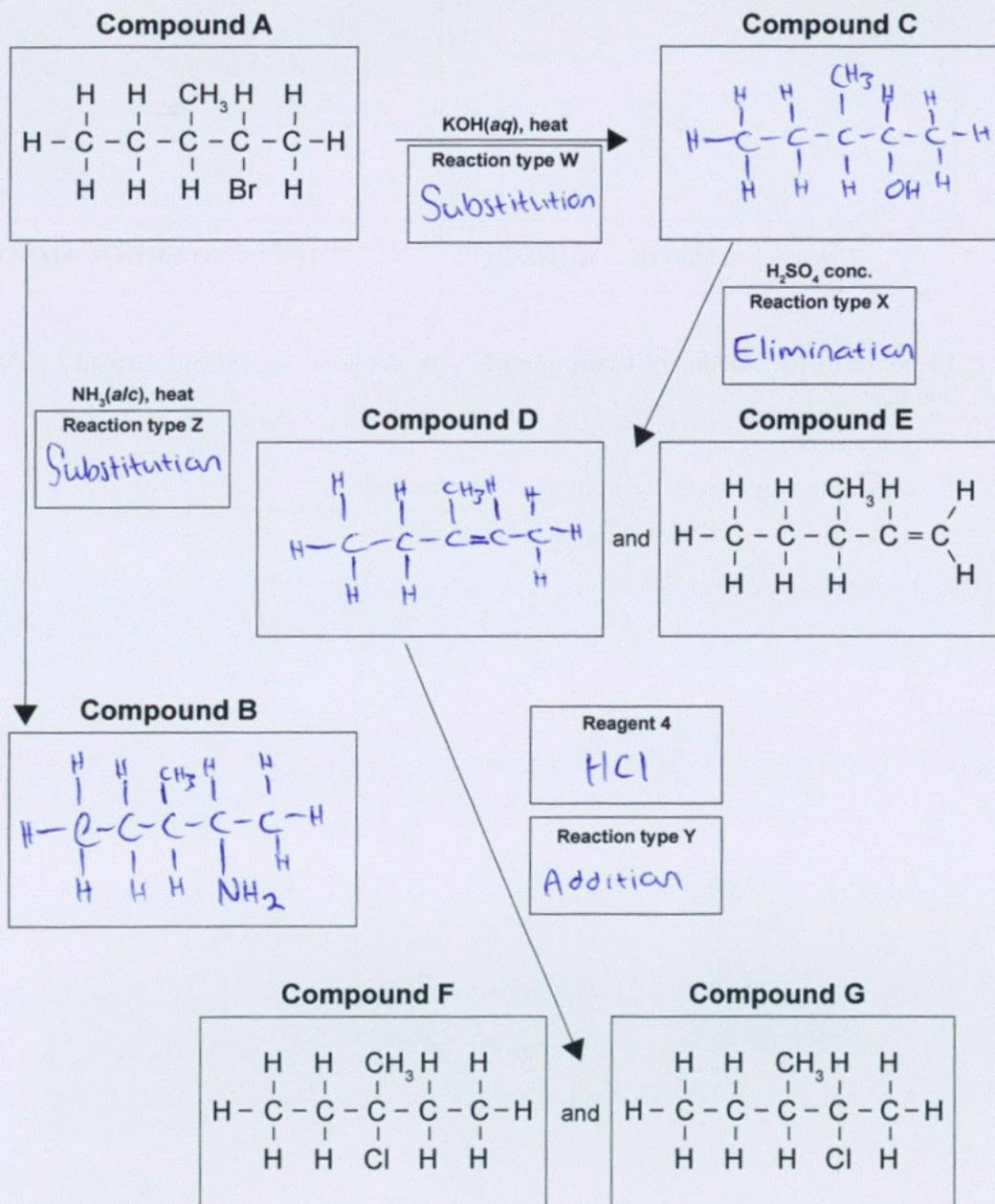
- explain why two different products are formed
- justify your choice of major and minor products.

When compound K reacts with $\text{KOH}(\text{alc})$ and heat, an elimination reaction occurs as the chlorine atom is removed and an H atom from one of the ~~remaining~~ ^{neighbouring} C atoms is also removed*. Two different products are formed because Compound K is asymmetrical about the $-\text{C}-\text{Cl}$ functional group and the double bond can form either between C_1 and C_2 or C_2 and C_3 , producing 2 different products. The major product is the product produced in greater quantity and is created when the hydrogen atom is removed from the carbon atom (neighbouring the carbon atom bonded to the Cl atom) already attached to the fewest H atoms. C_1 is attached to 3 H atoms while C_3 is attached to only 1 H atom so the H atom is preferentially removed from C_3 and the double bond forms between C_2 and C_3 , forming the major product. If the H atom were removed from C_1 , the double bond would form between C_1 and C_2 and the minor product is formed. *and a double bond is formed between those 2 carbon atoms.

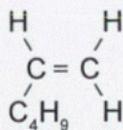
QUESTION TWO

(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.

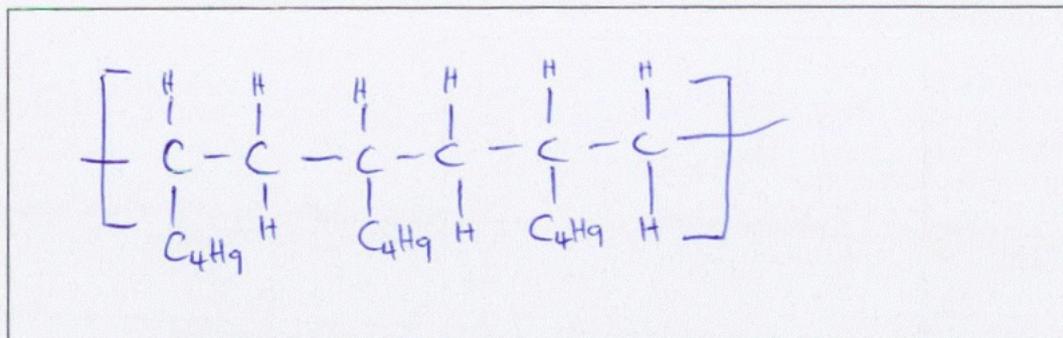


- (b) **Compound E** can be redrawn, as below, to enable it to be viewed as a monomer suitable to undergo addition polymerisation.



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:

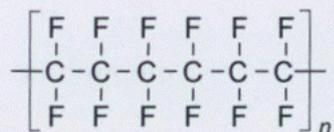
- identify the structure and bonding feature of **Compound E** that makes it suitable to undergo addition polymerisation
- explain how an addition polymerisation reaction occurs
- compare the relative reactivity of the monomer and the polymer.

Compound E is an alkene and has a double ~~carbon~~ carbon-carbon bond. This means it is an unsaturated molecule as atoms/groups of atoms can be added to it, making it reactive*. Addition polymerisation occurs when the double bond is broken, enabling each of the carbon atoms previously attached to the double bond to gain a new single bond, allowing it to bond to bond to other monomer units, creating a repeating chain of monomer units, thus forming a polymer. The polymer is then saturated as there are no longer any double bonds and no new atoms or groups of atoms can be added to it, making it more unreactive compared to the monomer.

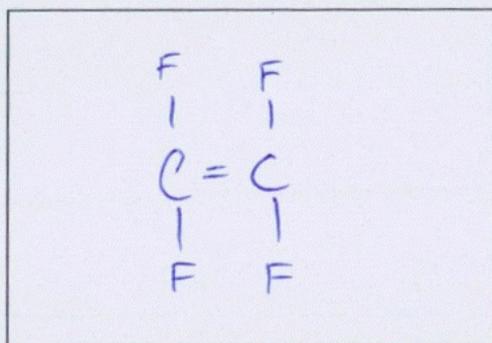
*and able to undergo addition polymerisation.

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.

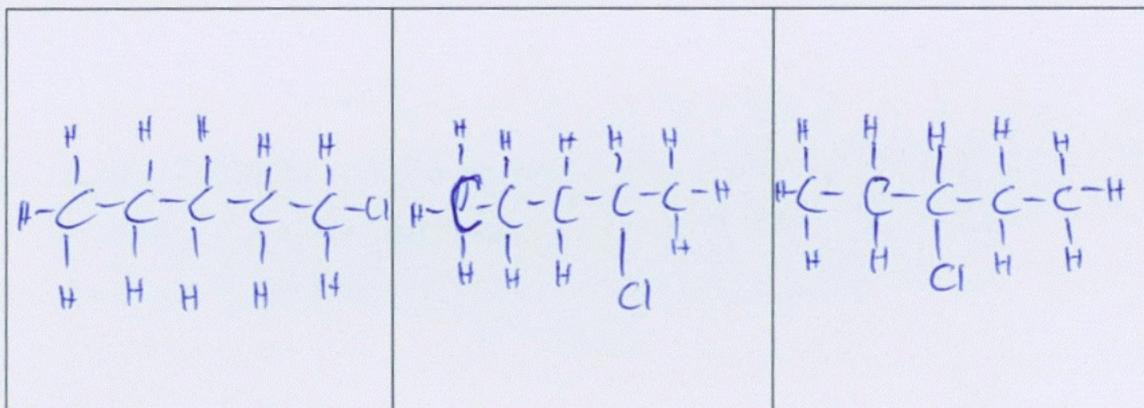


(iv) Teflon is also used as a non-stick coating on cooking pots and frying pans.

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

It is non-polar (alkanes are non-polar) and is insoluble in polar solvents like water so won't dissolve in pots or pans that have water placed in them for cooking. Teflon is a saturated molecule and so, chemically inert/unreactive, so won't react with oils/foods used for cooking and contaminate it and make it unsafe to eat.

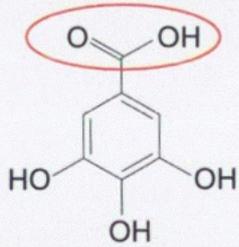
(c) Draw three straight-chain (non-branched) isomers of $\text{C}_5\text{H}_{11}\text{Cl}$.



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 (~~Carboxyl~~ -COOH)

(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 larger the ^{parent} carbon chain of amines, the greater the melting and boiling point. 1-heptanamine has a 7 carbon ~~the~~ parent chain which is larger than that of 1-propanamine which has a 3 carbon parent chain. Hence, by boiling both solutions, the solution with the ~~from~~ shorter parent chain ~~will~~ molecules can be found as it will boil before the solution containing the molecules with the larger parent chain. Therefore, the solution which boils first must have the lower boiling point and shorter ^{parent} carbon chain and must be 1-propanamine. The solution to boil last ~~is~~ has a higher boiling point and longer parent carbon chain and must be 1-heptanamine.

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.

Gallic acid is a carboxylic acid and when placed in water ~~dissolves~~ produces H_3O^+ ions, hence turning blue litmus paper red. 1-heptanamine, ~~is~~ when placed in water, produces OH^- ions and produces a basic solution, turning red litmus paper blue.

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

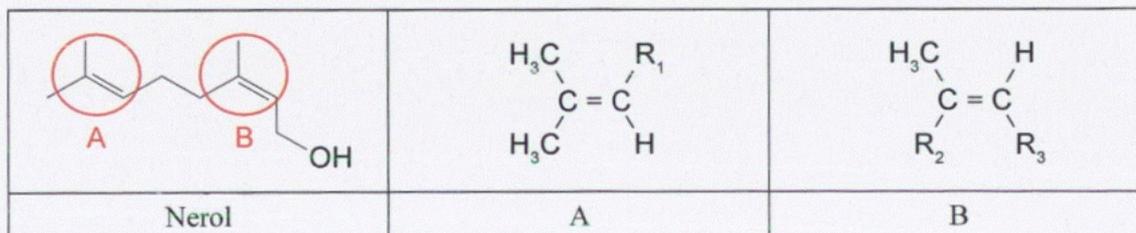
In your answer:

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

Gallic acid can be tested for by reacting it with a metal as the reagent. The general products formed is hydrogen gas and a metal salt. The observation is fizzing / bubbling due to the production of hydrogen gas.

- (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.

The requirements of geometric isomerism is a double bond as ~~the~~ atoms / groups of atoms are unable to rotate freely around the double bond and so, are fixed in space, producing varying versions of the structure of the molecule called geometric isomers. Both A and B have double bonds and satisfy this condition. The second requirement is that each carbon atom around the double bond must be attached to 2 different atoms or groups of atoms to form geometric isomers. In A, the first carbon atom of the double bond is bonded to 2 identical groups: CH_3 , therefore, it cannot form geometric isomers. In B, each carbon atom is attached to 2 different groups: the first carbon atom to CH_3 and R_2 and the second carbon atom to H and R_3 . Hence, B can form geometric isomers.

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

QUESTION
NUMBER

91165

Excellence

Subject: L2 Chemistry

Standard: 91165

Total score: 22

Q	Grade score	Marker commentary
One	E8	The candidate was awarded E8 for the following reasons: in (b) they correctly explained how to distinguish between Compound G and Compound H, including the type of reaction, observations, conditions, and correctly drawing the product formed; in (c)(iii) they explained why there were two different products formed and how to determine the major / minor products with specific reference to the number of hydrogens on each carbon.
Two	E8	The candidate was awarded E8 for the following reasons: in (a) they were able to identify 8 correct structures and reaction types; in (b)(ii) they correctly explained the process of addition polymerisation with specific links to the reactivity of the Compound E and the corresponding polymer; in (b)(iv) they linked the low reactivity of Teflon to a specific use in pots/pans (e.g., will not react with food).
Three	M6	The candidate was awarded M6 for the following reasons: in (a)(ii) they correctly linked the chain length to the difference in melting point, but did not link this to intermolecular forces of attraction; in (b)(ii) they correctly explained the requirements for geometric isomerism, linked to the specific groups in both option A and B.