

1. **Nov/2023/Paper\_9701/11/No.32**

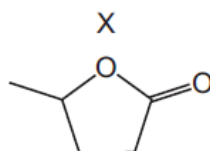
Propanoic acid can be made from bromoethane using a two-stage synthesis.

Which pair of reagents is most suitable?

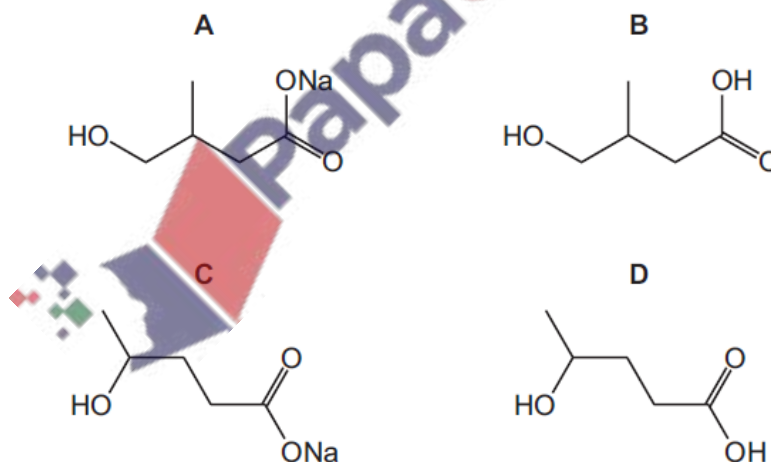
	reagent for stage 1	reagent for stage 2
<b>A</b>	hydrogen cyanide	aqueous sodium hydroxide
<b>B</b>	aqueous sodium hydroxide	excess acidified potassium dichromate(VI)
<b>C</b>	ethanolic sodium hydroxide	acidified potassium manganate(VII)
<b>D</b>	potassium cyanide	dilute hydrochloric acid

2. **Nov/2023/Paper\_9701/11/No.38**

The structure of compound X is shown.



What is produced when X is heated with NaOH(aq)?



3. Nov/2023/Paper\_9701/12/No.33

Propanoic acid can be used to make propene by a two-stage synthesis.

Which row shows suitable reagents for this synthesis?

	reagent for first stage	reagent for second stage
<b>A</b>	$\text{LiAlH}_4$	conc. $\text{H}_2\text{SO}_4$
<b>B</b>	$\text{LiAlH}_4$	$\text{NaOH}$ in ethanol
<b>C</b>	$\text{NaBH}_4$	conc. $\text{H}_2\text{SO}_4$
<b>D</b>	$\text{NaBH}_4$	$\text{NaOH}$ in ethanol

4. Nov/2023/Paper\_9701/12/No.37

Which alcohol reacts with alkaline  $\text{I}_2(\text{aq})$  to produce ethanoate ions?

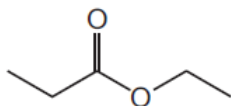
- A** ethanol
- B** methylpropan-2-ol
- C** propan-2-ol
- D** butan-2-ol

5. Nov/2023/Paper\_9701/12/No.38

How many esters with the molecular formula  $\text{C}_5\text{H}_{10}\text{O}_2$  can be made by reacting a primary alcohol with a carboxylic acid?

- A** 4                      **B** 5                      **C** 6                      **D** 8

The diagram shows an ester. It is heated under reflux with an excess of NaOH(aq).



Which row shows the 2 products of the reaction?

	product 1	product 2
<b>A</b>		
<b>B</b>		
<b>C</b>		
<b>D</b>		

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7. Nov/2023/Paper\_9701/22/No.4(a)

Lactic acid,  $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ , and pyruvic acid,  $\text{CH}_3\text{COCOOH}$ , both contain two functional groups.

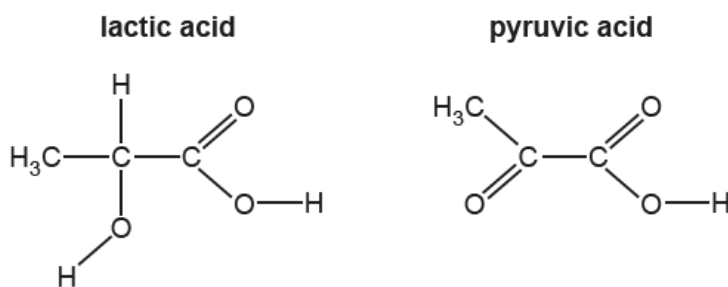


Fig. 4.1

(a) (i) Explain why lactic acid exists as optical isomers.

.....  
.....  
..... [1]

(ii) Give the systematic name of lactic acid.

..... [1]

(iii) Lactic acid forms hydrogen bonds with water.

Complete Fig. 4.2 to show the formation of a hydrogen bond between one molecule of lactic acid and one molecule of water.

Label the hydrogen bond. Show any relevant dipoles and lone pairs of electrons.

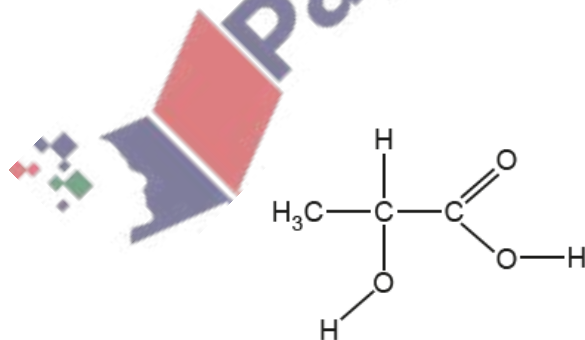


Fig. 4.2

[3]

8. June/2023/Paper\_9701/11/No.36

Which method could produce butanoic acid?

- A an acid–base reaction involving  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na}$
- B the hydrolysis of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CN}$
- C the acidic hydrolysis of  $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_2\text{CH}_3$
- D the oxidation of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

9. June/2023/Paper\_9701/11/No.37

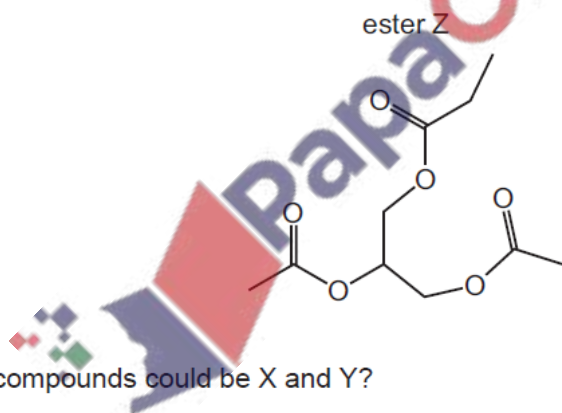
Which ester may be hydrolysed to produce two products, one of which may be reduced to the other?

- A  $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_3$
- B  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$
- C  $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}(\text{CH}_3)_2$
- D  $(\text{CH}_3)_2\text{CHCO}_2\text{CH}(\text{CH}_3)_2$

10. June/2023/Paper\_9701/11/No.38

Two compounds, X and Y, are mixed and a little concentrated  $\text{H}_2\text{SO}_4$  is added.

Ester Z is found in the resulting mixture of products.



Which two compounds could be X and Y?

	X	Y
<b>A</b>	$\text{CH}_3\text{CH}_2\text{OH}$	$\text{CH}(\text{CO}_2\text{H})_3$
<b>B</b>	$\text{CH}_3\text{CH}_2\text{OH}$	$\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{OCOCH}_2\text{CH}_3$
<b>C</b>	$\text{CH}_3\text{CO}_2\text{H}$	$\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$
<b>D</b>	$\text{CH}_3\text{CO}_2\text{H}$	$\text{CH}_2(\text{OH})\text{CH}(\text{OH})\text{CH}_2(\text{OH})$

11. June/2023/Paper\_9701/12/No.38

Which reaction will form propanoic acid?

- A acidic hydrolysis of propyl ethanoate
- B alkaline hydrolysis of ethyl propanoate
- C acidic hydrolysis of propanenitrile
- D acidic hydrolysis of ethanenitrile

12. June/2023/Paper\_9701/13/No.1

Propanoic acid is treated with reagent X at room temperature. The organic product of the reaction is sodium propanoate. No gas is produced during the reaction.

What could be reagent X?

- A  $\text{NaHCO}_3(\text{aq})$
- B  $\text{NaOH}(\text{aq})$
- C  $\text{Na}_2\text{CO}_3(\text{aq})$
- D  $\text{Na}_2\text{SO}_4(\text{aq})$

13. June/2023/Paper\_9701/13/No.35

Methylbut-2-ene reacts with HBr at room temperature to produce compound X as a major product.

Compound X reacts with KCN in ethanol to produce compound Y.

Compound Y is hydrolysed with acid to produce compound Z.

What is compound Z?

- A 2,2-dimethylbutanoic acid
- B 2,3-dimethylbutanoic acid
- C 2-methylpentanoic acid
- D 3-methylpentanoic acid

14. June/2023/Paper\_9701/13/No.36

Compound Q can be hydrolysed by  $\text{HCl}(\text{aq})$ . The two products of this hydrolysis have the same empirical formula.

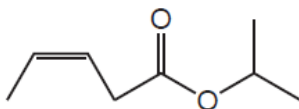
What could Q be?

- A  $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{OH}$
- B  $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- C  $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- D  $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$

15. June/2023/Paper\_9701/13/No.37

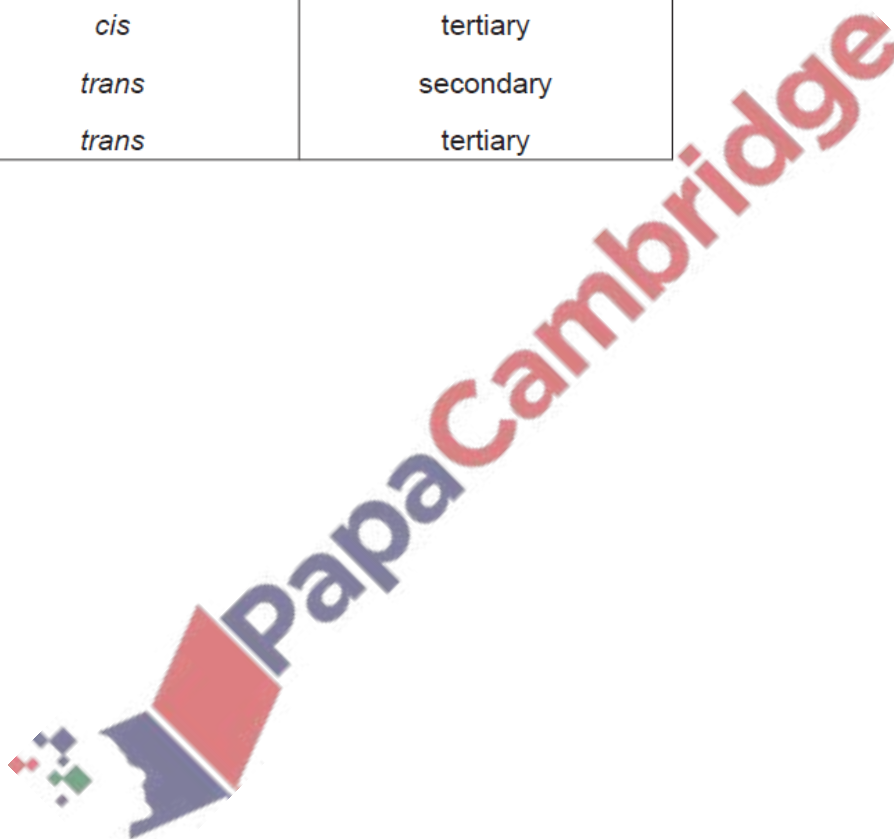
An unsaturated carboxylic acid reacts with alcohol X to form an ester.

The structure of the ester is shown.



Which geometrical isomer is shown in this ester and to which class of alcohol does X belong?

	geometrical isomer	class of alcohol X
<b>A</b>	<i>cis</i>	secondary
<b>B</b>	<i>cis</i>	tertiary
<b>C</b>	<i>trans</i>	secondary
<b>D</b>	<i>trans</i>	tertiary



16. June/2023/Paper\_9701/21/No.4  
V is a colourless liquid.

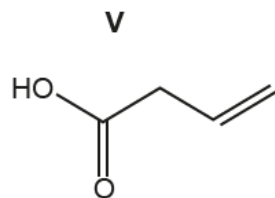
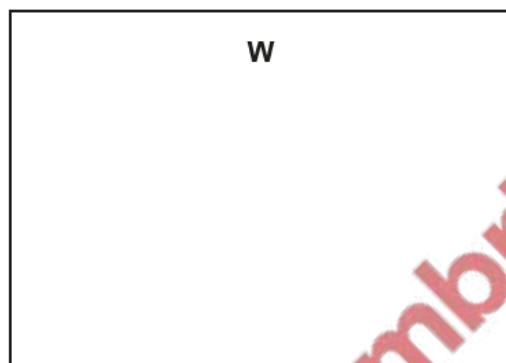


Fig. 4.1

(a) V reacts with an excess of  $\text{LiAlH}_4$  to form W.

(i) Draw the structure of W in the box.



[1]

(ii) Identify the role of  $\text{LiAlH}_4$  in the reaction with V.

..... [1]

(b) V reacts to form Z in a single reaction, as shown in Fig. 4.2.

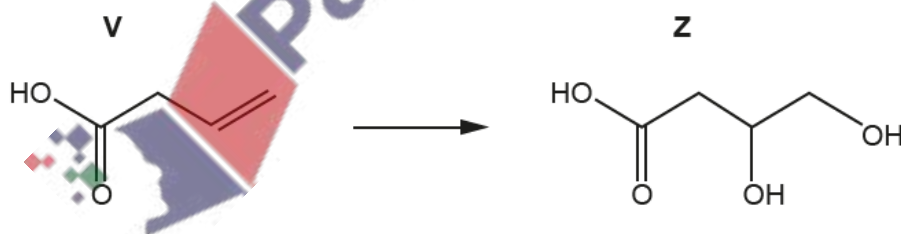


Fig. 4.2

(i) Suggest the reagent and conditions needed to form Z from V.

..... [1]

(ii) Deduce the empirical formula of Z.

..... [1]



- (iii) Complete Table 4.1 to show the number of  $sp^2$  and  $sp^3$  hybridised carbon atoms that are present in a molecule of **V**.

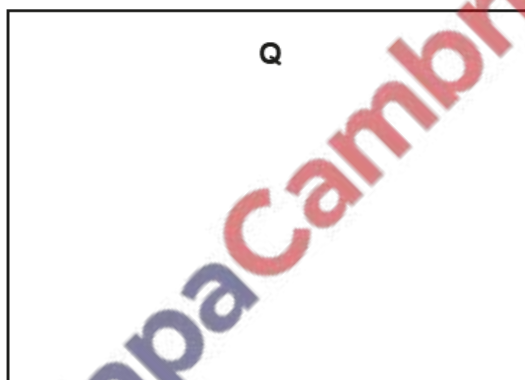
Table 4.1

type of hybridisation	$sp^2$	$sp^3$
number of carbon atoms in <b>V</b>		

[2]

- (c) **Q** contains the elements carbon, hydrogen and oxygen only. It is a saturated molecule with no branching in its carbon backbone.  
**Q** contains only one functional group.  
The relative molecular mass of **Q** is 88.  
No effervescence is seen when  $Na_2CO_3$  is added to **Q**.  
Effervescence is seen when sodium is added to **Q**.  
**Q** reacts with alkaline  $I_2(aq)$  to form a yellow precipitate.

Draw the structure of **Q** in the box.



[2]

[Total: 8]

Y is formed from X in a single-step reaction, as shown in Fig. 5.1.

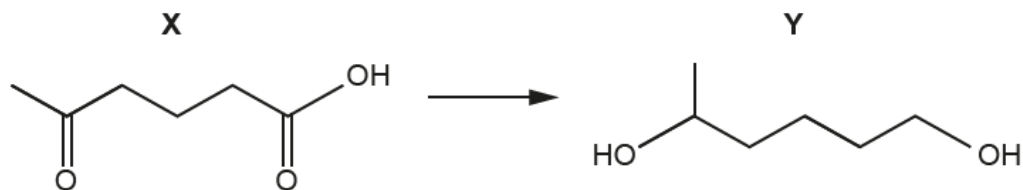


Fig. 5.1

(a) Deduce the empirical formula of Y.

..... [1]

(b) The formation of Y from X requires the addition of a suitable reducing agent.

(i) Construct an equation using molecular formulae and [H] for the reaction in Fig. 5.1. Use [H] to represent one atom of hydrogen from the reducing agent.

..... [1]

(ii) Identify a suitable non-gaseous reducing agent for the formation of Y from X.

..... [1]

(c) Complete Table 5.1 to show the number of  $sp^2$  and  $sp^3$  hybridised carbon atoms in a molecule of X.

Table 5.1

type of hybridisation	$sp^2$	$sp^3$
number of carbon atoms in X		

[2]

- (d) Complete Table 5.2 with the expected observations that occur when the reagents shown are added to separate solutions of **X** and **Y**. Do **not** refer to temperature changes in your answer.

Table 5.2

reagent	observation on addition to <b>X</b>	observation on addition to <b>Y</b>
aqueous sodium carbonate		
2,4-dinitrophenylhydrazine (2,4-DNPH reagent)		
alkaline aqueous iodine		

[3]

[Total: 8]

18. March/2023/Paper\_9701/12/No.25

Which two formulae correctly represent a pair of structural isomers?

- A  $\text{CH}_3\text{CH}(\text{CH}_3)\text{COOH}$  and  $(\text{CH}_3)_2\text{CHCOOH}$
- B  $\text{CH}_3\text{CH}(\text{COOH})\text{CH}_3$  and  $(\text{CH}_3)_2\text{CHCOOH}$
- C  $\text{CH}_3\text{CHCOOH}$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$  and  $(\text{CH}_3)_2\text{CHCOOH}$

19. March/2023/Paper\_9701/12/No.32

Tartaric acid,  $\text{HOOCCH}(\text{OH})\text{CH}(\text{OH})\text{COOH}$ , is found in many plants.

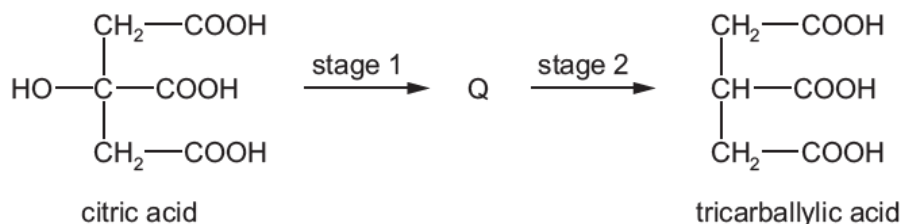
A sample of tartaric acid reacts with an excess of  $\text{LiAlH}_4$  to form the organic product J.

What happens when  $\text{NaOH}(\text{aq})$  is added to separate samples of tartaric acid and J?

- A Both tartaric acid and J react.
- B Only tartaric acid reacts.
- C Only J reacts.
- D Neither tartaric acid nor J react.

20. March/2023/Paper\_9701/12/No.33

Citric acid can be converted into tricarballic acid in two stages. An intermediate, Q, is formed.



Which reagents are needed for each stage?

	stage 1	stage 2
<b>A</b>	concentrated $\text{H}_2\text{SO}_4$	$\text{H}_2(\text{g})$ and Ni
<b>B</b>	concentrated $\text{H}_2\text{SO}_4$	$\text{LiAlH}_4$
<b>C</b>	$\text{LiAlH}_4$	$\text{H}_2\text{SO}_4(\text{aq})$
<b>D</b>	$\text{NaOH}(\text{aq})$	$\text{H}_2(\text{g})$ and Ni

21. March/2023/Paper\_9701/12/No.36

The ester ethyl butanoate can be hydrolysed using an excess of dilute sodium hydroxide solution.

Which substance is a product of this reaction?

- A**  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na}$
- B**  $\text{CH}_3\text{CO}_2\text{Na}$
- C**  $\text{CH}_3\text{CH}_2\text{ONa}$
- D**  $\text{H}_2\text{O}$

22. March/2023/Paper\_9701/12/No.37

An aqueous solution contains 4.00 g of a carboxylic acid, Q. When this solution reacts with an excess of magnesium,  $380 \text{ cm}^3$  of gas is produced, measured at s.t.p.

What is the relative formula mass of Q?

- A** 59
- B** 118
- C** 126
- D** 236