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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 3 Chemistry 2024

91391 Demonstrate understanding of the properties of organic compounds

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the properties of organic compounds.	Demonstrate in-depth understanding of the properties of organic compounds.	Demonstrate comprehensive understanding of the properties of 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 L3–CHEMR.

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

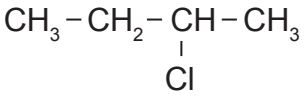
Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

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.

QUESTION ONE

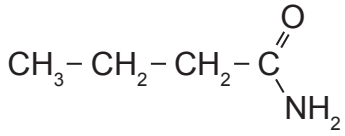
(a) 2-chlorobutane exists as enantiomers (optical isomers).



(i) Draw the enantiomers of 2-chlorobutane in the box below.

(ii) Explain why 2-chlorobutane can exist as enantiomers.

(iii) Devise a reaction scheme to convert 2-chlorobutane into butanamide.

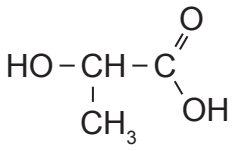


butanamide

For each step include:

- the reagents
- the structural formula of the organic product after each step.

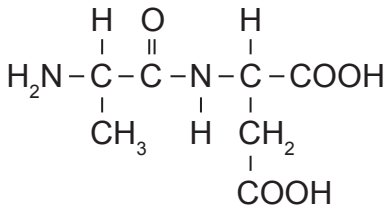
(b) Polylactic acid (PLA) is a polyester with various uses, including medical implants, tissue engineering, and 3D printing. It is made from lactic acid, shown below:



(i) In the box below, draw a section of the PLA chain to show THREE repeating units.

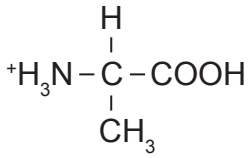
(ii) Identify and explain the type of reaction occurring to form PLA.

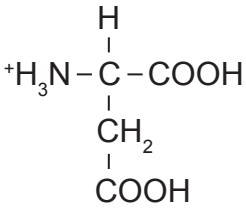
(c) Below is the structural formula of a dipeptide:



(i) Circle the amide (peptide) linkage on the dipeptide above.

(ii) The dipeptide can undergo a chemical reaction to form the following products:



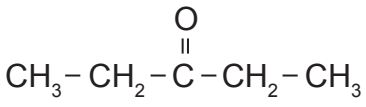
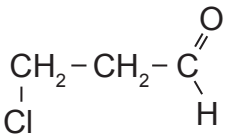


Identify and justify the type of chemical reaction that has occurred to form the above products.

(iii) Draw the structural formulae of the organic products formed when the dipeptide is heated under reflux with sodium hydroxide solution.

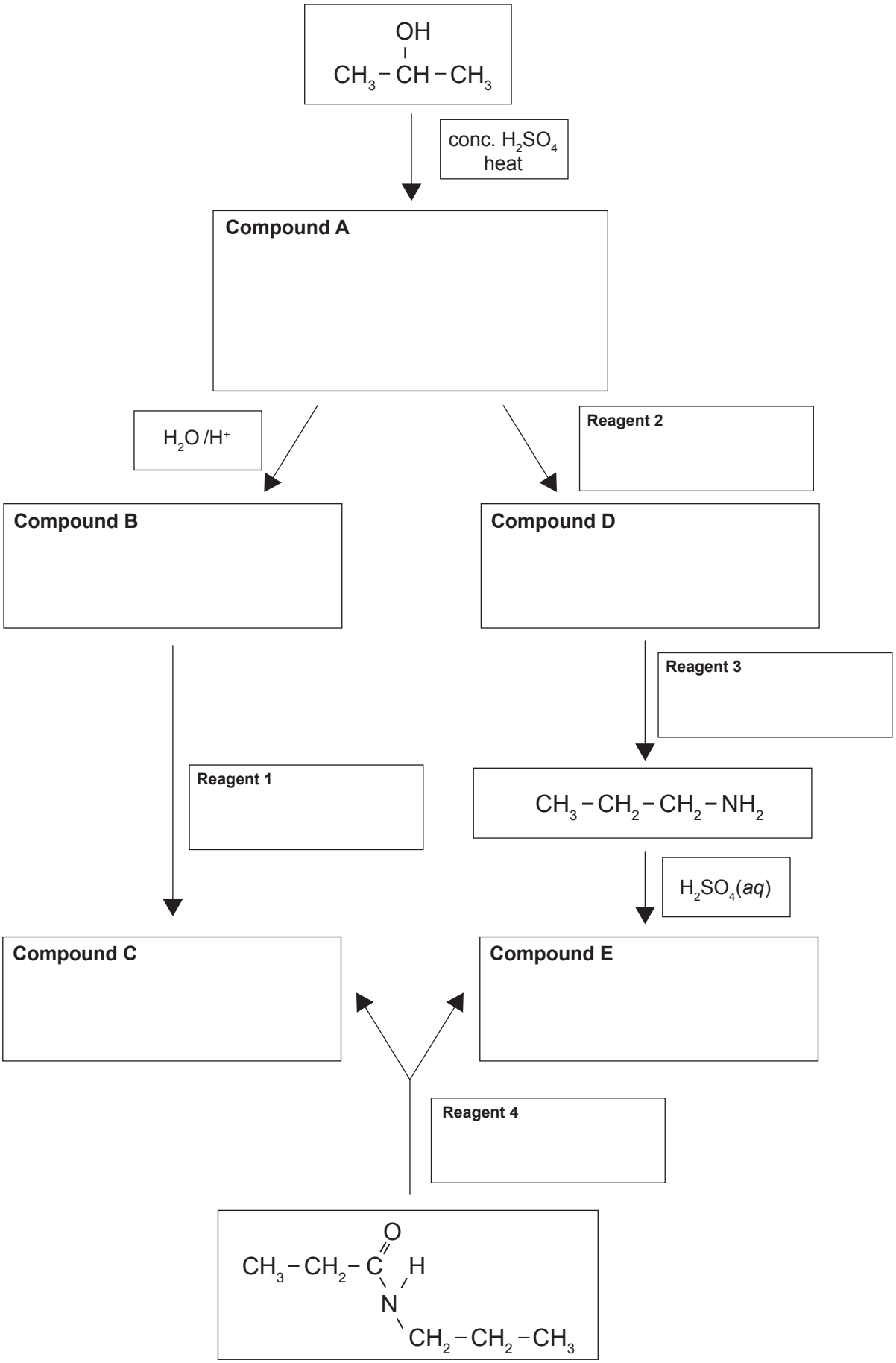
QUESTION TWO

(a) (i) Complete the table below to show the structural formula or the IUPAC (systematic) name for each compound.

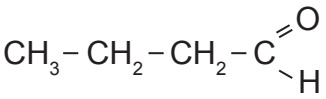
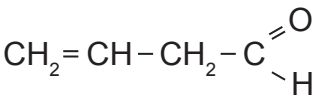
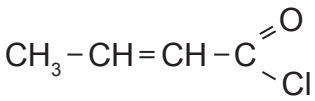
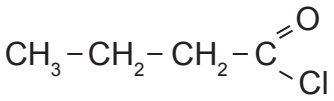
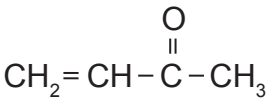
Compound	Structural formula	IUPAC (systematic) name
A		methyl propanoate
B		
C		
D		2-hydroxybutanoyl chloride

(ii) Draw THREE constitutional (structural) isomers of **Compound C** that contain a carbonyl group (C=O).

(b) Complete the flowchart below by drawing the structural formulae for **Compounds A**, **B**, **C**, **D**, and **E**, and identifying **Reagents 1**, **2**, **3**, and **4**.



(c) The following table lists the structural formulae for six different organic compounds.

1		**2**	
3		**4**	
5		**6**	

(i) Choose the appropriate organic compounds from the table above to match the observations recorded from chemical tests. Enter the chosen compound number in the table below.

Observations from chemical tests	**Compound number**
Heating with acidified potassium dichromate, $K_2Cr_2O_7(aq)/H^+$, causes the solution to change from orange to green. Heating with Tollens' reagent does not produce a silver mirror.	
Heating with Fehling's reagent forms an orange-red solid. Mixing with potassium permanganate solution, $KMnO_4(aq)$, causes the purple solution to decolourise and a brown solid to form.	
Mixing with bromine water, $Br_2(aq)$, results in steamy fumes, and the solution changes from orange to colourless.	

(ii) Justify your chosen structural formula for each of the three compounds.

Your answer should:

- relate the observations to the functional groups identified
- identify and explain the types of reaction involved.

QUESTION THREE

(a) A student followed the procedure outlined below to prepare a pure sample of ethyl propanoate in the laboratory:

Step 1: Add propanoic acid, ethanol, and concentrated H_2SO_4 to a round-bottomed flask.
Step 2: Heat the reaction mixture under reflux for 30 minutes.
Step 3: Add sodium carbonate until the bubbling stops.
Step 4: Add water and separate the layers.
Step 5: Add a drying agent to the organic layer.
Step 6: Distill the organic layer to purify the ethyl propanoate.

(i) Describe the function of the concentrated H_2SO_4 added in step 1.

(ii) Give TWO reasons to explain why the reaction mixture was heated under reflux in step 2.

(1)

(2)

(iii) Why was sodium carbonate added in step 3?

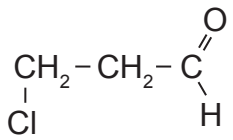
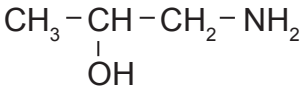
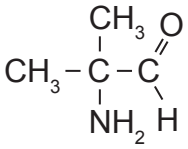
(iv) Explain how distillation was used in step 6 to purify the ethyl propanoate from the organic layer.

Your answer should refer to relevant boiling point(s) from the table below.

Compound	Boiling point / °C
Propanoic acid	141
Ethanol	78.3
Ethyl propanoate	99.1

Question Three continues on the next page.

(b) (i) Consider Compounds A, B, and C, shown below:

Compound A	Compound B	Compound C
		

Choose the ONE compound that has ALL the following properties:

- cannot exist as enantiomers (optical isomers)
- forms a silver mirror when heated with Tollens' reagent
- turns damp red litmus paper blue.

Compound (A, B, or C): _____

Explain your choice.

(ii) Draw the structural formula for the constitutional (structural) isomer of C_5H_9OCl that has the following properties:

- exists as enantiomers (optical isomers)
- branched carbon chain
- produces steamy fumes upon addition of water.

(iii) Draw the structural formula for the constitutional (structural) isomer of C_4H_7OBr that has the following properties:

- exists as cis-trans (geometric) isomers
- straight chain arrangement
- causes a colour change of orange to green when heated with acidified potassium dichromate to produce an organic product that does not react with Benedict's solution.

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

QUESTION NUMBER

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QUESTION NUMBER

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