SUPERVISOR'S USE ONLY

2

91165

911650

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

+

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.

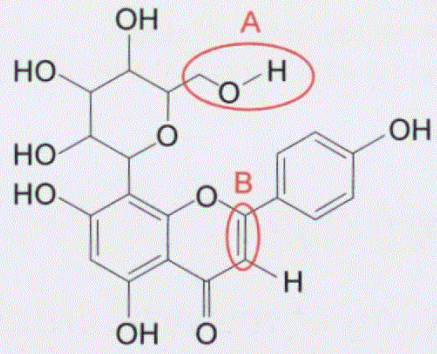
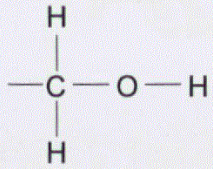
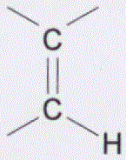
Excellence

TOTAL 21

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: Hydroxyl B: Alkene C=C dable bond

(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^+

B: Br_2

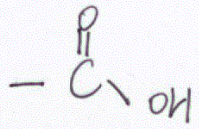
(iii) Describe the observation that would occur in a positive test for each group.

Include:

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

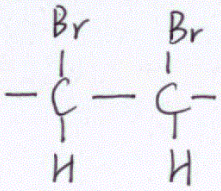
A: This is an ~~oxd~~ oxidation reaction, the functional group -COOH is carboxyl group

Functional group of the product:



B: This is an addition reaction, the functional group is Bromine atoms (halogen)

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.

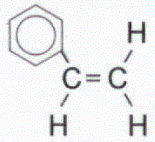
Give reasons for the different results between solvents.

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

These three organic compounds can be distinguished by dissolving each of the ~~sample~~ them in water. In this way, hexane will be distinguished as hexan is a non-polar molecule and will not dissolve in water which is a polar solvent whereas the remaing two, methanol and ethanol will dissolve as they're polar. Then methanol and ethanol can be distinguished by ~~slowly~~ slowly heating up two remaing sample solutions, the one boils first is methanol as it contains less no. of carbon compared to ethanol, meaning the intermolecular forces holding molecules together is weaker thus requires less energy to break bonds compared to ethanol. Thus, methanol has lower boiling point than ethanol and will boil first.

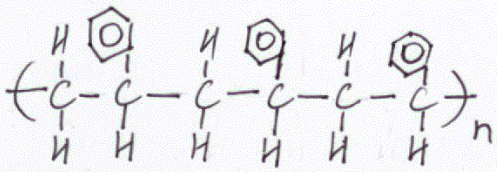
(c) Polystyrene has been used widely in the manufacture of plastic produce such as bags, plates, bowls, and cutlery. However, single-use plastics, such as these, are being phased out.

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.

The addition polymerisation for styrene means that, the reactive double bond C=C is broken, allowing two more ~~of~~ single bonds to join between each ~~st~~ monomer, forming repeating ~~the~~ long chain polystyrene, as the polystyrene only contains single C-C bond, meaning this single bond will be less reactive compared to C=C.

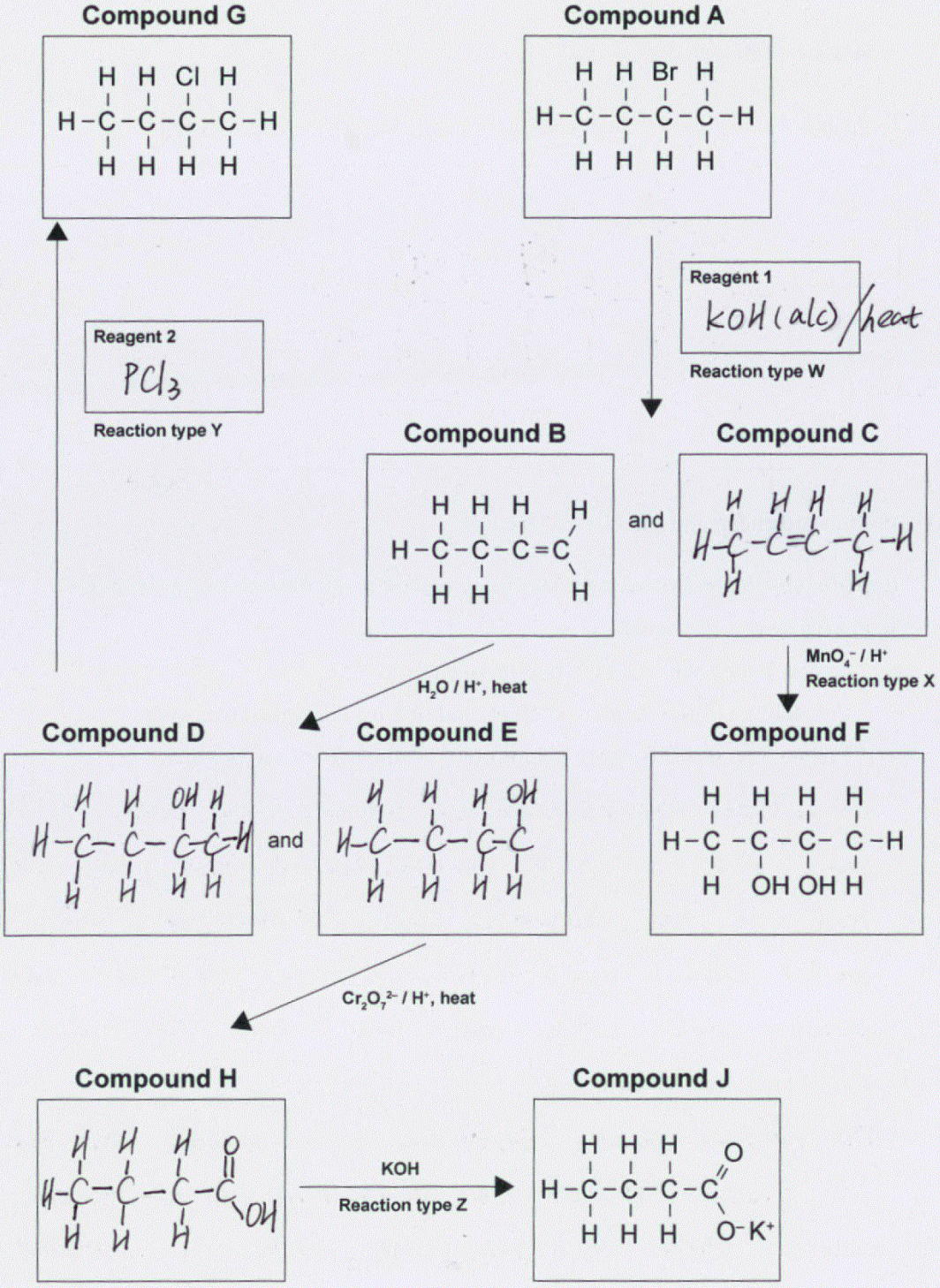
This difference allows polystyrene to be suitable for making single-used plastics products as polystyrene is less reactive than monomer styrene which means it won't react with any substances that plastic products may get contact with, such as moist or food when beg used for cutlery.

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.

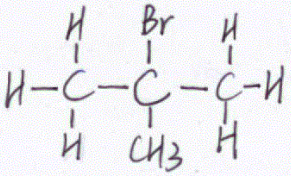


(iii) Name the **Reaction types W, X, Y,** and **Z** in the table below.

Reaction type W	Elimination
Reaction type X	Oxidation
Reaction type Y	Substitution
Reaction type Z	Acid – Base

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

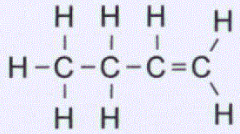
Draw the tertiary isomer of bromobutane and explain why it is classified as tertiary.



2-bromo-2-methylpropane

As shown in the diagram, this is the tertiary isomer of bromobutane as the carbon atom in which Br atom is attached to also connects to another 3 C atoms. thus this is a tertiary haloalkane.

(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:

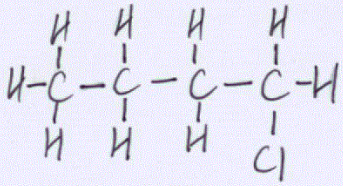
- name and explain this type of reaction
- draw the structures of both products, in the appropriate box for the major and minor products
- justify your choice of major and minor products.

without heat

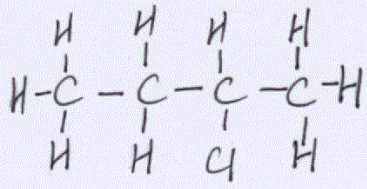
Compound B as an alkene, reacts with HCl V. this is an addition reaction in which C=C double bond breaks, addg H atom and Cl atom from HCl to each ~~of~~ the C atoms in the double bond to form a ~~haloalkane~~. haloalkane.

Due to the position ~~of~~ the double bond C=C, resulty the molecule beg asymmetrical, this means H atom and ~~H~~ Cl atom have 2 possible positions to bond with C atoms from the double bond. The C atoms in the double bond with most number of H atoms attached will gain the H atom from HCl to become the major product (2-chlorobutane) as shown in the diagram ~~and the other one (with~~ as V C_1 has 2 H atoms attached whereas C_2 only has one in the double bond. The minor product forms when C_2 receives the H atom (1-chlorobutane) and the major product forms when C_1 gains H atom.

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.

Both reactions are addition reactions.
Compound B reacts with Cl_2 can only form 1 type of product as Cl_2 provides 2 Cl atoms (same atoms) that add to each of the C atoms in the double bond, so regardless which C in the double bond receives the Cl atom, there's only one product (1,2-dichlorobutane) will form.
Compared to the reaction with HCl, as it provides one H atom and one Cl atom (2 different atoms) that will be add between double bond C atoms, this results in 2 possible positions that H atom and Cl atom can bond to, thus resulting two types of products. (2-chlorobutane as major product and 1-chlorobutane as minor product)

Space for drawing structures

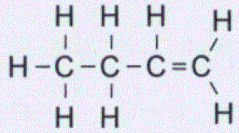
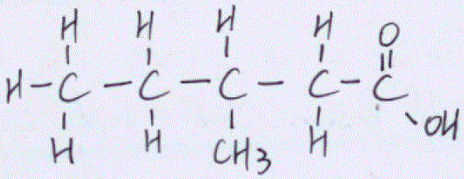
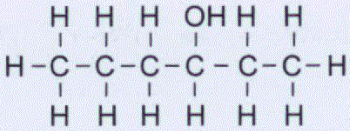
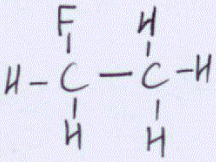
$$CH_3-CH_2-CH=CH_2 + Cl_2 \longrightarrow CH_3-CH_2-\underset{Cl}{CH}-\underset{Cl}{CH_2}$$

$$CH_3-CH_2-CH=CH_2 + HCl \begin{cases} CH_3-CH_2-\underset{Cl}{CH}-CH_3 & \text{Major} \\ CH_3-CH_2-CH_2-\underset{Cl}{CH_2} & \text{Minor} \end{cases}$$

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

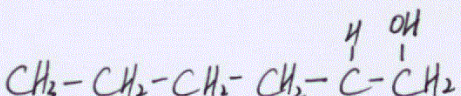
Structure	Name
 **Compound K**	but-1-ene
 **Compound L**	3-methylpentanoic acid
 **Compound M**	hexan-3-ol
 **Compound N**	fluoroethane

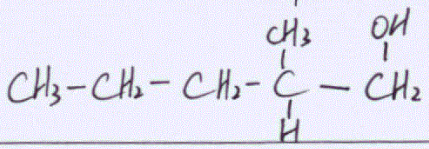
(b) **Compound M** above has the formula $C_6H_{14}O$.

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

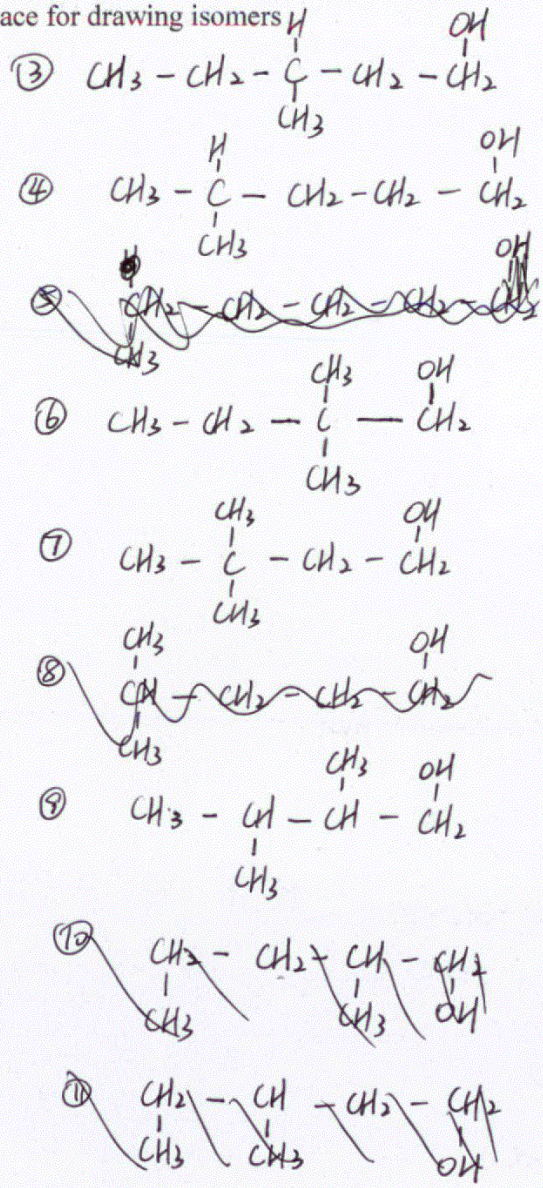
There is space below, as well as additional space at the back of this booklet, for working.

Space for working

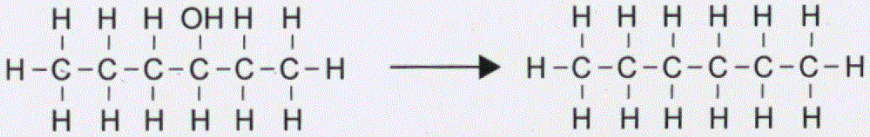
① 

② 

Space for drawing isomers



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



Compound M **Compound P**

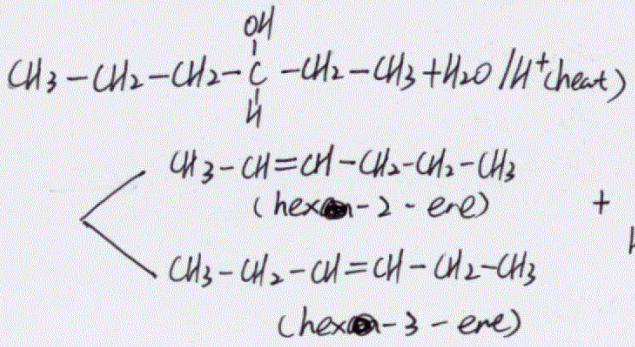
Step 1 starts with **Compound M**:

Reaction type: Elimination reaction

Reagents and any conditions: H_2O / H^+ (heat)

Products' functional group: alkene (C=C)

Draw the structure of ALL products.



Step 2 ends with **Compound P**:

Reaction type: Addition reaction

Reagents and any conditions: 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.

This is an elimination reaction in which one OH group and one H atom from neighbouring C atom is removed from compound M to form an alkene. As the molecule of compound M is asymmetrical, depends on which H atom is eliminated from the adjacent C atom of C_3, this will form two types of products.
The major product forms when H is eliminated from the neighbourg C atom that has least number of H attache to. In this case, C_2 and C_4 are considered as neighbourg C atoms of C_3, but they both have 2 H atoms attach to, meanf the two products will be in the same quantity but with different structural formulas (~~geometric~~ constitutional isomers).
(hex-2-ene) and (hex-3-ene)

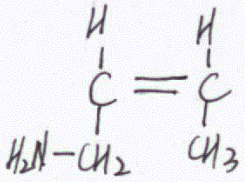
(d) **Compounds Q** and **R** below each contain a carbon to carbon double bond, but only one of them can form geometric isomers.

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

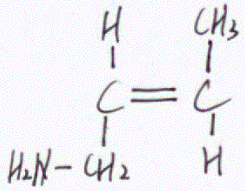
$H_2N-CH_2-CH_2-CH=CH_2$ **Compound R**

(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***)

Excellence

Subject: Chemistry

Standard: 91165

Total score: 21

Q	Grade score	Marker commentary
One	M6	The candidate was awarded M6 for the following reasons: in (a) they correctly identified reagents which could be used to identify the functional groups and draw the products but were unable to identify all of the associated observations; in (b) were able to distinguish between methanol and ethanol based on the number of carbons and boiling point but were unable to link solubility to the observations when trying to differentiate hexane; in (c) (ii) they were able to describe an addition polymerisation reaction, link the reactivity of styrene/polystyrene to the C=C/C-C and link this to its suitability as a plate.
Two	E8	The candidate was awarded E8 for the following reasons: in (a) they were able to identify 10 correct structures/reaction types; in (c) (i) they were able to explain why it was an addition reaction and how to determine the major/minor products with specific reference to the number of Hydrogens on each Carbon.
Three	E7	The candidate was awarded E7 for the following reasons: in (b) they were able to draw 7 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 it was an elimination reaction with reference to the location of groups/atoms lost and then explain why the products formed in equal amounts