CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



EXAM QUESTION PACK

18 CARBOXYLIC ACIDS AND DERIVATIVES

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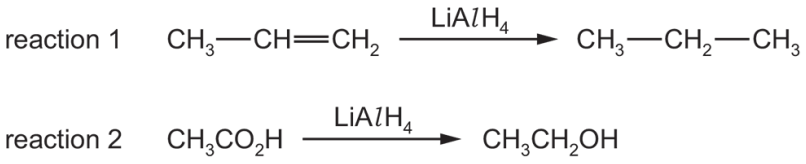
Chapter 18

Carboxylic acids and derivatives

18.1 Carboxylic acids

1084. 9701_m22_qp_12 Q: 34

A student suggests two uses of $LiAlH_4$.



Which reactions would give the product shown?

A both reactions

B reaction 1 only

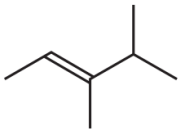
C reaction 2 only

D neither reaction

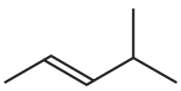
1085. 9701_s21_qp_11 Q: 21

Which compound would produce two different carboxylic acids when treated with hot, concentrated, acidified manganate(VII) ions?

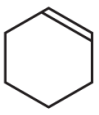
A



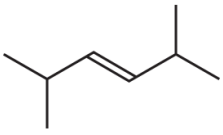
B



C



D



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1086. 9701_s21_qp_13 Q: 28

Compound Y is treated with a single reagent under suitable conditions. 2-methylbutanoic acid is produced.

What could compound Y be?

A pentan-2-one

B 2-methylbutan-2-ol

C 2-methylbutanenitrile

D methylpropanenitrile

1087. 9701_w21_qp_12 Q: 24

Butanoic acid can be made from 1-bromopropane in two stages.

stage 1 $CH_3CH_2CH_2Br \rightarrow CH_3CH_2CH_2CN$

stage 2 $CH_3CH_2CH_2CN \rightarrow CH_3CH_2CH_2CO_2H$

Which types of reaction are stage 1 and stage 2?

	stage 1	stage 2
A	electrophilic addition	hydrolysis
B	electrophilic addition	oxidation
C	nucleophilic substitution	hydrolysis
D	nucleophilic substitution	oxidation

1088. 9701_w21_qp_12 Q: 29

Organic compound Z has an alcohol group and a carboxylic acid group.

Compound Z reacts with magnesium carbonate to make a salt with a relative formula mass of 230.3.

Compound Z does **not** react with acidified potassium manganate(VII).

What could be the identity of compound Z?

A 2-hydroxy-2-methylbutanoic acid

B 2-hydroxy-2-methylpropanoic acid

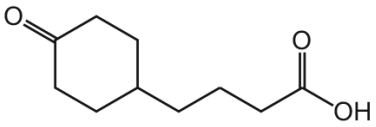
C 3-hydroxy-2-methylbutanoic acid

D 3-hydroxy-2-methylpropanoic acid

1089. 9701_m20_qp_12 Q: 28

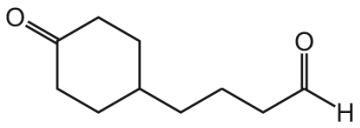
Compound X is treated with an excess of lithium aluminium hydride. The reaction is allowed to go to completion.

X

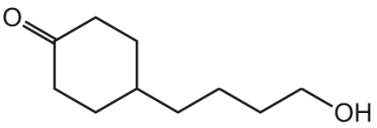


What is the structure of the organic product?

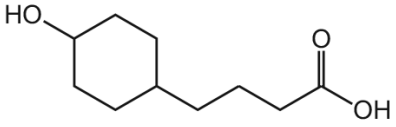
A



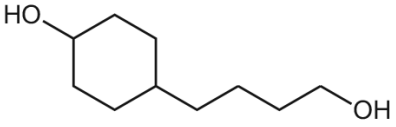
B



C



D



1090. 9701_s20_qp_11 Q: 30

Which reaction produces an organic anion with a good yield?

A heating ethanenitrile under reflux with dilute sodium hydroxide

B heating ethanenitrile under reflux with dilute sulfuric acid

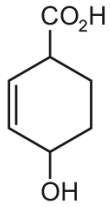
C heating ethane with sodium metal

D heating ethanol under reflux with dilute sodium hydroxide

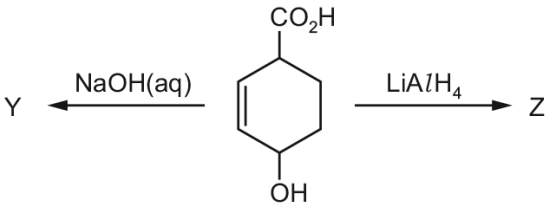
1091. 9701_s20_qp_12 Q: 20

Compound X is shown.

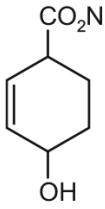
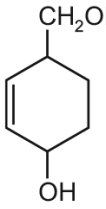
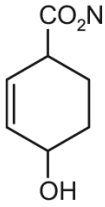
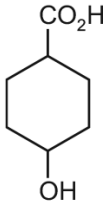
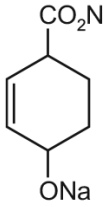
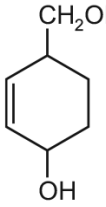
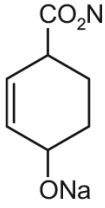
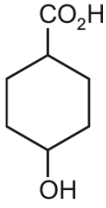
compound X



X is treated separately with NaOH(aq) and LiAlH$_4$ to give Y and Z.



What are Y and Z?

	Y	Z
A		
B		
C		
D		

1092. 9701_s20_qp_13 Q: 23

Butanoic acid can be produced from 1-bromopropane in two steps using reagents V and W as shown.



What could be reagents V and W?

	V	W
A	KCN in ethanol	HCl(aq)
B	KCN in ethanol	NaOH(aq)
C	NH_3 in ethanol	HCl(aq)
D	NaOH(aq)	$H^+ / Cr_2O_7^{2-}$(aq)

1093. 9701_s20_qp_13 Q: 26

Which reagent reacts with **both** of the –OH groups in lactic acid, $CH_3CH(OH)CO_2H$?

A acidified potassium dichromate(VI)

B ethanol

C sodium

D sodium hydroxide

1094. 9701_w20_qp_11 Q: 24

A student converts 1-iodopropane, C_3H_7I, into butanoic acid, $C_3H_7CO_2H$, by a two-stage chemical synthesis.

In the **first** of the two stages, which reagent is reacted with 1-iodopropane?

A aqueous sodium hydroxide

B ethanolic ammonia

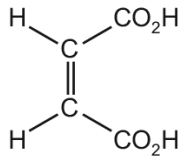
C ethanolic potassium cyanide

D ethanolic sodium hydroxide

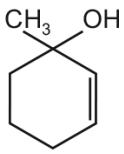
1095. 9701_w20_qp_11 Q: 29

Which compound is chiral and reacts with Na_2CO_3 to give CO_2?

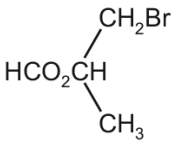
A



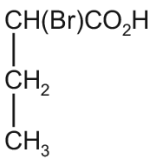
B



C



D



1096. 9701_w20_qp_12 Q: 18

Which substance, when warmed with aqueous ammonium chloride, would produce an alkaline gas?

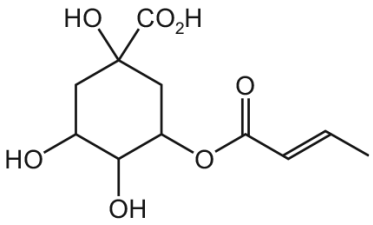
A CH_3CO_2H **B** CH_3CH_2OH **C** $CH_3CO_2CH_3$ **D** CH_3CH_2ONa

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1097. 9701_w20_qp_12 Q: 29

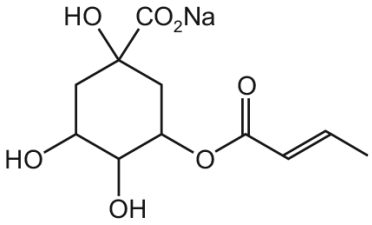
Compound Z is shown.

compound Z

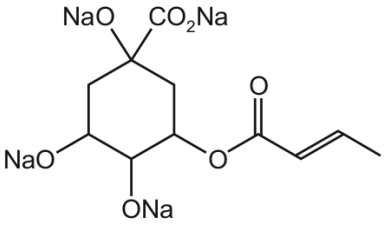


What is produced in good yield when compound Z is treated with an excess of sodium carbonate solution at room temperature?

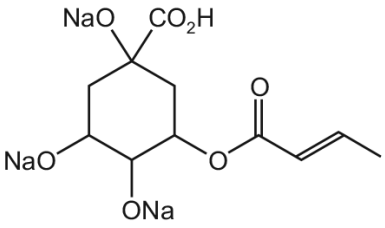
A



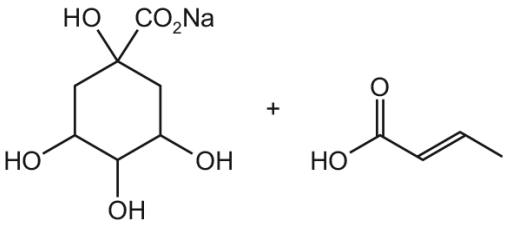
B



C



D



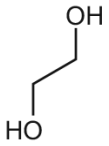
1098. 9701_m19_qp_12 Q: 29

1 mole of each of the following four compounds is reacted separately with:

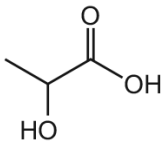
- an excess of sodium
- an excess of sodium carbonate.

Which compound produces the same volume of gas with each of the **two** reagents?

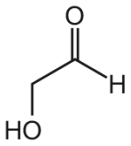
A



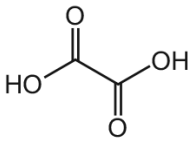
B



C



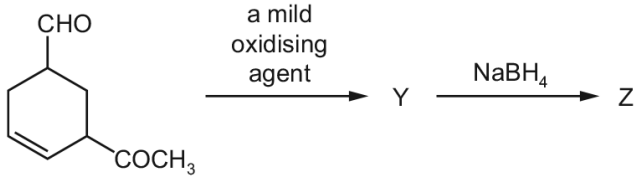
D



1099. 9701_s19_qp_11 Q: 28

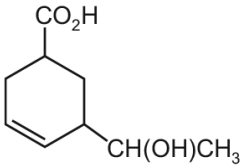
Compound X is treated with two reagents successively, forming compound Z.

X

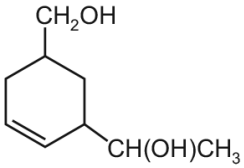


What could be Z?

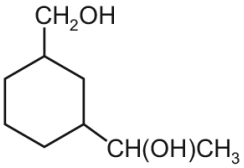
A



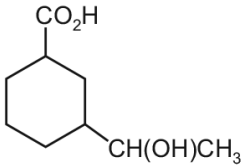
B



C

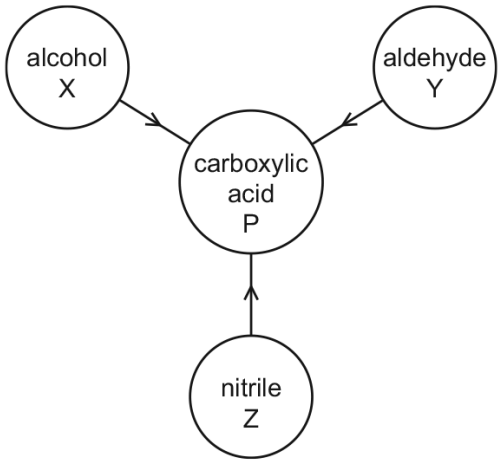


D



1100. 9701_s19_qp_12 Q: 28

The diagram shows that a carboxylic acid P may be formed from X, Y or Z.



Which row is correct?

	alcohol X is	the change in M_r is greatest for
A	primary	Y to P
B	primary	Z to P
C	secondary	Y to P
D	secondary	Z to P

1101. 9701_w19_qp_11 Q: 28

Tartaric acid, $HO_2CCH(OH)CH(OH)CO_2H$, is found in many plants.

A sample of tartaric acid reacts with an excess of $LiAlH_4$ to form the organic product J.

What happens when NaOH(aq) is added to separate samples of tartaric acid and J?

A Both tartaric acid and J react.

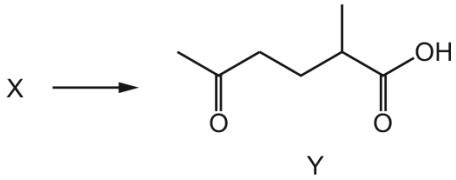
B Only tartaric acid reacts.

C Only J reacts.

D Neither tartaric acid nor J react.

1102. 9701_m18_qp_12 Q: 22

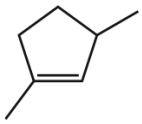
Compound X can be converted into compound Y in a single step.



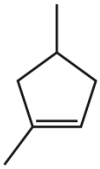
Y

What could be the identity of X?

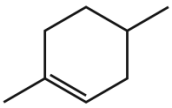
A



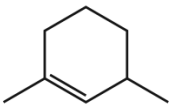
B



C



D



1103. 9701_s18_qp_11 Q: 28

Which reagent could be used to carry out the following reaction?



A a solution containing acidified dichromate(VI) ions

B a solution containing dilute, acidified manganate(VII) ions

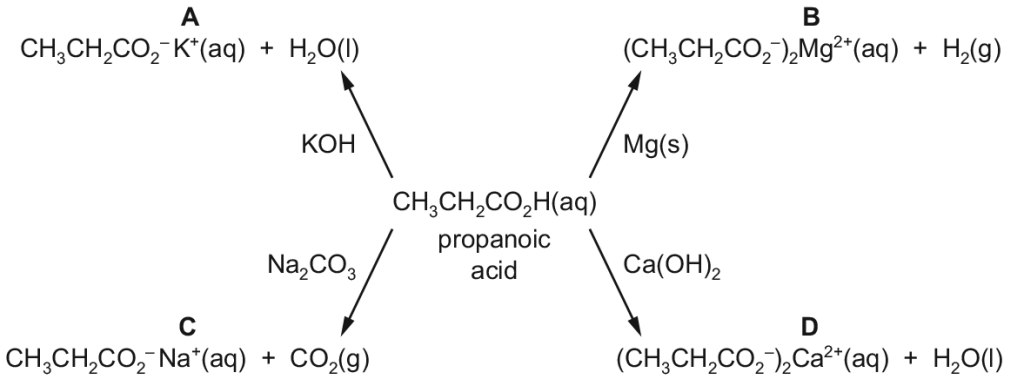
C a solution containing hot, concentrated, acidified manganate(VII) ions

D concentrated sulfuric acid

1104. 9701_s18_qp_11 Q: 29

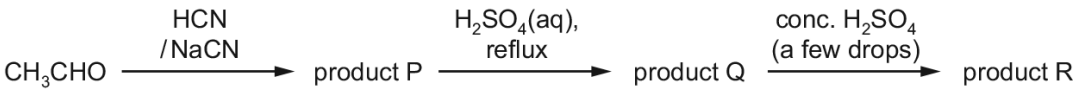
Four reactions of propanoic acid to form salts and other products are shown.

Which reaction does **not** show the formulae of **all** the correct products?



1105. 9701_s18_qp_12 Q: 28

Ethanal, CH_3CHO, is used to make product R in a three-stage synthesis.



Two molecules of Q react to give one molecule of R plus two molecules of water.

R has two ester functional groups in each molecule. R does not react with sodium.

What is the empirical formula of R?

A CHO **B** $C_3H_4O_2$ **C** $C_3H_5O_2$ **D** $C_6H_{10}O_5$

1106. 9701_s18_qp_13 Q: 28

A student carried out a **two-stage** synthesis in which $CH_3CH_2CH_2Br$ was converted into $CH_3CH_2CH_2CO_2H$.

Which compound could have been formed by the first stage of this synthesis?

A $CH_3CH_2CH_2OH$

B $CH_3CH_2CH_2CHO$

C CH_3CH_2CN

D $CH_3CH_2CH_2CN$

1107. 9701_w18_qp_11 Q: 26

Sodium reacts with 1 mol of compound Y to produce 1 mol of H_2(g).

Which compound could Y be?

A $CH_3CH_2CH_2CH_2OH$

B $(CH_3)_3COH$

C $CH_3CH_2CH_2CO_2H$

D $CH_3CH(OH)CO_2H$

1108. 9701_w18_qp_11 Q: 28

Ethanedioic acid, HO_2CCO_2H, is reduced using an excess of lithium aluminium hydride, $LiAlH_4$.

What is the organic product of the reaction?

A ethanol

B ethane-1,2-diol

C ethanedial, OHCCHO

D methane

1109. 9701_w18_qp_12 Q: 29

Which compound can be used to make propanoic acid by treatment with a single reagent?

A CH_2=$CHCH_2CH_3$

B $CH_3CH_2CH_2CN$

C $CH_3CH(OH)CN$

D $CH_3CH(OH)CH_3$

1110. 9701_s17_qp_11 Q: 27

Q is a compound with the molecular formula $C_4H_{10}O$. **Q** can be oxidised with acidified potassium dichromate(VI). **Q cannot** be made by reducing a carboxylic acid with $LiAlH_4$.

What is the structure of **Q**?

A $CH_3CH(OH)CH_2CH_3$

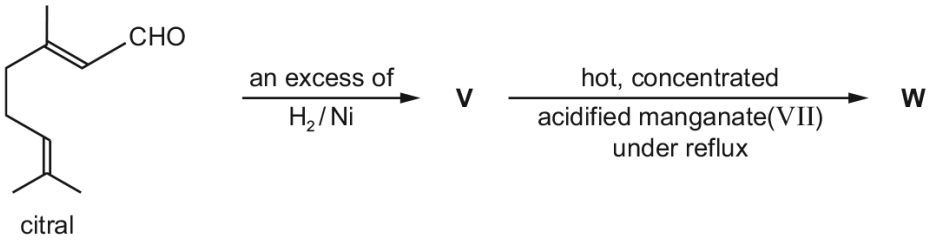
B $CH_3CH_2CH_2CH_2OH$

C $(CH_3)_3COH$

D $(CH_3)_2CHCH_2OH$

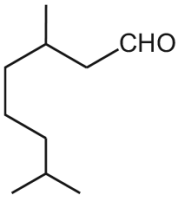
1111. 9701_s17_qp_11 Q: 30

Citral is found in lemongrass oil. It can react to give compound **W**.

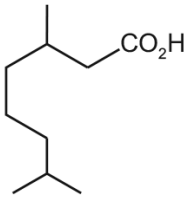


What could compound **W** be?

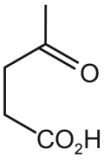
A



B



C



D



1112. 9701_s17_qp_13 Q: 23

Carboxylic acids may be prepared by several different methods.

In which reaction would propanoic acid be formed?

A adding ammonium propanoate to dilute sulfuric acid

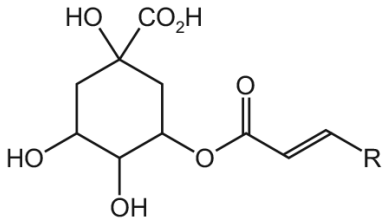
B heating ethyl propanoate with aqueous sodium hydroxide

C heating propan-2-ol with acidified potassium manganate(VII) under reflux

D heating propyl ethanoate with dilute sulfuric acid

1113. 9701_s17_qp_13 Q: 28

Chlorogenic acid is found in green coffee beans and is used in treatments for weight loss.

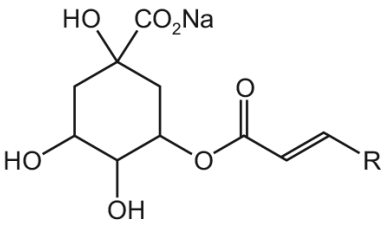


chlorogenic acid

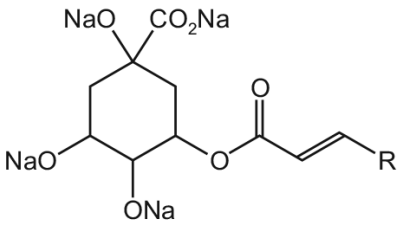
R = $C_6H_5O_2$ and takes no part in the reaction with sodium carbonate.

What is produced in good yield when chlorogenic acid is treated with an excess of sodium carbonate solution at room temperature?

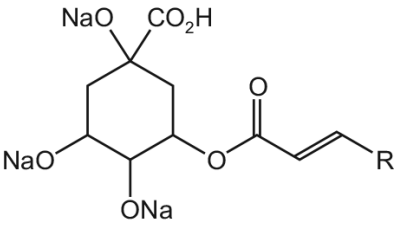
A



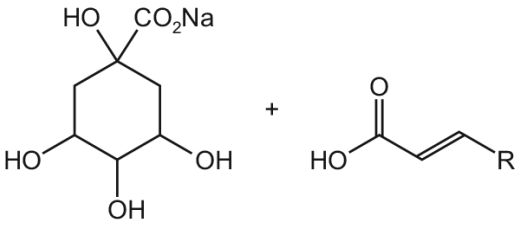
B



C



D



1114. 9701_s17_qp_13 Q: 29

Butanoic acid can be produced from 1-bromopropane using reagents X and Y as shown.

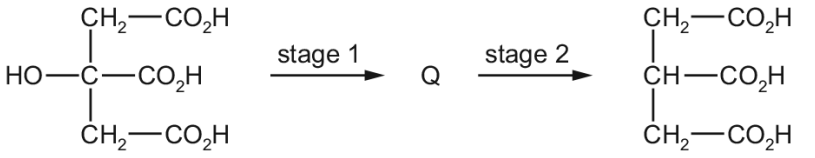


What could be reagents X and Y?

	X	Y
A	KCN in ethanol	HCl(aq)
B	KCN in ethanol	NaOH(aq)
C	NH_3 in ethanol	HCl(aq)
D	NaOH(aq)	$H^+ / Cr_2O_7^{2-}$(aq)

1115. 9701_w17_qp_11 Q: 25

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



citric acid tricarballylic acid

Which reagents are needed for each stage?

	stage 1	stage 2
A	concentrated H_2SO_4	H_2(g) and Ni
B	concentrated H_2SO_4	LiA$l$$H_4$
C	LiA$l$$H_4$	H_2SO_4(aq)
D	NaOH(aq)	H_2(g) and Ni

1116. 9701_w17_qp_11 Q: 27

3-methylbutanone is treated with alkaline aqueous iodine. The mixture of products is then acidified.

Which compound is present in the final mixture of products?

A 3-methylbutanoic acid

B butanoic acid

C methylpropanoic acid

D propanoic acid

1117. 9701_w17_qp_11 Q: 28

At room temperature, propanoic acid was reacted to produce sodium propanoate. No gas was produced during the reaction.

What could the propanoic acid have reacted with?

A $NaHCO_3(aq)$ **B** $NaOH(aq)$ **C** $Na_2CO_3(aq)$ **D** $Na_2SO_4(aq)$

1118. 9701_s16_qp_11 Q: 22

Which pair of reagents will take part in a redox reaction?

A CH_3CHCH_2 + Br_2

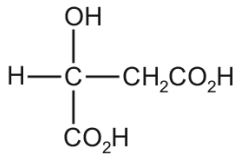
B $CH_3CH_2CH_2OH$ + concentrated H_3PO_4

C CH_3COCH_3 + HCN

D $HCO_2C_2H_5$ + dilute H_2SO_4

1119. 9701_s16_qp_11 Q: 26

Malic acid is found in apples.



malic acid

Which reagent will react with all three –OH groups present in the malic acid molecule?

A ethanol in the presence of concentrated sulfuric acid

B potassium hydroxide

C sodium

D sodium carbonate

1120. 9701_s16_qp_12 Q: 28

How many of the following compounds produce a carboxylic acid on heating under reflux with an excess of hot acidified $K_2Cr_2O_7$?

CH_3CH_2CHO

CH_3COCH_3

$CH_3CH_2CH_2OH$

$CH_3CH(OH)CH_3$

A 1 **B** 2 **C** 3 **D** 4

1121. 9701_w16_qp_11 Q: 28

Which reaction would **not** give ethanoic acid?

A heating ethanenitrile under reflux with dilute sodium hydroxide

B heating ethanenitrile under reflux with dilute sulfuric acid

C heating ethanal under reflux with acidified sodium dichromate(VI)

D heating ethanol under reflux with acidified sodium dichromate(VI)

1122. 9701_s15_qp_12 Q: 23

Butanedioic acid may be synthesised in two steps from 1,2-dibromoethane.

$$BrCH_2CH_2Br \xrightarrow{\text{step 1}} X \xrightarrow{\text{step 2}} HO_2CCH_2CH_2CO_2H$$

Which reagents could be used for this synthesis?

	step 1	step 2
A	HCN(g)	HC*l*(aq)
B	HCO_2Na(aq)	HC*l*(aq)
C	KCN(alcoholic)	H_2SO_4(aq)
D	NaOH(aq)	$K_2Cr_2O_7/H_2SO_4$(aq)

1123. 9701_s15_qp_13 Q: 25

Compound **X**, $C_5H_{12}O$, is oxidised by acidified sodium dichromate(VI) to compound **Y**.

Compound **Y** reacts with butan-2-ol in the presence of a little concentrated sulfuric acid to give liquid **Z**.

What could be the formula of **Z**?

A $CH_3(CH_2)_3CO_2CH(CH_3)CH_2CH_3$

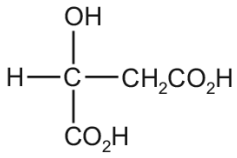
B $CH_3(CH_2)_3CO_2(CH_2)_3CH_3$

C $CH_3(CH_2)_2CO_2CH(CH_3)CH_2CH_3$

D $(CH_3)_2CHCH_2CO_2C(CH_3)_3$

1124. 9701_s15_qp_13 Q: 30

Malic acid occurs in apples.



malic acid

Under suitable conditions, which substance will react with only one of the –OH groups in the malic acid molecule?

A $Cr_2O_7^{2-}/H^+(aq)$

B Na(s)

C NaOH(aq)

D $PCl_5(s)$

1125. 9701_w15_qp_11 Q: 25

If the starting material is iodoethane, which sequence of reactions will produce propanoic acid as the main final product in good yield?

A add NaOH(aq), isolate the organic product, add acidified $K_2Cr_2O_7$ and boil under reflux

B add NaOH(aq), isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

C heat with HCN in ethanol, isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

D heat with KCN in ethanol, isolate the organic product, add $H_2SO_4(aq)$ and boil under reflux

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18.2 Esters

1126. 9701_m22_qp_12 Q: 27

Which compound will decolourise $Br_2(aq)$?

A $CH_3CH_2CH_2CH_2CH_2CO_2H$

B $CH_3CH_2CH_2CH_2CH_2CHO$

C $CH_3CHCHCH_2CH_2CH_2OH$

D $CH_3CH_2CH_2CO_2CH_2CH_3$

1127. 9701_m22_qp_12 Q: 35

Compound X contains a single ester group.

X contains 27.6% by mass of oxygen.

Which pair of products could be produced by the hydrolysis of X?

A butan-1-ol and ethanoic acid

B ethanol and propanoic acid

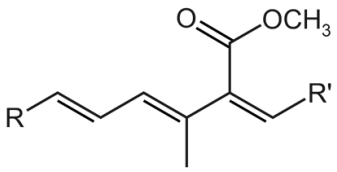
C methanol and methanoic acid

D propan-2-ol and butanoic acid

1128. 9701_m21_qp_12 Q: 23

Part of the structure of strobilurin is shown. R and R' are inert groups.

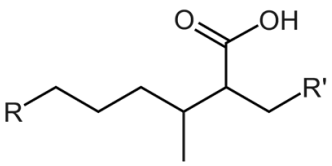
strobilurin



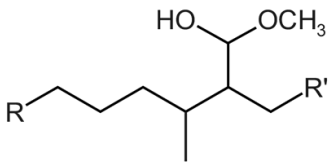
Strobilurin is warmed with aqueous sulfuric acid producing compound X. Compound X is then treated with hydrogen in the presence of a nickel catalyst producing compound Y.

What could be the structure of compound Y?

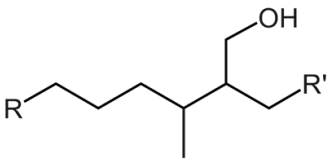
A



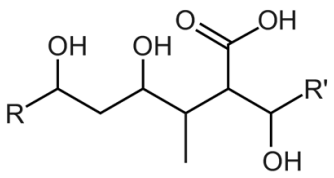
B



C



D



1129. 9701_m21_qp_12 Q: 28

Ethanedioic acid has the formula HO_2CCO_2H.

What is the formula of aluminium ethanedioate?

A AlC_2O_4 **B** $Al(C_2O_4)_3$ **C** $Al_2C_2O_4$ **D** $Al_2(C_2O_4)_3$

1130. 9701_m21_qp_12 Q: 29

Which reaction gives butanoic acid as one of its products?

A acid hydrolysis of butyl ethanoate

B alkaline hydrolysis of butyl ethanoate

C acid hydrolysis of ethyl butanoate

D alkaline hydrolysis of ethyl butanoate

1131. 9701_s21_qp_11 Q: 24

The compound cetyl palmitate, $C_{15}H_{31}CO_2C_{16}H_{33}$, is a waxy solid.

Cetyl palmitate is heated under reflux with an excess of aqueous sodium hydroxide.

Which products will be formed?

A $C_{15}H_{31}ONa$ and $C_{16}H_{33}CO_2Na$

B $C_{15}H_{31}CO_2Na$ and $C_{16}H_{33}ONa$

C $C_{15}H_{31}OH$ and $C_{16}H_{33}CO_2Na$

D $C_{15}H_{31}CO_2Na$ and $C_{16}H_{33}OH$

1132. 9701_s21_qp_13 Q: 29

To which classes of alcohol do P and Q belong?

	P	Q
A	primary	primary
B	primary	secondary
C	secondary	primary
D	secondary	secondary

1133. 9701_w21_qp_11 Q: 29

The structural formula of an ester is $(CH_3)_2CHOCO(CH_2)_2CH_3$.

This ester is boiled with aqueous hydrochloric acid.

Which two products are formed?

A propan-1-ol and butanoic acid

B propan-2-ol and butanoic acid

C propan-1-ol and propanoic acid

D propan-2-ol and propanoic acid

1134. 9701_w21_qp_13 Q: 29

The structural formula of an ester is $(CH_3)_2CHOCO(CH_2)_2CH_3$.

This ester is boiled with aqueous hydrochloric acid.

Which two products are formed?

A propan-1-ol and butanoic acid

B propan-2-ol and butanoic acid

C propan-1-ol and propanoic acid

D propan-2-ol and propanoic acid

1135. 9701_m20_qp_12 Q: 27

Which reaction would produce propanoic acid as one of its products?

A heating $(CH_3)_2C{=}CHCH_2CH_3$ with concentrated, acidified $KMnO_4$

B heating $CH_3CH_2CO_2CH_2CH_2CH_3$ with NaOH(aq)

C heating CH_3CH_2OH with acidified $K_2Cr_2O_7$ under reflux

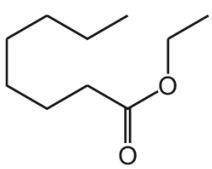
D reacting CH_3CHO with HCN then heating the organic product with H_2SO_4(aq)

1136. 9701_s20_qp_11 Q: 26

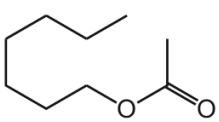
When compound X is heated under reflux with aqueous sodium hydroxide solution two products are formed: sodium ethanoate and hexan-1-ol.

What is compound X?

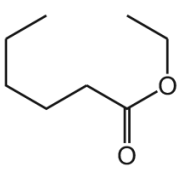
A



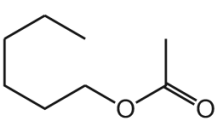
B



C



D



1137. 9701_s20_qp_12 Q: 23

Ester X is shown.

ester X

$CH_3CO_2(CH_2)_7CH_3$

Ester X is hydrolysed using aqueous sodium hydroxide.

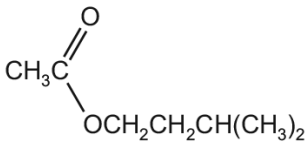
What is the molecular formula of one of the products?

A $C_2H_4O_2$ **B** $C_2H_3O_2Na$ **C** $C_8H_{16}O$ **D** $C_8H_{17}O_2Na$

1138. 9701_s20_qp_13 Q: 21

Ester P has the following structural formula.

ester P



Which compounds are produced when P is hydrolysed using dilute hydrochloric acid?

A CH_3COCl and $(CH_3)_2CHCH_2CH_2OH$

B CH_3CH_2OH and $(CH_3)_2CHCH_2CO_2H$

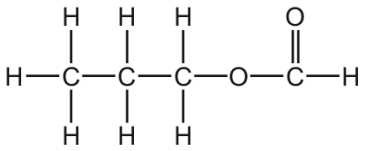
C CH_3CO_2H and $(CH_3)_2CHCH_2CO_2H$

D CH_3CO_2H and $(CH_3)_2CHCH_2CH_2OH$

1139. 9701_s19_qp_12 Q: 29

One molecule of compound R is shown.

compound R

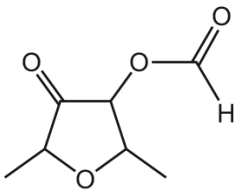


What is the name of compound R and how does its boiling point compare with that of butanoic acid?

	name of R	boiling point of R
A	methyl propanoate	higher than butanoic acid
B	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

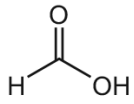
1140. 9701_s19_qp_13 Q: 30

An ester is shown.

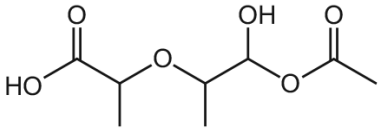


What is the structure of the carboxylic acid that would be obtained by acid hydrolysis of the ester linkage?

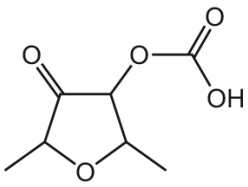
A



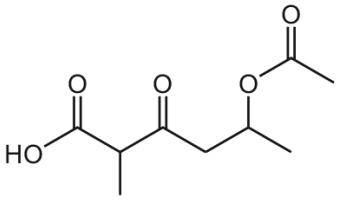
B



C



D



1141. 9701_w19_qp_12 Q: 29

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

What could Q be?

A $CH_3CO_2CH_2CH_2OH$

B $CH_3CO_2CH_2CH_2CO_2H$

C $CH_3CH_2CO_2CH_2CH_2CH_3$

D $CH_3CH_2CH(OH)CH(OH)CH_2CH_3$

1142. 9701_s18_qp_11 Q: 11

Hydrogen ions catalyse the hydrolysis of esters.

Which statement is correct?

A The hydrogen ions act as a heterogeneous catalyst.

B The hydrogen ions are in the same phase as the reactants.

C The hydrogen ions are used up in the reaction.

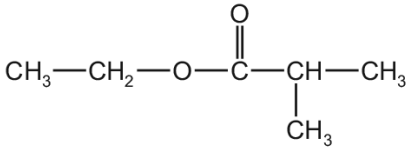
D The hydrogen ions have no effect on the activation energy of the reaction.

1143. 9701_s18_qp_11 Q: 27

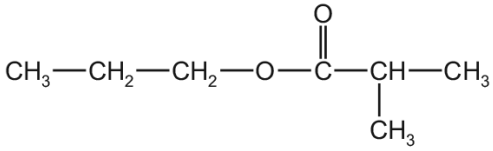
Ethyl propanoate is refluxed with aqueous sodium hydroxide. The alcohol produced is then reacted with methyl propanoic acid to make a second ester.

What is the structural formula of this second ester?

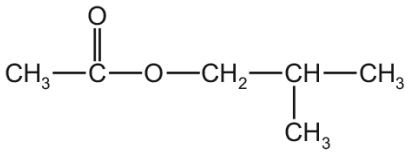
A



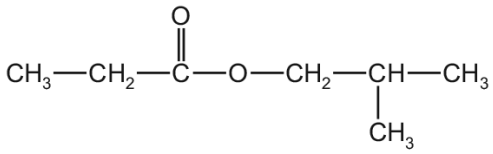
B



C



D



1144. 9701_s18_qp_12 Q: 29

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

Which substance is a product of this reaction?

A $CH_3CH_2CH_2CO_2Na$

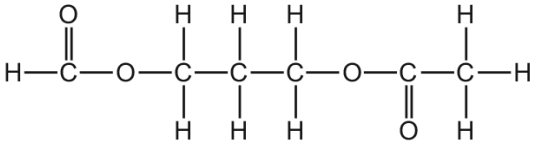
B CH_3CO_2Na

C CH_3CH_2ONa

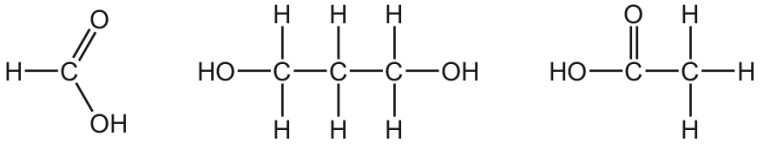
D H_2O

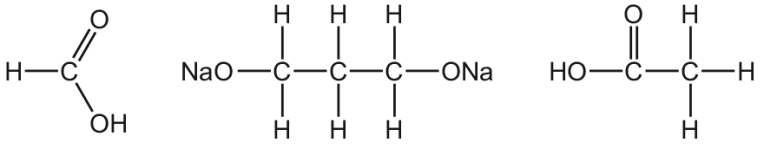
1145. 9701_w18_qp_11 Q: 29

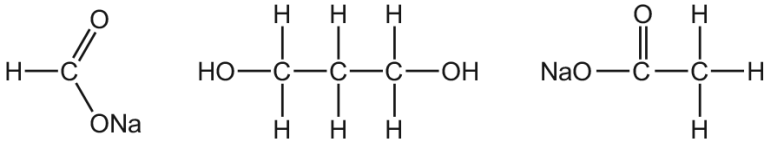
The diester shown can be hydrolysed by heating with an excess of aqueous sodium hydroxide.

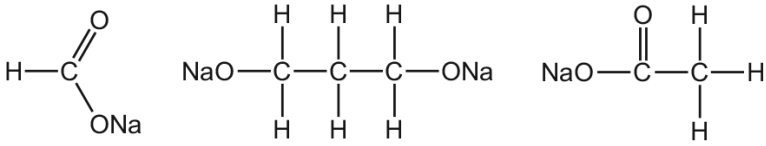


What would the products of this reaction be?

A 

B 

C 

D 

1146. 9701_w18_qp_12 Q: 28

Compound **Y** gives methanol and sodium ethanoate on treatment with aqueous sodium hydroxide.

What is the structure of **Y**?

A $CH_3CO_2CH_3$

B $HCO_2C_2H_5$

C HO_2CCH_2CHO

D $HOCH_2CH_2COOH$

1147. 9701_s17_qp_12 Q: 30

Which compound, when hydrolysed, gives propanoic acid and propan-2-ol?

A $CH_3CH_2CO_2CH_2CH(CH_3)CH_3$

B $(CH_3)_2CHCO_2CH_2CH_3$

C $CH_3CH_2CO_2CH(CH_3)CH_3$

D $CH_3CH_2CH_2CO_2CH(CH_3)CH_3$

1148. 9701_w17_qp_11 Q: 30

A sample of the ester $CH_3CH_2CH_2CO_2CH_2CH_3$ is hydrolysed. The product mixture is then treated with hot, acidified $KMnO_4$.

What are the final carbon-containing products?

A $CH_3CH_2CO_2H$ only

B CH_3CO_2H + $CH_3CH_2CO_2H$

C CH_3CO_2H + $CH_3CH_2CH_2CO_2H$

D CH_3CH_2OH + $CH_3CH_2CH_2CO_2H$

1149. 9701_m16_qp_12 Q: 28

Which mixture could be used to produce propyl methanoate?

A $CH_3CH_2CO_2H$ and CH_3OH

B $CH_3CH_2CH_2CH_2OH$ and HCO_2H

C $CH_3CH_2CH_2OH$ and HCO_2H

D $CH_3CH_2CH_2CO_2H$ and CH_3OH

1150. 9701_m16_qp_12 Q: 30

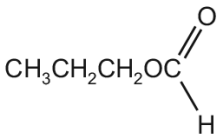
Which row of the table is correct?

	increasing number of carbon atoms ⟶			
A	ethyl methanoate	methyl propanoate	pentyl pentanoate	propyl butanoate
B	ethyl methanoate	methyl propanoate	propyl butanoate	pentyl pentanoate
C	methyl propanoate	propyl butanoate	ethyl methanoate	pentyl pentanoate
D	propyl butanoate	ethyl methanoate	pentyl pentanoate	methyl propanoate

---

1151. 9701_s16_qp_11 Q: 21

The structural formula of compound **X** is shown below.



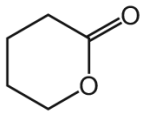
compound **X**

What is the name of compound **X** and how does its boiling point compare with that of butanoic acid?

	name of **X**	boiling point of **X**
A	methyl propanoate	higher than butanoic acid
B	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

1152. 9701_s16_qp_11 Q: 27

Cyclic esters are also known as lactones. *Delta* lactone is used as a solvent and in the manufacture of polyesters.



delta lactone

From which compound could *delta* lactone be made by a single reaction?

A $HOCH_2CH_2CH_2CH_2CHO$

B $HOCH_2CH_2CH_2CH_2CO_2H$

C $HOCH_2CH_2CH_2CH_2CH_2OH$

D $HOCH_2CH_2CH_2CH_2CH_2CO_2H$

1153. 9701_s16_qp_11 Q: 29

The ester $CH_3CH_2CH_2CO_2CH_2CH(CH_3)_2$ was hydrolysed under acidic conditions.

What are the organic products of this hydrolysis?

A butanoic acid and 2-methylpropan-1-ol

B butanoic acid and 2-methylpropan-2-ol

C butan-1-ol and 2-methylpropanoic acid

D propanoic acid and 2-methylpropan-1-ol

1154. 9701_s16_qp_12 Q: 30

Compound X, $C_4H_8O_2$, has an unbranched carbon chain. An aqueous solution of X has an approximate pH of 3.

Compound Y, C_3H_8O, is a secondary alcohol.

X and Y are reacted together in the presence of a little concentrated sulfuric acid to form Z as the major organic product.

What is the structural formula of Z?

A $(CH_3)_2CHCO_2CH_2CH_2CH_3$

B $CH_3(CH_2)_2CO_2CH(CH_3)_2$

C $CH_3(CH_2)_2CO_2(CH_2)_2CH_3$

D $(CH_3)_2CHCO_2CH(CH_3)_2$

1155. 9701_s16_qp_13 Q: 29

The ester, $CH_3CH_2CO_2CH_3$, is hydrolysed by boiling with aqueous sodium hydroxide.

Which compound is one of the products?

A ethanol

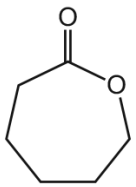
B propan-1-ol

C sodium methanoate

D sodium propanoate

1156. 9701_s16_qp_13 Q: 30

Caprolactone is a cyclic ester. It is being used increasingly for the manufacture of specialist polymers.



caprolactone

From which compound could caprolactone be made by a single reaction?

A $OHCCH_2CH_2CH_2CH_2CHO$

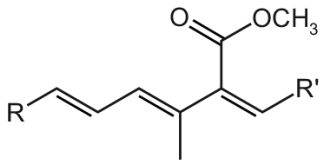
B $HOCH_2CH_2CH_2CH_2CH_2CH_2OH$

C $HOCH_2CH_2CH_2CH_2CH_2CO_2H$

D $HO_2CCH_2CH_2CH_2CH_2CO_2H$

1157. 9701_w16_qp_11 Q: 23

Part of the structure of a fungicide, strobilurin, is shown. R and R' are inert groups.

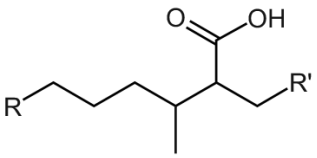


strobilurin

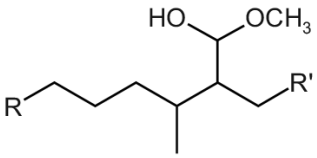
In this reaction, strobilurin is warmed with aqueous sulfuric acid producing compound X. Compound X is then treated with hydrogen in the presence of a nickel catalyst producing compound Y.

What could be the structure of compound Y?

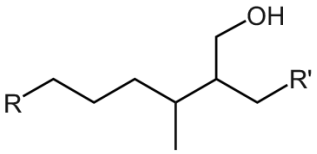
A



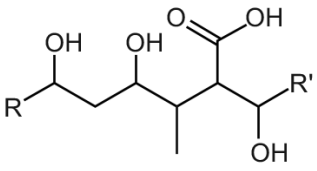
B



C



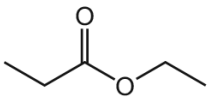
D



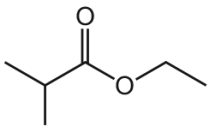
1158. 9701_w16_qp_11 Q: 29

Which formula represents an ester that will form propanoic acid on hydrolysis with dilute sulfuric acid?

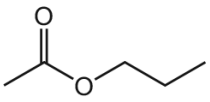
A



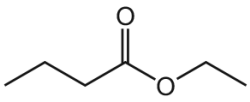
B



C



D



1159. 9701_w16_qp_12 Q: 26

Ethane-1,2-diol, $HOCH_2CH_2OH$, reacts with an excess of ethanoic acid, CH_3CO_2H, in the presence of an acid catalyst. A compound is formed with the molecular formula $C_6H_{10}O_4$.

What is the structure of this compound?

A $CH_3OCOCH_2CH_2CO_2CH_3$

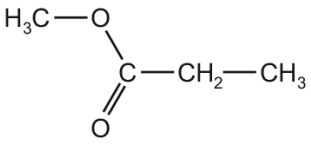
B $CH_3CO_2CH_2CH_2CO_2CH_3$

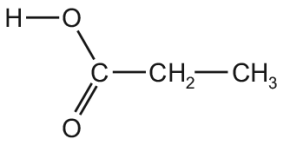
C $CH_3CO_2CH_2CH_2OCOCH_3$

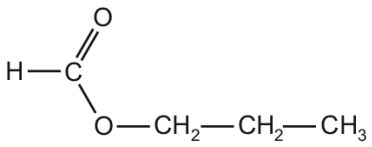
D $HOCH_2CH_2COCH_2OCOCH_3$

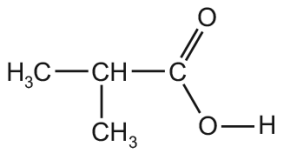
1160. 9701_w16_qp_12 Q: 29

How many of the compounds shown will react with aqueous sodium hydroxide to form the sodium salt of a carboxylic acid?





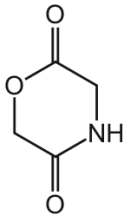




A 1 **B** 2 **C** 3 **D** 4

1161. 9701_s15_qp_11 Q: 21

The cyclic compound M is heated with dilute hydrochloric acid.



compound M

What are the products of the reaction?

A $HOCH_2CO_2H$ and $H_2NCH_2CO_2H$

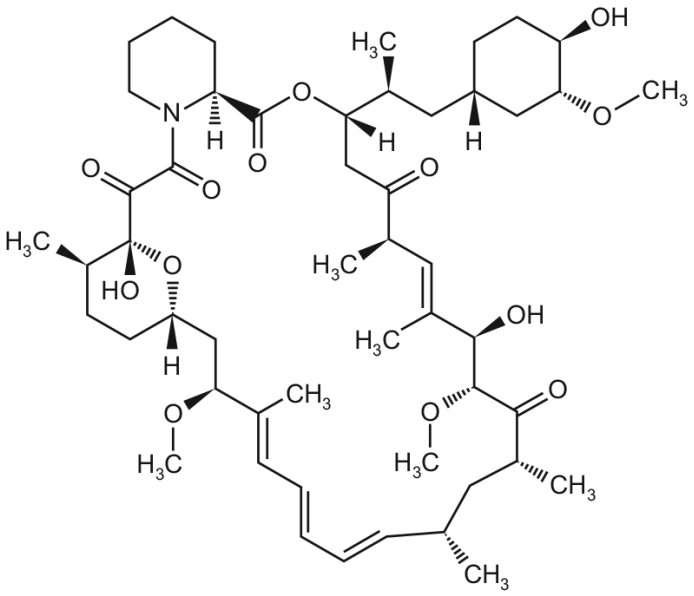
B HO_2CCH_2OH and $HO_2CCH_2NH_3^+$

C H_2NCOCH_2OH and $HOCH_2CHO$

D $HOCH_2CONH_3^+$ and $HOCH_2CHO$

1162. 9701_s15_qp_12 Q: 30

The drug *Sirolimus* is used to treat patients after kidney transplants.

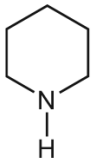


Sirolimus

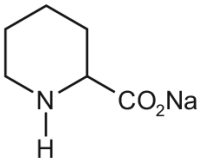
On reaction with hot aqueous sodium hydroxide, *Sirolimus* produces an equimolar mixture of two organic products.

What is the structural formula of the product with the lower relative molecular mass?

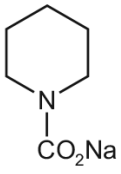
A



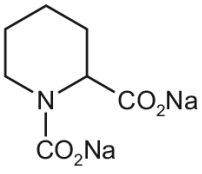
B



C

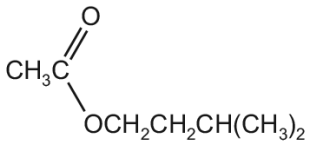


D



1163. 9701_s15_qp_13 Q: 23

An ester P with a fruity odour has the following structural formula.



Which compounds are produced when P is hydrolysed using hydrochloric acid?

A CH_3COCl and $(CH_3)_2CHCH_2CH_2OH$

B CH_3CHO and $(CH_3)_2CHCH_2CH_2OH$

C CH_3CO_2H and $(CH_3)_2CHCH_2CH_2CHO$

D CH_3CO_2H and $(CH_3)_2CHCH_2CH_2OH$

1164. 9701_w15_qp_11 Q: 30

Which compound produces butan-2-ol and ethanoic acid on hydrolysis?

A $CH_3CO_2CH(CH_3)_2$

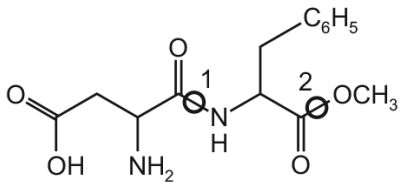
B $CH_3CO_2CH(CH_3)CH_2CH_3$

C $CH_3CH(CH_3)CO_2CH_2CH_3$

D $CH_3CH_2CO_2CH(CH_3)CH_2CH_3$

1165. 9701_w15_qp_12 Q: 30

The structure of aspartame, which is used as an artificial sweetener, is shown.



aspartame

If aspartame is warmed in aqueous alkali, which of bonds 1 and 2 will be broken?

A both bond 1 and bond 2

B bond 1 only

C bond 2 only

D neither bond 1 nor bond 2

Chapter 18

Carboxylic acids and derivatives

STEMUP.CO.UK

18.1 Carboxylic acids

154. 9701_s21_qp_21 Q: 1

Ethanedioic acid, HO_2CCO_2H, has a relative molecular mass of 90.0.

(a) (i) Explain what is meant by the term *relative molecular mass*.

.....

.....

..... [2]

(ii) State the empirical formula of ethanedioic acid.

..... [1]

(iii) Calculate how many atoms of carbon are present in 0.18 g of ethanedioic acid, HO_2CCO_2H.

Show your working.

atoms of carbon present = ... [3]

(b) Solid ethanedioic acid reacts with aqueous calcium ions to make a precipitate of calcium ethanedioate, CaC_2O_4.

CaC_2O_4 breaks down when heated to form calcium oxide, carbon dioxide and carbon monoxide.

(i) Construct an equation to represent the reaction of CaC_2O_4 when heated. Include state symbols.

..... [2]

(ii) Identify the type of reaction which occurs when CaC_2O_4 is heated.

..... [1]

(iii) Identify another compound containing calcium ions which will also produce carbon dioxide and calcium oxide when it is heated.

..... [1]

[Total: 10]

155. 9701_s21_qp_21 Q: 4

Aqueous bromine reacts with methanoic acid to form hydrogen bromide and carbon dioxide gas.

$$Br_2(aq) + HCO_2H(aq) \rightarrow 2HBr(aq) + CO_2(g)$$

The table shows the oxidation numbers of bromine and carbon in the species involved in this reaction.

	Br in Br_2	C in HCO_2H	Br in HBr	C in CO_2
oxidation number	0	+2	–1	+4

(a) Identify the oxidising agent in this reaction. Explain your reasoning with reference to oxidation numbers.

.....

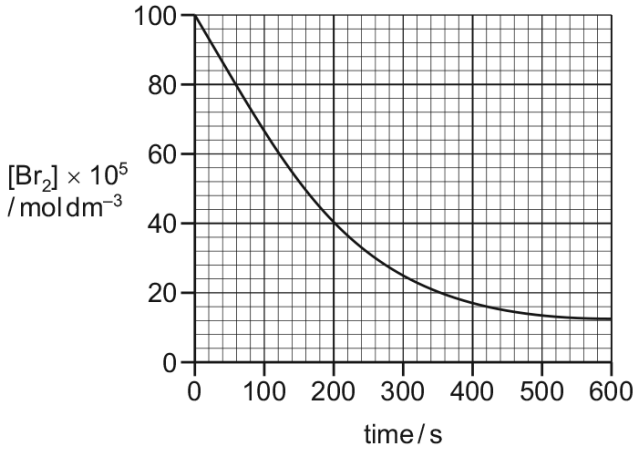
..... [1]

(b) Suggest one change you would observe, ignoring temperature changes, when bromine reacts with methanoic acid.

..... [1]

(c) This reaction can be followed by measuring the concentration of bromine present in the mixture at regular time intervals.

The graph shows the change in concentration of bromine against time in a reaction carried out at 20 °C.



(i) Use the graph to calculate the average rate of reaction at 20 °C during the first 600 s. State the units of this rate of reaction.

average rate of reaction ..... units .....

[2]

The experiment is repeated at a temperature of 40 °C. This relatively small increase in temperature produces a large increase in reaction rate.

(ii) Sketch a graph, on the same axes, to show the expected results when repeating the experiment at 40 °C. [1]

(iii) The rate of reaction increases when the frequency of successful collisions between reactant particles increases.

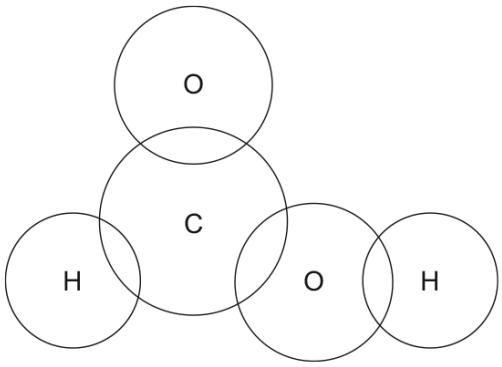
Explain why an increase in temperature produces this effect.

.....

.....

..... [2]

(d) Complete the 'dot-and-cross' diagram, showing outer electrons only, to show the bonding in methanoic acid, HCO_2H.

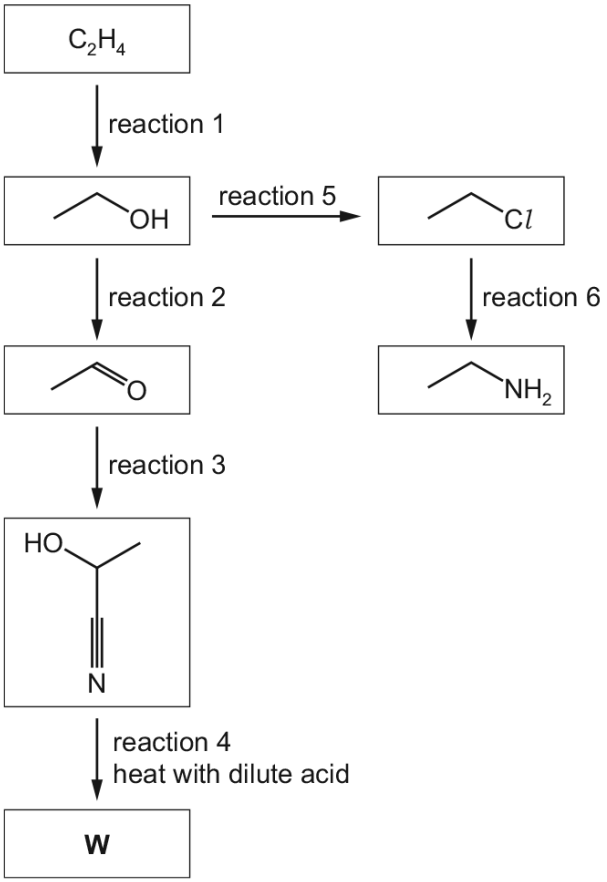


[2]

[Total: 9]

156. 9701_s20_qp_22 Q: 5

The reaction sequence shows how ethene, C_2H_4, can be converted into other organic molecules.



(a) Complete the table to give

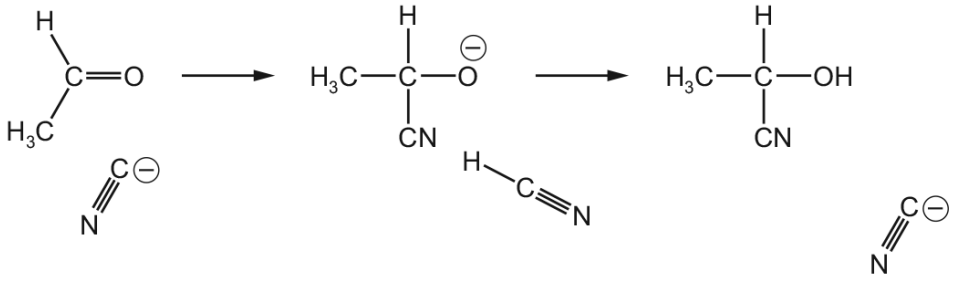
- the name of the reaction mechanisms of reactions 1 and 6
- the reagents and conditions required for reactions 1, 2 and 6.

reaction	name of mechanism	**name** of reagents and conditions
1		
2		
6		

[6]

(b) In reaction 3 the organic molecule reacts with HCN and a KCN catalyst.

(i) Complete the diagram to show the mechanism of the reaction occurring.
Include all relevant dipoles, lone pairs and curly arrows in your answer.



[3]

(ii) Name the functional groups present in the product of reaction 3.

..... [2]

(c) Draw the structure of the organic molecule **W** formed in reaction 4.

[1]

[Total: 12]

157. 9701_w15_qp_22 Q: 4

Halogenoalkanes are useful intermediates in the synthesis of a wide variety of compounds.

(a) 2-bromobutane reacts in two different ways with sodium hydroxide depending on the conditions.

When warmed with aqueous sodium hydroxide, 2-bromobutane produces an alcohol that exists as a pair of optical isomers.

(i) Give the name of the mechanism of the reaction between 2-bromobutane and aqueous sodium hydroxide.

..... [1]

(ii) Explain why the alcohol produced exists as a pair of optical isomers.

.....

..... [1]

(iii) Draw the three-dimensional structure of the two optical isomers of the alcohol produced in **(ii)**.

[2]

Heating 2-bromobutane with ethanolic sodium hydroxide produces a mixture of three alkenes, two of which are a pair of geometrical isomers.

(iv) Give the name of the mechanism of the reaction between 2-bromobutane and ethanolic sodium hydroxide.

..... [1]

(v) Draw and name the structures of the pair of geometrical isomers formed by reaction of 2-bromobutane with ethanolic sodium hydroxide.

name .....

name .....

[2]

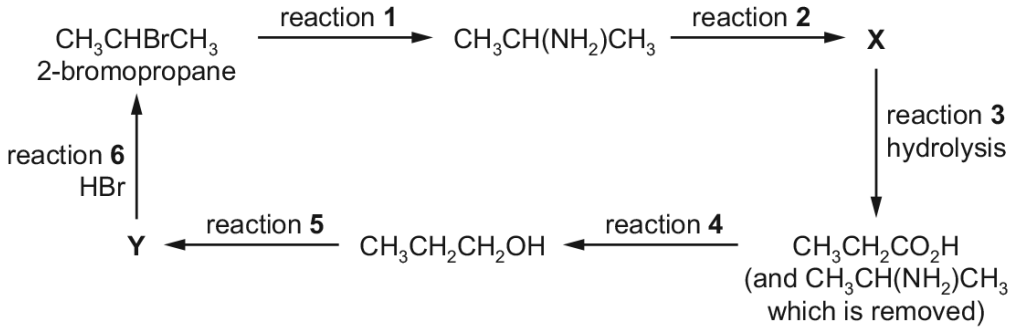
(vi) Name the third alkene produced by reaction of 2-bromobutane with ethanolic sodium hydroxide and explain why it does **not** show geometrical isomerism.

.....

.....

..... [2]

(b) Some reactions involving 2-bromopropane are shown.



(i) State the reagent needed for reaction **1**.

..... [1]

(ii) State the reagent needed for reaction **2**.

..... [1]

(iii) Give the structural formula of **X**.

[1]

(iv) Name the type of reaction involved in reaction **4** and suggest a suitable reagent.

.....

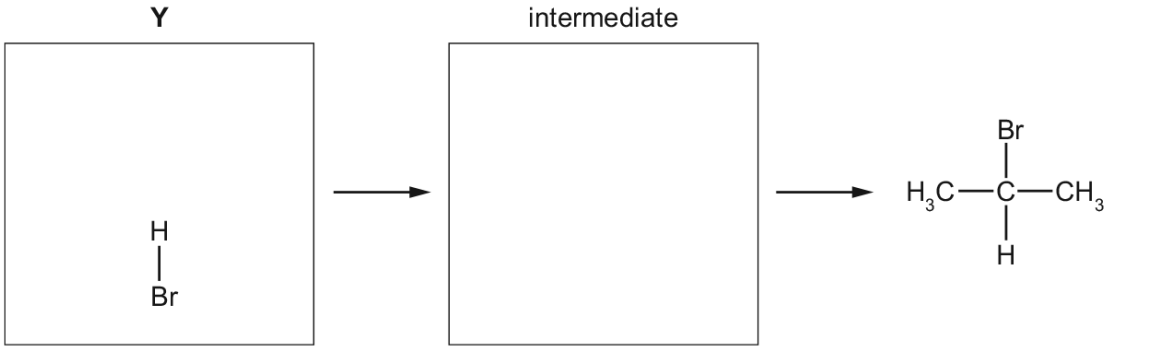
..... [2]

(v) State the name of a solid catalyst for reaction **5**.

..... [1]

(vi) Complete the mechanism for the production of 2-bromopropane from **Y** in reaction **6** shown below.

Include the structure of **Y** and any necessary lone pairs, curly arrows, charges and partial charges.



[4]

(vii) Give the name of the mechanism in **(vi)**.

..... [1]

(viii) 1-bromopropane is a minor product of reaction **6**.

Explain why 2-bromopropane is the major product of reaction **6**.

.....

.....

.....

..... [2]

[Total: 22]

18.2 Esters

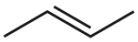
158. 9701_s20_qp_23 Q: 5

C, **D** and **E** are isomers of each other.
They are made by passing an alcohol vapour over an aluminium oxide catalyst.

C



D



E



(a) (i) Name the type of reaction occurring.

..... [1]

(ii) Draw the displayed formula of the alcohol used in this reaction.

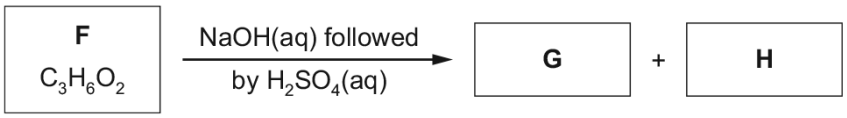
[2]

(iii) Name the isomers **C**, **D** and **E**.

isomer	name
C	
D	
E	

[2]

(b) **F** is an organic molecule which has the molecular formula $C_3H_6O_2$.
When **F** is heated with NaOH(aq) followed by H_2SO_4(aq) the products **G** and **H** are made.



Separate samples of **G** and **H** are added to

- Na_2CO_3(aq)
- sodium metal
- alkaline aqueous iodine.

The observations are described in the table.

reagent(s)	**G**	**H**
Na_2CO_3(aq)	colourless bubbles of gas produced	no visible reaction
Na(s)	colourless bubbles of gas produced	colourless bubbles of gas produced
alkaline aqueous iodine	no visible reaction	yellow precipitate forms

(i) Complete the table to identify the functional groups present in **F**, **G** and **H**.

	functional group
F	
G	
H	

[3]

(ii) Name the yellow precipitate formed when alkaline aqueous iodine reacts with **H**.

..... [1]

(iii) Draw the structures of **G** and **H**.

G	**H**

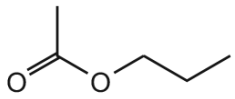
[2]

[Total: 11]

159. 9701_s19_qp_22 Q: 5

Many naturally occurring esters are used as flavourings in food.

(a) The structure of ester **V** is shown.



V

(i) Name **V**.

..... [1]

V reacts with a reagent to form a salt of a carboxylic acid and an alcohol.

(ii) Identify a reagent that could be used in this reaction.

..... [1]

(iii) Draw the displayed formula of the alcohol made during this reaction.

[1]

(iv) State one other possible use for **V**, apart from as a food flavouring.

..... [1]

(b) Ester **W** is made up of 54.5% carbon, 9.1% hydrogen and 36.4% oxygen.

(i) Calculate the empirical formula of **W**.

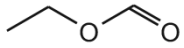
[3]

(ii) State what additional information is required to determine the molecular formula of **W**.

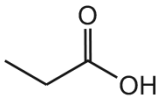
..... [1]

(c) Compounds **X**, **Y** and **Z** are shown. They all have the same molecular formula.

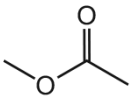
X



Y



Z



(i) Deduce the molecular formula of **X**, **Y** and **Z**.

..... [1]

(ii) In three experiments, sodium is added to separate samples of **X**, **Y** and **Z**.

Complete the table to show the observations for each of these three experiments. Ignore any temperature changes which may occur.

experiment	observations
Na + **X**	
Na + **Y**	
Na + **Z**	

[2]

(d) Sodium carbonate solution reacts with methanoic acid.

Write the equation for this reaction.

..... [1]

[Total: 12]

1.

2-Bromopropane, $(CH_3)_2CHBr$, may be used as the starting point for making $(CH_3)_2CHCO_2H$.

Which of the following sequences would be most suitable?

A $(CH_3)_2CHBr \rightarrow (CH_3)_2CHOH \rightarrow (CH_3)_2CHCO_2H$

B $(CH_3)_2CHBr \rightarrow (CH_3)_2CHCN \rightarrow (CH_3)_2CHCO_2H$

C $(CH_3)_2CHBr \rightarrow (CH_3)_2CHOH \rightarrow (CH_3)_2CHCN \rightarrow (CH_3)_2CHCO_2H$

D $(CH_3)_2CHBr \rightarrow (CH_3)_2CHCN \rightarrow (CH_3)_2CHOH \rightarrow (CH_3)_2CHCO_2H$

[2002 M/J (23)]

2.

A compound **X** has all of the following properties:

it is a liquid at room temperature and atmospheric pressure;

it does not mix completely with water;

it does not decolorise acidified potassium manganate(VII).

What could **X** be?

A ethane

B ethanoic acid

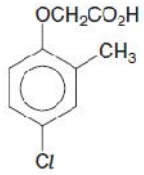
C ethanol

D ethyl ethanoate

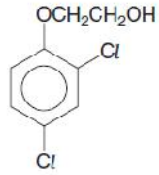
[2002 M/J (27)]

3.

MCPA and 2,4-D are two widely-used selective weedkillers.



MCPA



2,4-D

Which reagent will distinguish MCPA from 2,4-D?

A acidified $AgNO_3(aq)$

B Fehling's solution

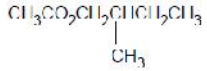
C Na

D $Na_2CO_3(aq)$

[2002 M/J (29)]

4.

An ester with an odour of banana has the following formula.



In which of the following do the substances react together, under suitable conditions, to produce this ester?

A $CH_3CH_2CHCH_2CO_2H + CH_3OH$ (CH3 branch)

B $CH_3CH_2CHCO_2H + CH_3CH_2OH$ (CH3 branch)

C $CH_3CO_2H + CH_3CH_2CHCH_2OH$ (CH3 branch)

D $CH_3CO_2H + CH_3CH_2CHCH_2OH$ (CH3 branch)

[2002 O/N (30)]

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5.

A compound **X** has all of the properties below.

- It is a liquid at 25 °C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could **X** be?

A ethanoic acid

B ethanol

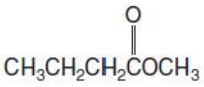
C ethene

D ethyl ethanoate

[2003 O/N (30)]

6.

The flavour of pineapples is partly due to the compound **Q**.



Q

When **Q** is heated under reflux with NaOH(aq) and the mixture distilled, what compounds will be found in the distillate?

1 CH_3OH

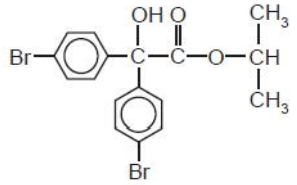
2 $CH_3CH_2CH_2CO_2Na$

3 $CH_3CH_2CH_2OH$

[2003 O/N (40)]

7.

Acarol is sold as an insecticide for use on fruit and vegetables.



Acarol

The final stage of its manufacture is an esterification.

Which alcohol is used to form the ester?

A di(4-bromophenyl)methanol

B methanol

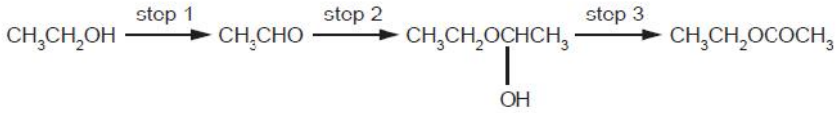
C propan-1-ol

D propan-2-ol

[2004 O/N (30)]

8.

Ethyl ethanoate is a very important solvent in industry. Currently, researchers are investigating ways of producing the ester from cheap, low grade ethanol by the following process.



What types of reaction are steps 1 and 3?

	step 1	step 3
A	elimination	esterification
B	elimination	isomerisation
C	oxidation	esterification
D	oxidation	oxidation

[2005 M/J (25)]

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9.
Which compound reacts with its own oxidation product (an oxidation which involves no loss of carbon) to give a sweet-smelling liquid?

A propanal

B propanoic acid

C propanone

D propan–1–ol

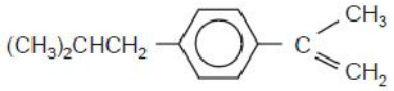
[2005 M/J (27)]

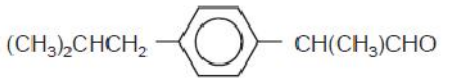
10.
Ibuprofen is an anti-inflammatory drug.

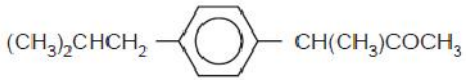


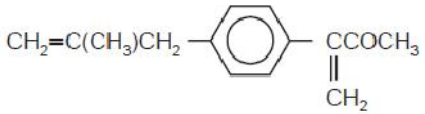
ibuprofen

What reaction would lead to its formation?

A  + hot concentrated $KMnO_4$

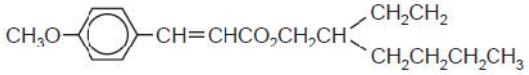
B  + warm acidified $K_2Cr_2O_7$

C  + warm $H_2SO_4(aq)$

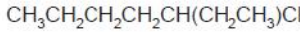
D  + H_2 / Pt catalyst

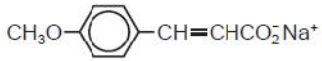
[2005 M/J (29)]

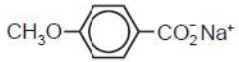
11.
A sun protection cream contains the following ester as its active ingredient.



What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

1 

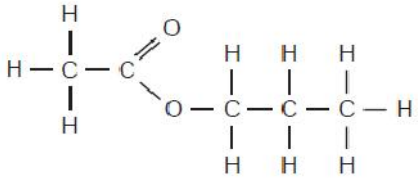
2 

3 

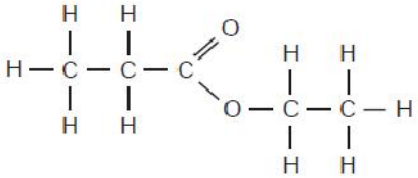
[2005 M/J (40)]

12.
What is the structure of the ester formed from propanoic acid and ethanol?

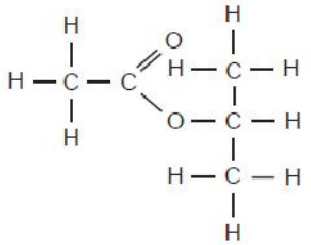
A



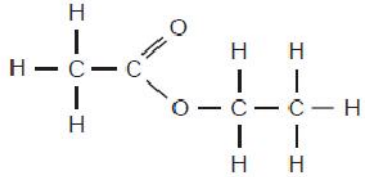
B



C



D

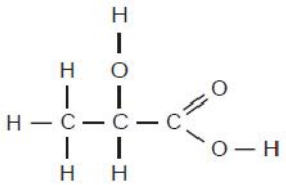


[2005 O/N (28)]

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13.
Lactic acid occurs naturally, for example in sour milk.

Its displayed formula is shown.



Which reaction occurs with lactic acid?

A It decolourises aqueous bromine rapidly.

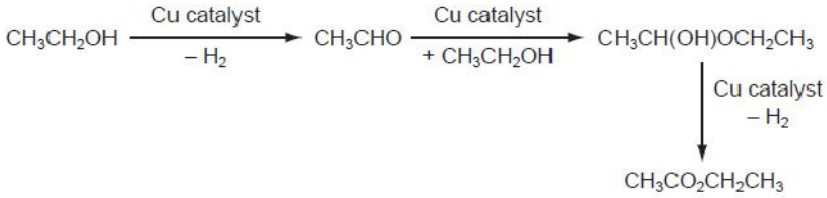
B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

[2005 O/N (29)]

14.
A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.



Which process is involved at some stage in this reaction sequence?

A disproportionation

B electrophilic addition

C nucleophilic addition

D reduction

[2006 M/J (20)]

15.
Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2Na^+$

[2006 M/J (30)]

16.
Which statements about lactic acid, $CH_3CH(OH)CO_2H$, are correct?

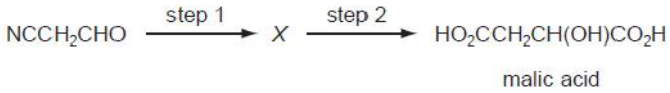
1 Lactic acid forms optical isomers.

2 Two hydrogen atoms per lactic acid molecule can be involved in hydrogen bonding.

3 Lactic acid would form an aldehyde when oxidised by acidified potassium dichromate(VI).

[2006 M/J (40)]

17.
Apples, the fruit of trees of the genus *Malus*, are rich in malic acid. Malic acid may be synthesised in the laboratory in two steps.



Which reagents could be used for this synthesis?

	step 1	step 2
A	HC*l*(aq)	HCN(g)
B	HCN, NaCN(aq/alcoholic)	H_2SO_4(aq)
C	H_2SO_4(aq)	$K_2Cr_2O_7/H_2SO_4$(aq)
D	KCN(aq/alcoholic)	HC*l*(aq)

[2006 O/N (29)]

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18.

Which pair of compounds is formed when the ester $C_2H_5CO_2CH_3$ is boiled with aqueous sodium hydroxide?

A $C_2H_5CO_2H$ CH_3OH

B $C_2H_5CO_2Na$ CH_3ONa

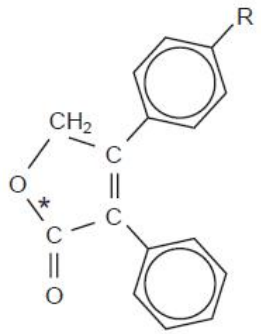
C $C_2H_5CO_2Na$ CH_3OH

D C_2H_5OH CH_3CO_2Na

[2006 O/N (30)]

19.

Rofecoxib, an efficient drug against arthritis, has the following structure. R is an inert group.



Which reactions are possible with this structure?

1 The bond marked * is hydrolysed by heating with aqueous sodium hydroxide.

2 Aqueous bromine is decolourised.

3 An orange precipitate is formed with 2,4-dinitrophenylhydrazine reagent.

[2006 O/N (40)]

20.

Which reagent could be used to convert $CH_3CO_2CH_3$ into $ClCH_2CO_2CH_3$?

A concentrated hydrochloric acid at 100 °C

B phosphorus pentachloride at room temperature

C sulphur dichloride oxide (thionyl chloride, $SOCl_2$) at 50 °C

D chlorine in bright sunlight at 100 °C

[2007 M/J (21)]

21.

Which formula represents the organic compound formed by the reaction of propanoic acid with methanol in the presence of concentrated sulphuric acid as a catalyst?

A $CH_3CH_2COCH_3$

B $CH_3CH_2CO_2CH_3$

C $CH_3CO_2CH_2CH_3$

D $CH_3CH_2CH_2CO_2CH_3$

[2007 M/J (30)]

22.

Fats and grease that build up on pans used in cooking are esters. Pans which are dirty from fats or grease may be cleaned by heating them with a reagent that will react with the ester group.

What may be used to clean such pans by this reaction?

1 vinegar - aqueous ethanoic acid, CH_3CO_2H

2 alcohol - ethanol, C_2H_5OH

3 baking powder - sodium hydrogencarbonate, $NaHCO_3$

[2007 M/J (40)]

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23.

The ester $CH_3CH_2CH_2CO_2CH_3$ is responsible for the aroma of apples.

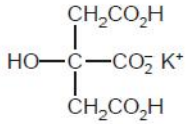
When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

A CH_4O **B** C_2H_4O **C** $C_2H_4O_2$ **D** $C_3H_7O_2$

[2007 O/N (30)]

24.

Monopotassium citrate is used as an emulsifying agent in powdered milk and in powdered soups. It may be represented by the formula shown.



Which statements about monopotassium citrate are correct?

1 It can form optical isomers.

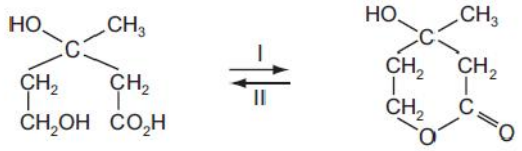
2 It can act as a dibasic acid.

3 It can form esters with both acids and alcohols.

[2007 O/N (40)]

25.

Mevalonic acid, 3,5-dihydroxy-3-methylpentanoic acid, is involved in cholesterol formation in the body. It is an oil that occurs as a mixture of the two interchanging molecules shown in the diagram.



What names are used to describe the pair of interchanging reactions I and II?

A condensation and addition

B dehydrogenation and hydrogenation

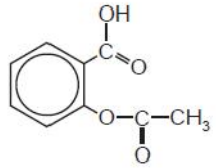
C esterification and hydrolysis

D neutralisation and acidification

[2008 M/J (24)]

26.

Aspirin is a widely-available pain-killer, whose properties have been known for centuries. The structure of aspirin is shown.



Which functional groups are present in aspirin?

1 alcohol

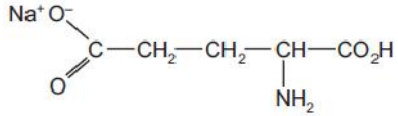
2 carboxylic acid

3 ester

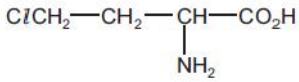
[2008 M/J (37)]

27.

The structure of monosodium glutamate, a flavour enhancer, is shown.



It may be prepared starting from the following compound.



Which set of reagents and reaction conditions could be used to prepare monosodium glutamate?

1 Heat under reflux with ethanolic KCN followed by hydrolysis with NaOH(aq).

2 Heat with sodium methanoate, $HCO_2^-Na^+$.

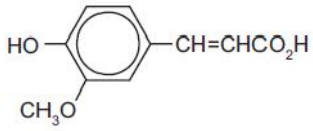
3 Heat under reflux with NaOH(aq).

[2008 M/J (38)]

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28.

Ferulic acid is an antioxidant that occurs widely in plants.



ferulic acid

Which reagents can react with the –CH=CHCO$_2$H part of the molecule?

1 NaOH(aq)

2 acidified $KMnO_4$

3 HBr

[2008 M/J (40)]

29.

Ethyl phenylethanoate, $C_6H_5CH_2CO_2C_2H_5$, gives a characteristic flowery aroma to honey.

Which sequence of reagents, with heating in each case, leads to the preparation of $C_6H_5CH_2CO_2C_2H_5$ from $C_6H_5CH_2Br$?

A $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5COCl}$

B $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5CO_2H,\ conc.\ H_2SO_4}$

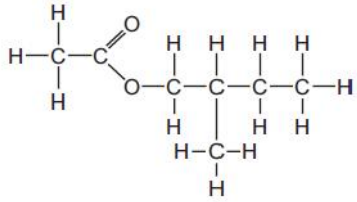
C $C_6H_5CH_2Br \xrightarrow{NaCN(alcoholic)} \xrightarrow{H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

D $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{conc.\ MnO_4^-,\ H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

[2008 O/N (26)]

30.

Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone. When disturbed, individual bees on guard will raise their abdomen and emit the alarm pheromone, fanning their wings to aid its dispersal. This alerts other bees to a danger and makes them ready to sting when required.



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

[2008 O/N (28)]

31.

Use of the Data Booklet is relevant to this question.

Ethyl ethanoate can be obtained from ethanoic acid and ethanol by the following reaction.

$$CH_3CH_2OH + CH_3CO_2H \rightleftharpoons CH_3CO_2CH_2CH_3 + H_2O$$

Ethanol (30 g) and ethanoic acid (30 g) are heated under reflux together, and 22 g of ethyl ethanoate are obtained.

What is the yield of the ester?

A 25% **B** 38% **C** 50% **D** 77%

[2008 O/N (30)]

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32.

Trichloroethanoic acid, CCl_3CO_2H, is used in cosmetic surgery to perform a 'chemical peel' to remove dead skin.

Trichloroethanoic acid can be made by reacting chlorine with ethanoic acid.

What is the mechanism of this reaction?

A electrophilic addition

B electrophilic substitution

C free radical addition

D free radical substitution

[2009 M/J (22)]

33.

Which ester is formed when the alcohol CH_3CH_2OH is reacted with $CH_3CH_2CH_2CO_2H$?

A ethyl propanoate

B ethyl butanoate

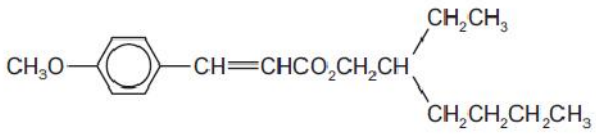
C propyl ethanoate

D butyl ethanoate

[2009 M/J (27)]

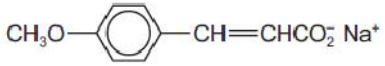
34.

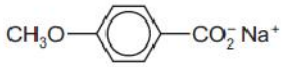
A sun protection cream contains the following ester as its active ingredient.



What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

1 $CH_3CH_2CH_2CH_2CH(CH_2CH_3)CH_2OH$

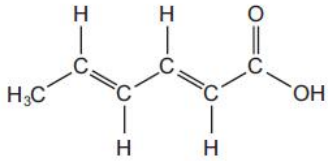
2 

3 

[2009 M/J (40)]

35.

Sorbic acid is used as a food preservative because it kills fungi and moulds.



sorbic acid

Sorbic acid will react with

- hydrogen in the presence of a nickel catalyst,
- bromine in an organic solvent.

How many moles of hydrogen and of bromine will be incorporated into one mole of sorbic acid by these reactions?

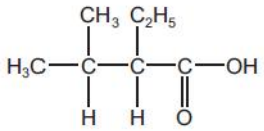
	moles of hydrogen	moles of bromine
A	2	2
B	2	$2\frac{1}{2}$
C	3	2
D	3	$2\frac{1}{2}$

[2009 O/N-11 (24)]

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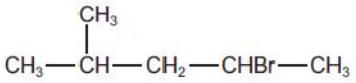
36.

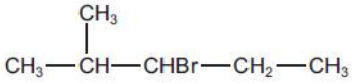
The characteristic odour of rum is attributed to the compound 2-ethyl-3-methylbutanoic acid.

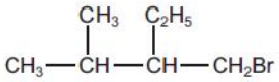


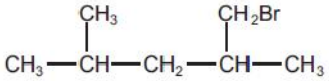
2-ethyl-3-methylbutanoic acid

Which compound will produce 2-ethyl-3-methylbutanoic acid by heating under reflux with alcoholic sodium cyanide and subsequent acid hydrolysis of the reaction product?

A 

B 

C 

D 

[2009 O/N-11 (29)]

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Carboxylic acids and derivatives - 2021

1. Nov/2020/Paper_42/No.6a-6c

(a) Ethanoic acid, CH_3CO_2H and trichloroethanoic acid, CCl_3CO_2H, are both carboxylic acids. Ethanoic acid can be used to make ethanamide, CH_3CONH_2.

Place these three compounds in order of acidity, starting with the **least** acidic.
Explain your answer.

..... < ..... < .....

least acidic most acidic

.....

.....

.....

.....

.....

[3]

(b) Methanoic acid, HCO_2H, and ethanedioic acid, HO_2CCO_2H, are two other carboxylic acids.

(i) State which, if any, of ethanoic acid, methanoic acid and ethanedioic acid will react with Fehling's reagent.

..... [1]

(ii) State which, if any, of ethanoic acid, methanoic acid and ethanedioic acid will react with warm acidified manganate(VII) ions.

..... [1]

(c) Ethanamide can be made from ethanoic acid in a two-step synthesis.

ethanoic acid $\xrightarrow{\text{step 1}}$ **A** $\xrightarrow{\text{step 2}}$ ethanamide

(i) Compound **A** contains chlorine.

Give the structural formula and name of **A**.

structural formula .....

name .....

[2]

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(ii) Suggest suitable reagents for steps 1 and 2.

step 1 .....

step 2 .....

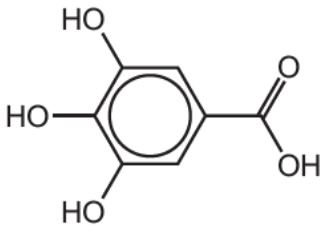
[2]

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2. March/2020/Paper_42/No.5a

Gallic acid, $C_7H_6O_5$, is a naturally occurring aromatic molecule.

gallic acid



(a) Gallic acid contains the carboxylic acid and phenol functional groups.

State and explain the relative acid strength of these two functional groups.

.....

.....

.....

..... [2]

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3. June/2020/Paper_41/No.6a,6c-6d

(a) Compare and explain the relative acidities of 2-chloropropanoic acid, 3-chloropropanoic acid, and propanoic acid. Explain your answer.

..... > ..... > .....

most acidic least acidic

explanation .....

.....

.....

.....

.....

.....

[3]

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(c) Three tests were carried out on separate samples of the organic acids shown in the table.
The following results were obtained.
✓ = observed change
✗ = no observed reaction

test	reagent(s) and conditions	HCO_2H	CH_3COCO_2H	HO_2CCO_2H	observed change
1	....	✓	✗	✗	
2	....	✗	✓	✗	
3	....	✓	✗	✓	

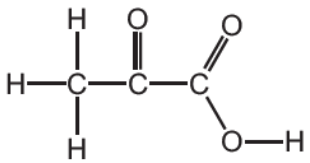
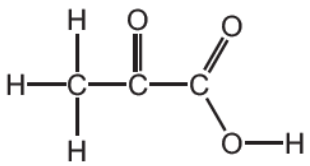
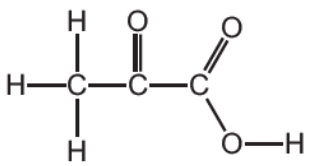
Complete the table with the reagent(s) and conditions and the observed change for each test.
Assume these organic acids all have a similar acid strength. [5]

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(d) A sample of pyruvic acid, CH_3COCO_2H, is analysed by carbon-13 NMR spectroscopy. Three peaks are observed.

Complete the table by:

- circling the carbon atom responsible for the chemical shift
- stating the hybridisation of the circled carbon atom.

chemical shift (δ)	carbon atom responsible for chemical shift	hybridisation of the circled carbon atom
27		
163		
192		

[2]

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Carboxylic acids and derivatives - 2021

1. June/2021/Paper_41/No.6

(a) Compare and explain the relative acidities of butanoic acid, ethanol, ethanoic acid and water.

..... > ..... > ..... > .....

most acidic least acidic

.....

.....

.....

.....

.....

..... [4]

(b) Three carboxylic acids, methanoic acid, HCO_2H, ethanedioic acid, HO_2CCO_2H, and butanedioic acid, $HO_2CCH_2CH_2CO_2H$, are compared. Two tests were carried out on separate samples of each organic acid, as shown.

The following results were obtained. ✓ = observed change ✗ = no observed reaction

test	reagents and conditions	HCO_2H	HO_2CCO_2H	$HO_2CCH_2CH_2CO_2H$	observed change
1		✓	✗	✗	
2		✓	✓	✗	

(i) Complete the table with the reagents and conditions and the observed change for a positive test.
Assume these organic acids all have a similar acid strength. [3]

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(ii) Each compound, HCO_2H, HO_2CCO_2H and $HO_2CCH_2CH_2CO_2H$, is dissolved seperately in $CDCl_3$. Proton (^1H) NMR and carbon-13 (^{13}C) NMR spectra are then obtained.

Complete the table.

compound	number of peaks in proton NMR	number of peaks in carbon-13 NMR
HCO_2H		
HO_2CCO_2H		
$HO_2CCH_2CH_2CO_2H$		

[2]

(iii) The proton NMR spectrum of HCO_2H in D_2O is obtained.

Describe and explain the difference observed between this spectrum and the proton NMR spectrum of HCO_2H in **(b)(ii)**.

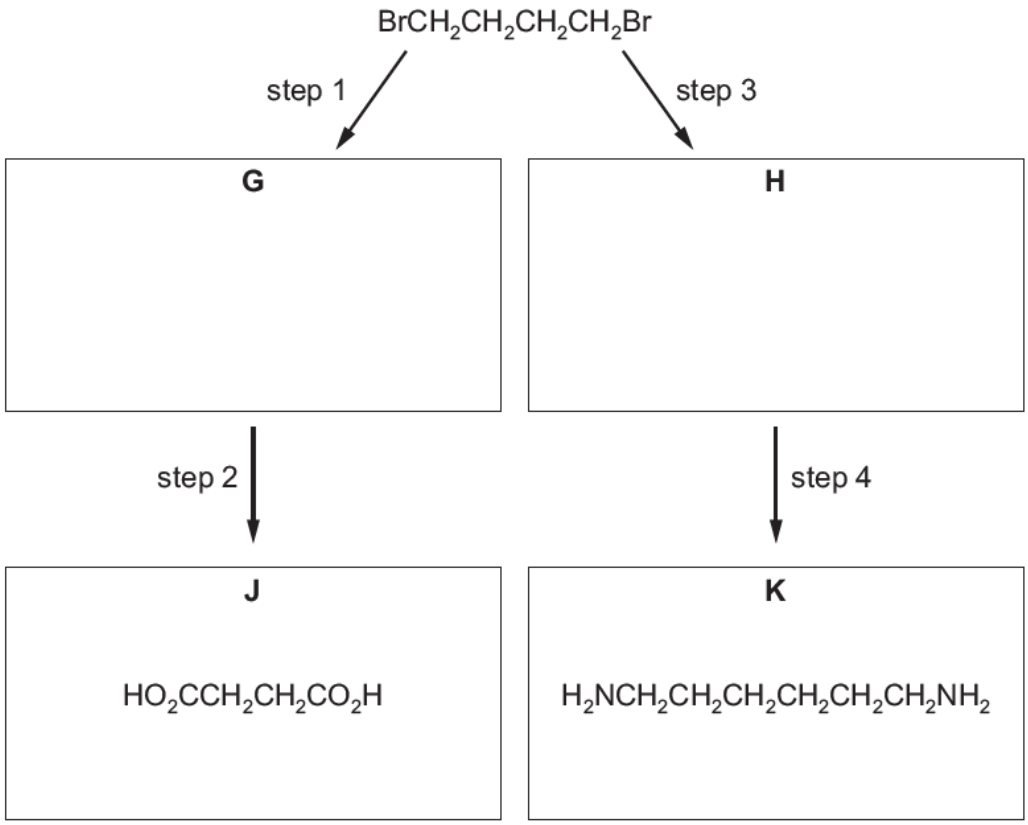
.....

.....

..... [1]

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(c) 1,4-dibromobutane, $Br(CH_2)_4Br$, is used in the synthesis of the dicarboxylic acid **J** and diamine **K** as shown.



(i) Draw the structures of **G** and **H** in the boxes. [2]

(ii) Suggest reagents and conditions for each of steps 1 to 4.

step 1 .....

step 2 .....

step 3 .....

step 4 .....

[4]

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(d) Polyamide **L** can be synthesised from dicarboxylic acid **J**, $HO_2C(CH_2)_2CO_2H$, and diamine **K**, $H_2N(CH_2)_6NH_2$.

Draw the repeat unit of the polymer formed in the box. Any functional groups should be shown displayed.

polyamide **L**

[2]

[Total: 18]

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2. June/2021/Paper_42/No.8

(a) State and explain the relative rate of hydrolysis of acyl chlorides, alkyl chlorides and aryl chlorides.

..... > ..... > .....

fastest slowest

.....

.....

.....

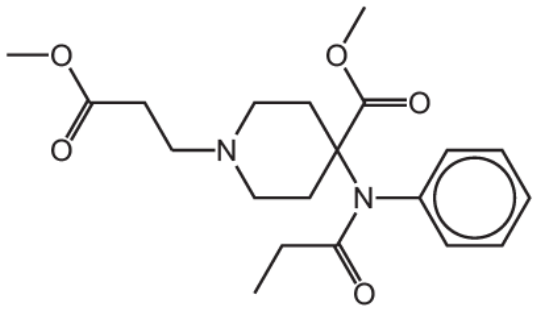
.....

..... [3]

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(b) The drug remifentanil is shown.

remifentanil



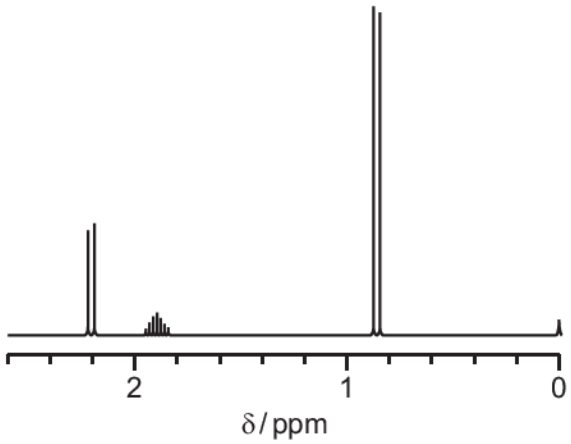
Remifentanil is **completely** hydrolysed under acidic conditions. Three different organic compounds are formed.

Draw the structures for these organic compounds in the boxes.

[3]

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(c) Compound **Y**, $C_5H_{10}O_2$, reacts with $Na_2CO_3(aq)$ to evolve bubbles of gas. The proton (^1H) NMR spectrum of compound **Y** in D_2O is shown.



(i) Use this information to suggest a structure for **Y**.

[1]

(ii) Use the *Data Booklet*, the proton (^1H) NMR spectrum and your answer to **(c)(i)** to complete the table.

chemical shift (δ)	environment of proton	splitting pattern	number of ^1H atoms responsible for the peak
0.95			
1.90			
2.20			

[3]

[Total: 10]

STEMUP.CO.UK

1. June/2022/Paper_41/No.5

(a) Compare the relative acidities of benzoic acid (C_6H_5COOH), phenylmethanol ($C_6H_5CH_2OH$), and phenol (C_6H_5OH).
Explain your reasoning.

..... > ..... > .....
most acidic least acidic

.....

.....

.....

.....

.....

[3]

(b) A series of nine separate experiments is carried out as shown in Table 5.1.

Complete the table by placing a tick (✓) in the relevant box if a reaction occurs. Place a cross (✗) in the box if no reaction occurs.

Table 5.1

	benzoic acid	phenylmethanol	phenol
Na(s)			
NaOH(aq)			
Na_2CO_3(aq)			

[3]

STEMUP.CO.UK

(c) (i) Benzoyl chloride, C_6H_5COCl, can be synthesised by the reaction of benzoic acid with either PCl_5 or $SOCl_2$.

Complete the equations for these reactions.

reaction 1 $C_6H_5COOH + PCl_5 \rightarrow C_6H_5COCl +$ ..... + ...

reaction 2 $C_6H_5COOH + SOCl_2 \rightarrow C_6H_5COCl +$ ..... + ...

[1]

(ii) Use your answer to **(c)(i)** to suggest why it is easier to isolate, in a pure form, the C_6H_5COCl from reaction 2 compared to reaction 1.

.....

..... [1]

(d) Benzoyl chloride is hydrolysed by water at room temperature to form benzoic acid.

(i) Complete the diagram to show the mechanism for the reaction between C_6H_5COCl and H_2O.

Include charges, dipoles, lone pairs of electrons and curly arrows as appropriate.



[4]

(ii) Name the type of mechanism you showed in **(d)(i)**.

..... [1]

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(e) Acyl chlorides react with sodium carboxylates to form acid anhydrides as shown in Fig. 5.1.

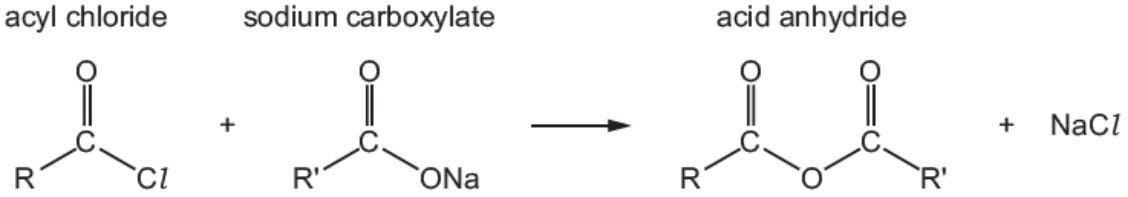


Fig. 5.1

The condensation polymers, polyanhydride and polyester, are formed by similar methods.

The repeat unit for a polyanhydride is shown in Fig. 5.2.

polyanhydride

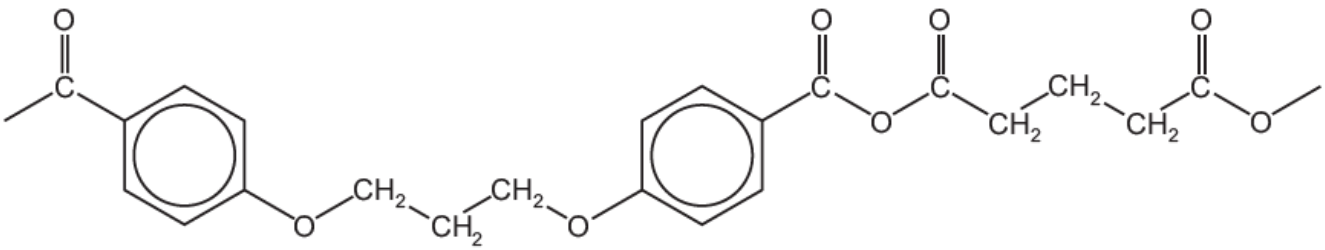


Fig. 5.2

(i) Use Fig. 5.1 and Fig. 5.2 to suggest the structures of the two monomers used to make this polyanhydride.

[2]

(ii) Polyanhydrides are biodegradable polymers.

Suggest how this polyanhydride can be degraded.

.....

..... [1]

[Total: 16]

STEMUP.CO.UK

2. June/2022/Paper_42No.8

(a) Compare the relative acidities of ethanol, ethanoic acid, chloroethanoic acid and phenol. Explain your reasoning.

..... > ..... > ..... > .....
most acidic least acidic

.....

.....

.....

.....

.....

.....

[4]

(b) An excess of ethanedioic acid, HOOCCOOH(aq), is reacted with warm acidified $KMnO_4$(aq).

State the type of reaction undergone by ethanedioic acid.
Describe what you would observe.
Write an equation for this reaction.

Your equation can use [O] or [H] as necessary.

type of reaction .....

observations .....

equation .....

[2]

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(c) A section of a polyester is shown.

polyester

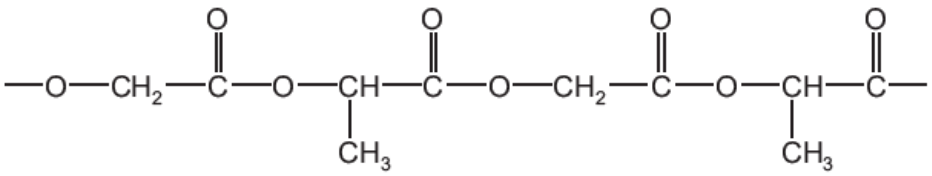


Fig. 8.1

Draw the structures of the two monomers that form this polyester.

[2]

(d) Serine can polymerise to form two different types of condensation polymer; a polyester and a polypeptide.

serine

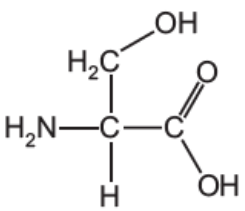


Fig. 8.2

Draw the structure of the polypeptide showing **two** repeat units. The peptide linkage should be shown displayed.

[2]

(e) Explain why condensation polymers normally biodegrade more readily than addition polymers.

.....

..... [1]

[Total: 11]

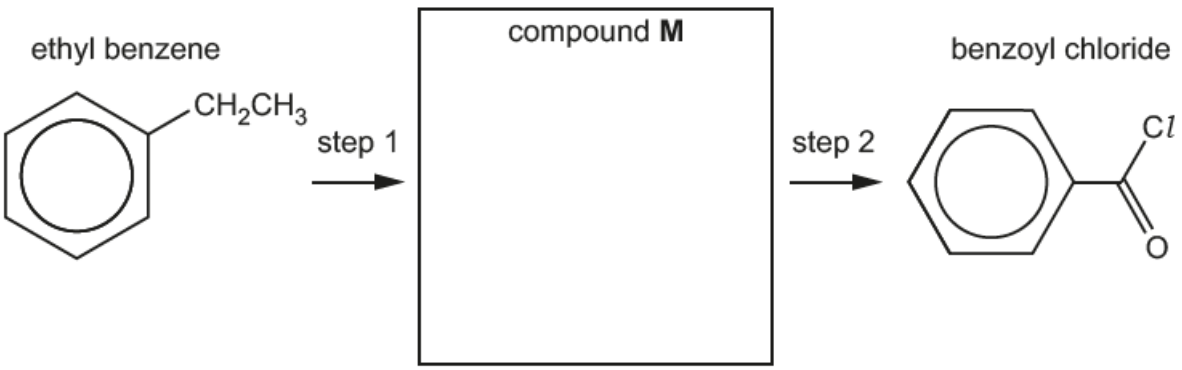
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Carboxylic acids and derivatives - 2023 A2 Chemistry 9701

1. Nov/2023/Paper_9701/41/No.9

(a) Benzoyl chloride, C_6H_5COCl, can be made from ethyl benzene in a two-step process.

A reaction scheme is shown.



(i) Draw the intermediate organic compound **M** in the box. [1]

(ii) Suggest suitable reagents and conditions for step 1 and step 2.

step 1 .....

step 2 .....

[2]

(iii) Identify the type of reaction in step 1 and step 2.

step 1 .....

step 2 .....

[2]

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(b) C_6H_5COCl reacts with phenol, C_6H_5OH, to give the ester phenyl benzoate, $C_6H_5COOC_6H_5$.

An incomplete description of the mechanism of this reaction is shown in Fig. 9.1.

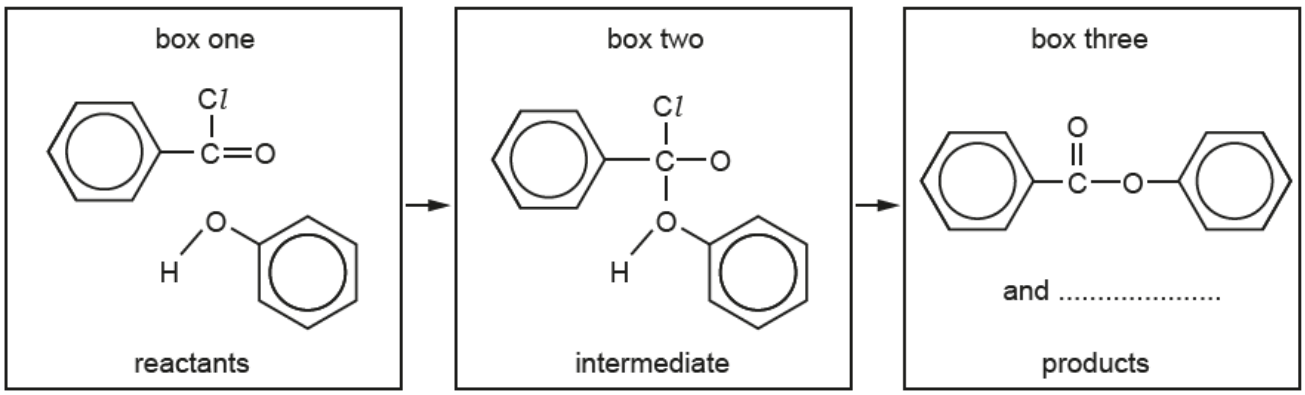


Fig. 9.1

(i) Complete the mechanism in Fig. 9.1 and include:

- all relevant dipoles (δ+ and δ–) and full electric charges (+ and –) on the species in box one and in box two
- all relevant lone pairs on the species in box one and in box two
- all relevant curly arrows to show the movement of electron pairs in box one and in box two
- the formula of the second product in box three.

[4]

(ii) Name this mechanism.

..... [1]

(c) Benzoyl chloride, chlorobenzene and chloroethane differ in their rates of hydrolysis when each compound is added separately to water at 25 °C.

Suggest the relative ease of hydrolysis of these three compounds.

Explain your answer.

....
hardest to hydrolyse easiest to hydrolyse

explanation .....

.....

.....

.....

.....

[3]

[Total: 13]

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2. June/2023/Paper_9701/41/No.6(a, b)

(a) Compound **H** has the structural formula $CH_2=CHCH(NH_2)COOH$.

(i) Name all the functional groups in **H**.

.....

..... [2]

(ii) Compound **H** exhibits stereoisomerism.

Draw three-dimensional structures for the two stereoisomers of **H**.
Name this type of stereoisomerism.

type of stereoisomerism .....
[2]

(b) Compound **H** can be prepared from the reaction of **J** with an excess of hot aqueous acid.

J

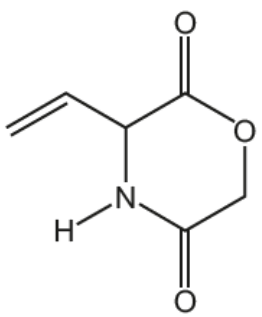
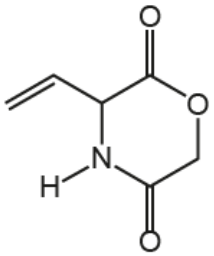


Fig. 6.1

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(i) Complete Fig. 6.2 to show the equation for this reaction.



+ → CH_2=CHCH(NH_2)COOH +

Fig. 6.2

[1]

(ii) Name the type of reaction in **(b)(i)**.

..... [1]

3. June/2023/Paper_9701/42/No.5(d)

(d) Acyl bromides, RCOBr, can be synthesised by the reaction of a carboxylic acid and $SOBr_2$.

This is a similar reaction to the synthesis of acyl chlorides using $SOCl_2$.

(i) Give an equation for the reaction between ethanoic acid and $SOBr_2$.

..... [1]

(ii) Suggest the relative ease of hydrolysis of acyl bromides, RCOBr, acyl chlorides, RCOCl, and alkyl chlorides, RCl.

Explain your answer.

..... > ..... > .....
easiest to hydrolyse hardest to hydrolyse

.....

.....

.....

.....

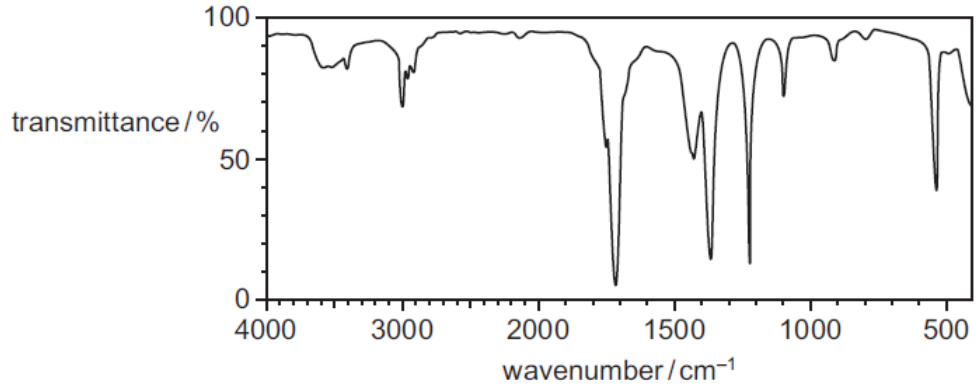
.....
[3]

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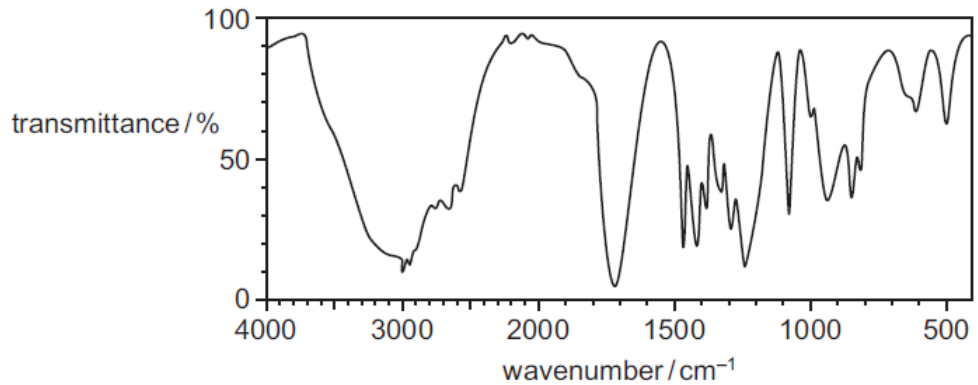
1. Nov/2021/Paper_11/No. 30

The infra-red spectra of three organic compounds are shown.

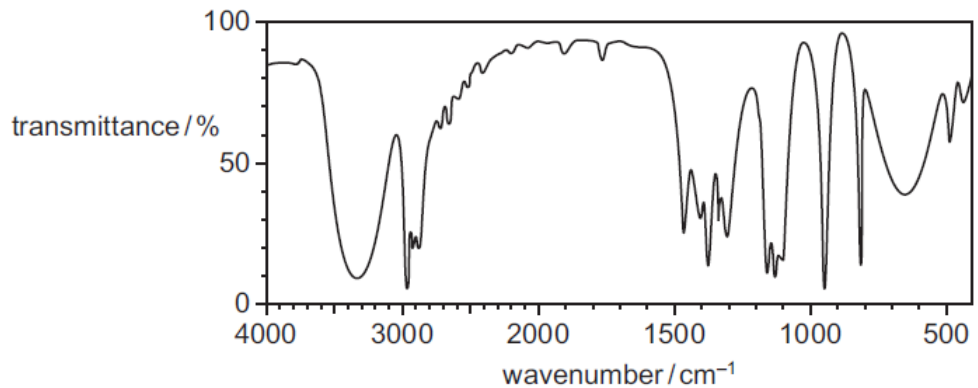
spectrum 1



spectrum 2



spectrum 3



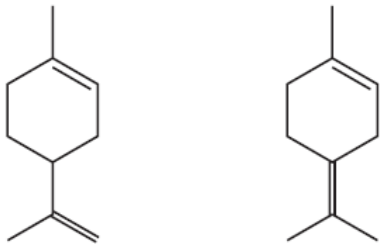
What could the three compounds be?

	spectrum 1	spectrum 2	spectrum 3
A	propanoic acid	propanone	propan-2-ol
B	propanone	propanoic acid	propan-2-ol
C	propanone	propan-2-ol	propanoic acid
D	propan-2-ol	propanoic acid	propanone

2. Nov/2021/Paper_11/No. 37

A diketo acid is a compound with two ketone groups and one carboxylic acid group.

limonene terpinolene



Which statements about the reactions of limonene and terpinolene are correct?

1 When reacted with an excess of hydrogen and a nickel catalyst, limonene and terpinolene produce the same compound.

2 An excess of hot concentrated acidified $KMnO_4$ reacts with limonene and with terpinolene to form different diketo acids.

3 The reactions of limonene and terpinolene with an excess of Br_2 produce positional isomers with the same number of chiral carbon atoms.

The responses **A** to **D** should be selected on the basis of

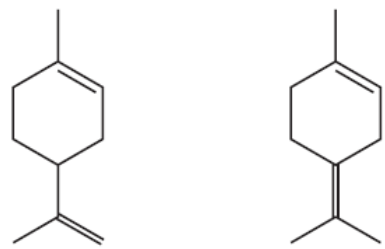
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

3. Nov/2021/Paper_13/No. 37

A diketo acid is a compound with two ketone groups and one carboxylic acid group.

limonene terpinolene



Which statements about the reactions of limonene and terpinolene are correct?

1 When reacted with an excess of hydrogen and a nickel catalyst, limonene and terpinolene produce the same compound.

2 An excess of hot concentrated acidified $KMnO_4$ reacts with limonene and with terpinolene to form different diketo acids.

3 The reactions of limonene and terpinolene with an excess of Br_2 produce positional isomers with the same number of chiral carbon atoms.

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The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

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4. March/2021/Paper_12/No. 29

Which reaction gives butanoic acid as one of its products?

A acid hydrolysis of butyl ethanoate

B alkaline hydrolysis of butyl ethanoate

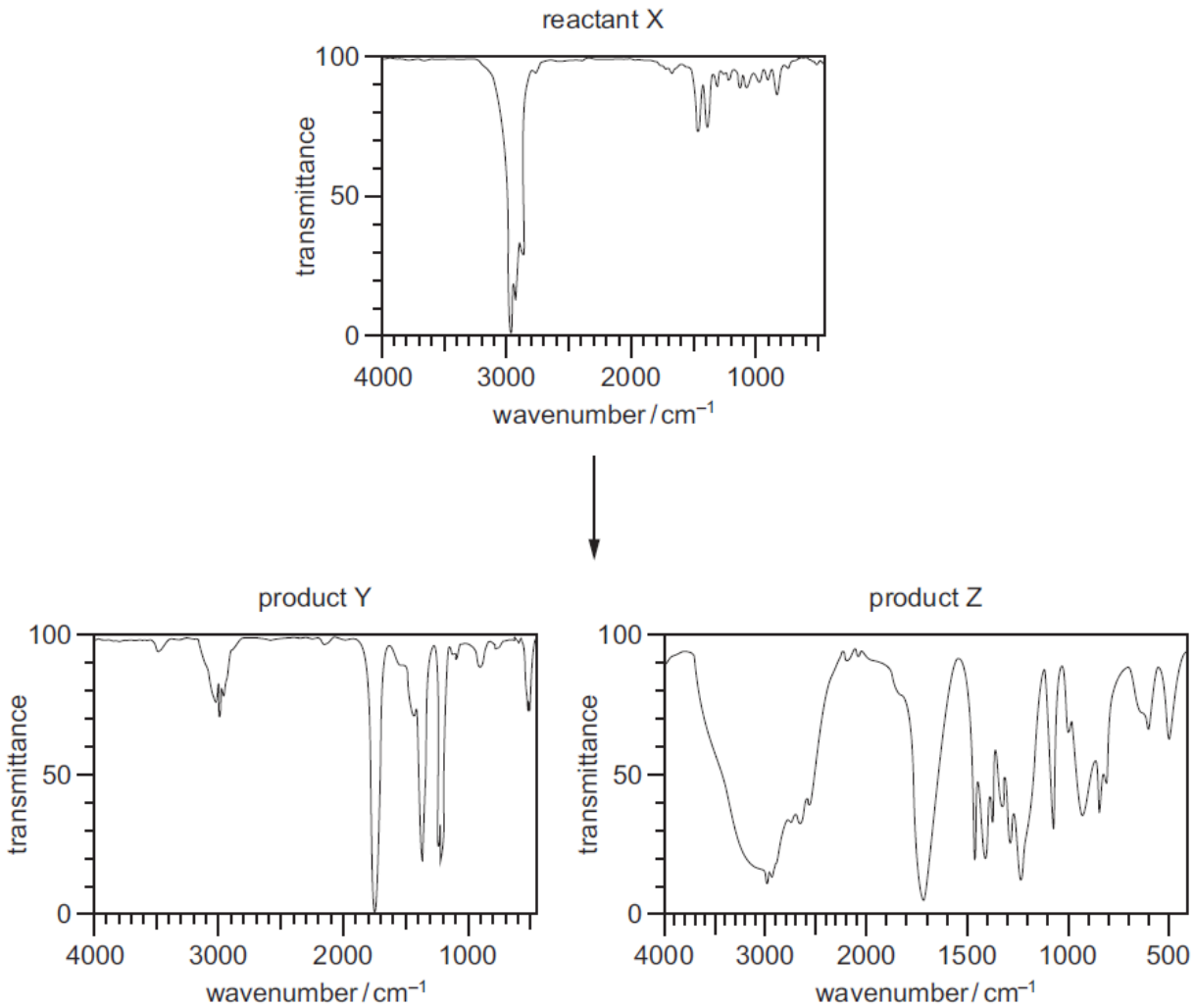
C acid hydrolysis of ethyl butanoate

D alkaline hydrolysis of ethyl butanoate

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5. March/2021/Paper_12/No. 30

When reactant X is treated with a suitable reagent, products Y and Z are formed. Infrared spectra of X. Y and Z are shown.



Which row could be correct?

	X	Y	Z
A	2,3-dimethylpent-2-ene	propanone	butanone
B	2-methylpent-2-ene	propanone	propanoic acid
C	pent-2-ene	ethanoic acid	propanoic acid
D	propyl propanoate	propan-1-ol	propanoic acid

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6. March/2021/Paper_12/No. 40

An organic compound, T, does **not** fizz when aqueous sodium carbonate is added to it.

Compound T contains 27.6% by mass of oxygen.

What could be the identity of T?

1 propanal

2 ethyl butanoate

3 3-methylpentanoic acid

7. June/2021/Paper_11/No.24

The compound cetyl palmitate, $C_{15}H_{31}CO_2C_{16}H_{33}$, is a waxy solid.

Cetyl palmitate is heated under reflux with an excess of aqueous sodium hydroxide.

Which products will be formed?

A $C_{15}H_{31}ONa$ and $C_{16}H_{33}CO_2Na$

B $C_{15}H_{31}CO_2Na$ and $C_{16}H_{33}ONa$

C $C_{15}H_{31}OH$ and $C_{16}H_{33}CO_2Na$

D $C_{15}H_{31}CO_2Na$ and $C_{16}H_{33}OH$

8. June/2021/Paper_11/No.30

Butanoic acid is prepared from 1-bromopropane.

This synthesis requires a sequence of two reactions.

Which compound is prepared in the first stage of the synthesis?

A 1-aminopropane

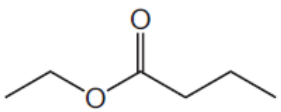
B propan-1-ol

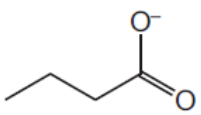
C butanal

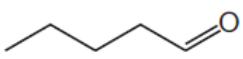
D butanenitrile

9. June/2021/Paper_12/No.40

Which mixtures form a carboxylic acid as one of the products?

1  + $H_2SO_4(aq)$ →

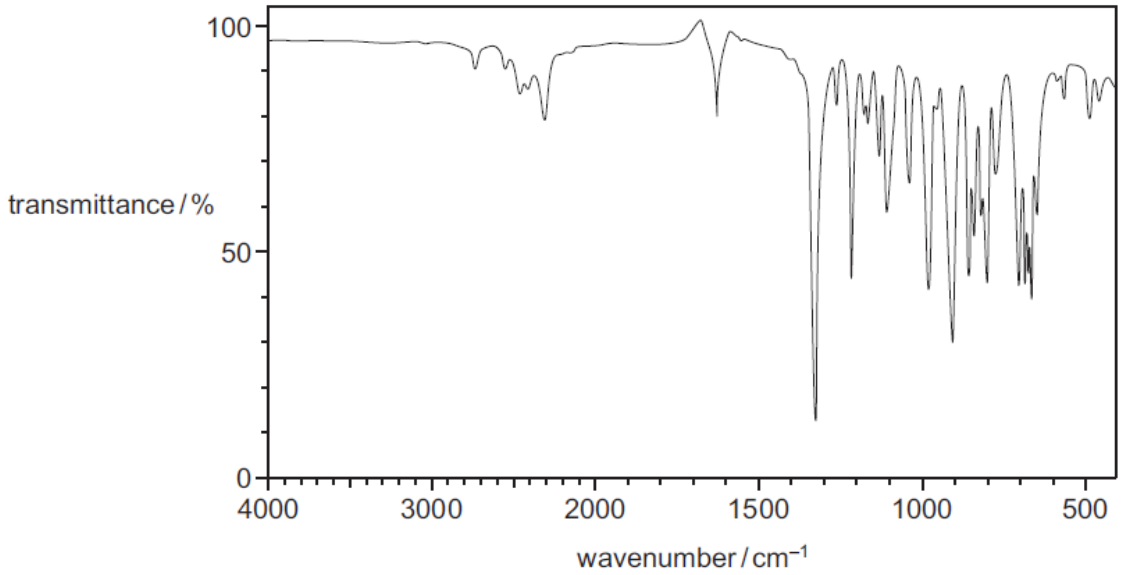
2  + $H_2SO_4(aq)$ →

3  + $H_2SO_4(aq)$ →

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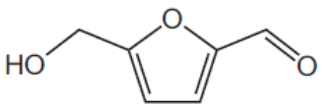
10. June/2021/Paper_13/No.30

The infra-red spectrum of molecule Z is shown.

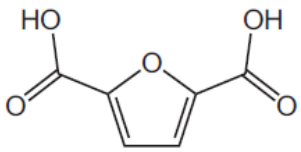


What could be the identity of Z?

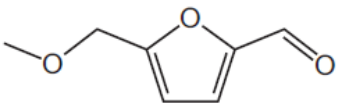
A



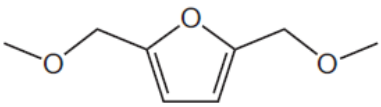
B



C



D



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Carboxylic acids and derivatives – 2022 June AS Chemistry 9701

1. June/2022/Paper_11/No.28

How many esters have the molecular formula $C_4H_8O_2$?

A 2 **B** 3 **C** 4 **D** 5

2. June/2022/Paper_11/No.37

Which compound produces butan-2-ol and ethanoic acid on hydrolysis?

A $CH_3CO_2CH(CH_3)_2$

B $CH_3CO_2CH(CH_3)CH_2CH_3$

C $CH_3CH(CH_3)CO_2CH_2CH_3$

D $CH_3CH_2CO_2CH(CH_3)CH_2CH_3$

3. June/2022/Paper_11/No.38

Two 1 g samples of Y are reacted separately and completely with sodium and with sodium carbonate. The volumes of the gases produced are collected and measured.

	relative volumes of gases	
	with Na	with Na_2CO_3
Y	2	1

What could Y be?

A $CH_3CH(OH)CH_2OH$

B $CH_3CH(OH)CO_2H$

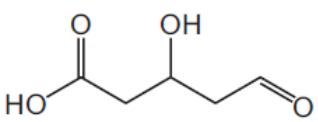
C CH_3COCH_2OH

D CH_3COCO_2H

4. June/2022/Paper_12/No.35

The skeletal formula of M is shown.

M



M is reacted with an excess of $LiAlH_4$. Dilute acid is then added.

What is the molecular formula of the final organic product?

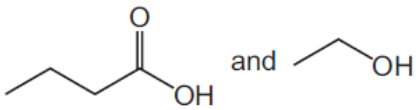
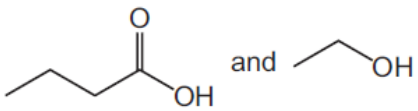
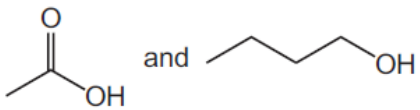
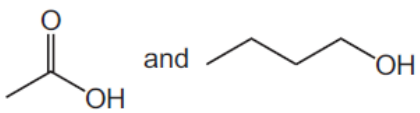
A $C_5H_6O_5$ **B** $C_5H_{10}O_4$ **C** $C_5H_{10}O_3$ **D** $C_5H_{12}O_3$

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5. June/2022/Paper_12/No.38

Ethyl butanoate is a flavouring, with a fruity flavour.

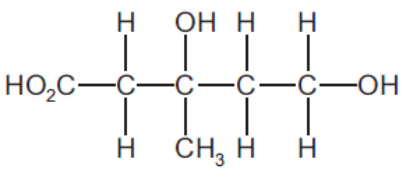
Which row is correct?

	alcohol and acid that react to form ethyl butanoate	the mass of water formed when 2.32 g of ester is formed
A		0.36 g
B		0.40 g
C		0.36 g
D		0.40 g

6. June/2022/Paper_13/No.28

The diagram shows the structural formula of mevalonic acid.

mevalonic acid



Which reagent and conditions will react with mevalonic acid to produce an organic compound **without** a chiral carbon atom?

A heat under reflux with CH_3OH / H^+

B heat under reflux with $Cr_2O_7^{2-} / H^+$

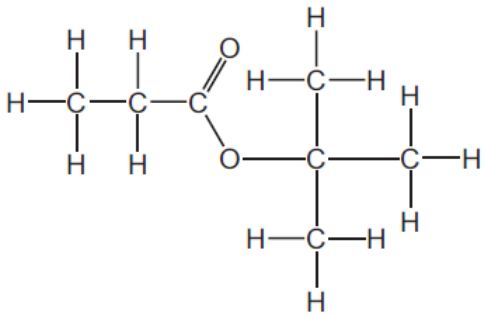
C Na at room temperature

D PCl_5 at room temperature

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7. June/2022/Paper_13/No.37

An ester is shown.



Which two compounds react to form this ester?

A 2-methylpropan-1-ol and propanoic acid

B 2-methylpropan-2-ol and propanoic acid

C propan-1-ol and 2-methylpropanoic acid

D 2-methylpropan-2-ol and ethanoic acid

8. June/2022/Paper_13/No.38

Which compound can be used to make propanoic acid by treatment with a single reagent?

A $CH_2=CHCH_2CH_3$

B $CH_3CH_2CH_2CN$

C $CH_3CH(OH)CN$

D $CH_3CH(OH)CH_3$

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9. June/2022/Paper_23/No.5(a)

(a) But-2-ene reacts with $KMnO_4$ to form organic product, **Y**.
Y does not react with Na_2CO_3.
A gas is produced when an excess of Na is added to **Y**.

(i) Describe the conditions for the $KMnO_4$ used in the reaction to form **Y** from but-2-ene.

..... [1]

(ii) $24.0\,cm^3$ of gas is produced when an excess of Na is added to 0.001 mol of **Y**, when measured under room conditions.
Assume that 1 mol of gas occupies $24.0\,dm^3$ under room conditions.

Deduce a possible structure of **Y**. Explain your answer.

.....

.....

.....
[3]

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Carboxylic acids and derivatives – 2022 Nov AS Chemistry 9701

1. Nov/2022/Paper_11/No.31

Three colourless liquids with the following formulae are contained in separate unlabelled bottles.

$CH_3CH_2CO_2H$ $CH_3CH(OH)CO_2H$ CH_3COCO_2H

Which two tests, carried out on separate samples of each liquid, will successfully identify each liquid?

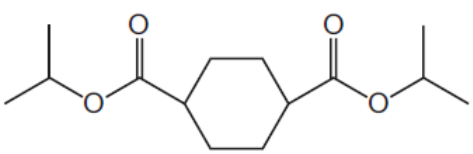
	test 1	test 2
A	$NaHCO_3$	2,4-DNPH reagent
B	$NaHCO_3$	Tollens' reagent
C	warm acidified dichromate	2,4-DNPH reagent
D	warm acidified dichromate	Tollens' reagent

2. Nov/2022/Paper_11/No.32

An alcohol, X, reacts with a dicarboxylic acid, Y, to form a double ester, Z.

The diagram shows the structure of the ester.

Z



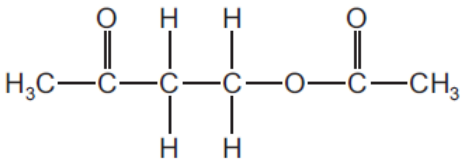
Which row about the reactants forming ester Z is correct?

	the class of alcohol X	the shape of the ring in Y
A	secondary	non-planar
B	secondary	planar
C	tertiary	non-planar
D	tertiary	planar

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3. Nov/2022/Paper_11/No.36

Compound X reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound shown.



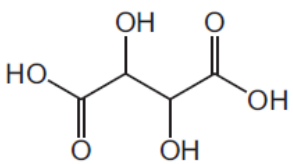
What is the molecular formula of compound X?

A C_2H_4O **B** $C_2H_6O_2$ **C** C_4H_8O **D** $C_4H_8O_2$

4. Nov/2022/Paper_12/No.26

The structure of tartaric acid is shown.

tartaric acid



Which statements about tartaric acid are correct?

1 A molecule of tartaric acid has more than one chiral centre.

2 The molecular formula of tartaric acid is $C_4H_4O_6$.

3 One molecule of tartaric acid produces four hydrogen ions in aqueous solution.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

5. Nov/2022/Paper_12/No.27

A carboxylic acid, P, has no chain isomers. It reacts with an alcohol, Q, that has only one positional isomer.

What could be the ester formed from a reaction between P and Q?

A butyl propanoate

B ethyl butanoate

C pentyl ethanoate

D propyl pentanoate

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Carboxylic acids and derivatives – 2023 June AS Chemistry 9701

1. Nov/2023/Paper_ 9701/11/No.32

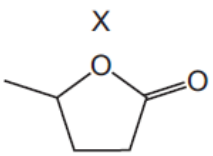
Propanoic acid can be made from bromoethane using a two-stage synthesis.

Which pair of reagents is most suitable?

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

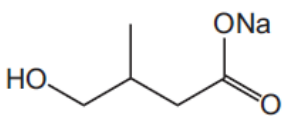
2. Nov/2023/Paper_ 9701/11/No.38

The structure of compound X is shown.

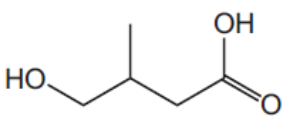


What is produced when X is heated with NaOH(aq)?

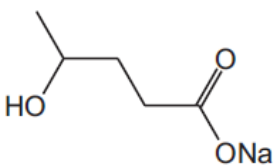
A



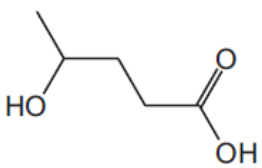
B



C



D



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
A	$LiAlH_4$	conc. H_2SO_4
B	$LiAlH_4$	NaOH in ethanol
C	$NaBH_4$	conc. H_2SO_4
D	$NaBH_4$	NaOH in ethanol

4. Nov/2023/Paper_ 9701/12/No.37

Which alcohol reacts with alkaline I_2(aq) to produce ethanoate ions?

A ethanol

B methylpropan-2-ol

C propan-2-ol

D butan-2-ol

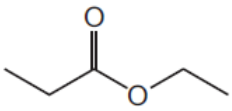
5. Nov/2023/Paper_ 9701/12/No.38

How many esters with the molecular formula $C_5H_{10}O_2$ can be made by reacting a primary alcohol with a carboxylic acid?

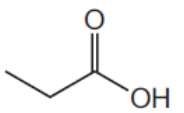
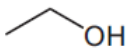
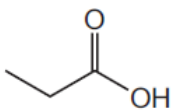
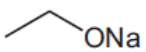
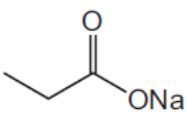
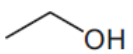
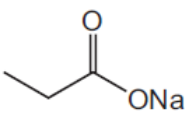
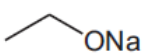
A 4 **B** 5 **C** 6 **D** 8

6. Nov/2023/Paper_ 9701/12/No.39

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
A		
B		
C		
D		

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7. Nov/2023/Paper_ 9701/22/No.4(a)

Lactic acid, $CH_3CH(OH)COOH$, and pyruvic acid, $CH_3COCOOH$, both contain two functional groups.

lactic acid **pyruvic acid**

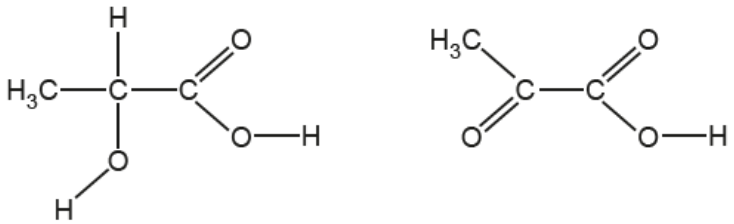


Fig. 4.1

(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.

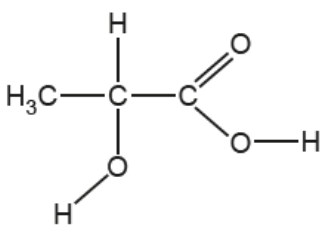


Fig. 4.2

[3]

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8. June/2023/Paper_9701/11/No.36

Which method could produce butanoic acid?

A an acid–base reaction involving $CH_3CH_2CH_2CO_2Na$

B the hydrolysis of $CH_3CH_2CH_2CH_2CN$

C the acidic hydrolysis of $CH_3CH_2COOCH_2CH_2CH_3$

D the oxidation of $CH_3CH_2CH_2OH$

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 $CH_3CH_2CO_2CH_3$

B $CH_3CH(CH_3)CO_2CH_2CH(CH_3)_2$

C $CH_3CH_2CO_2CH(CH_3)_2$

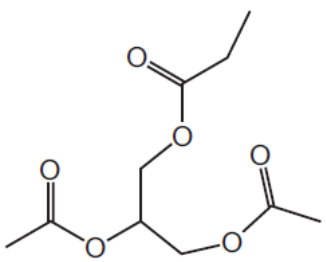
D $(CH_3)_2CHCO_2CH(CH_3)_2$

10. June/2023/Paper_9701/11/No.38

Two compounds, X and Y, are mixed and a little concentrated H_2SO_4 is added.

Ester Z is found in the resulting mixture of products.

ester Z



Which two compounds could be X and Y?

	X	Y
A	CH_3CH_2OH	$CH(CO_2H)_3$
B	CH_3CH_2OH	$CH_3CO_2CH_2CH(OH)CH_2OCOCH_2CH_3$
C	CH_3CO_2H	$CH_3CH_2CO_2CH_2CH(OH)CH_2OH$
D	CH_3CO_2H	$CH_2(OH)CH(OH)CH_2(OH)$

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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 $NaHCO_3(aq)$ **B** $NaOH(aq)$ **C** $Na_2CO_3(aq)$ **D** $Na_2SO_4(aq)$

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 $HCl(aq)$. The two products of this hydrolysis have the same empirical formula.

What could Q be?

A $CH_3CO_2CH_2CH_2OH$

B $CH_3CO_2CH_2CH_2CO_2H$

C $CH_3CH_2CO_2CH_2CH_2CH_3$

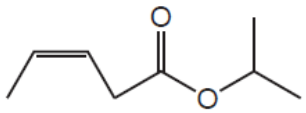
D $CH_3CH_2CH(OH)CH(OH)CH_2CH_3$

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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
A	*cis*	secondary
B	*cis*	tertiary
C	*trans*	secondary
D	*trans*	tertiary

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16. June/2023/Paper_9701/21/No.4

V is a colourless liquid.

V

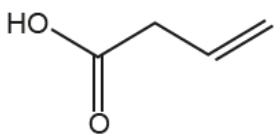


Fig. 4.1

(a) **V** reacts with an excess of $LiAlH_4$ to form **W**.

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

W

[1]

(ii) Identify the role of $LiAlH_4$ in the reaction with **V**.

..... [1]

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

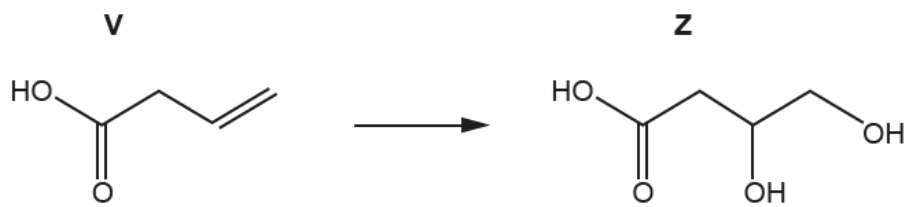


Fig. 4.2

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

..... [1]

(ii) Deduce the empirical formula of **Z**.

..... [1]

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(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 **V**		

[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.

Q

[2]

[Total: 8]

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17. June/2023/Paper_9701/23/No.5

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

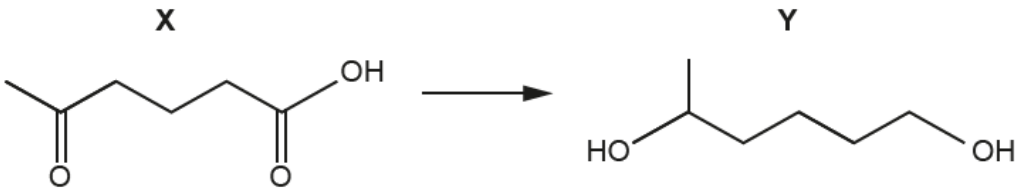


Fig. 5.1

(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]

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(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 **X**	observation on addition to **Y**
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 $CH_3CH(CH_3)COOH$ and $(CH_3)_2CHCOOH$

B $CH_3CH(COOH)CH_3$ and $(CH_3)_2CHCOOH$

C $CH_3CHCOOH$ and $CH_3CH_2CH_2COOH$

D $CH_3CH_2CH_2COOH$ and $(CH_3)_2CHCOOH$

19. March/2023/Paper_9701/12/No.32

Tartaric acid, HOOCCH(OH)CH(OH)COOH, is found in many plants.

A sample of tartaric acid reacts with an excess of $LiAlH_4$ to form the organic product J.

What happens when NaOH(aq) is added to separate samples of tartaric acid and J?

A Both tartaric acid and J react.

B Only tartaric acid reacts.

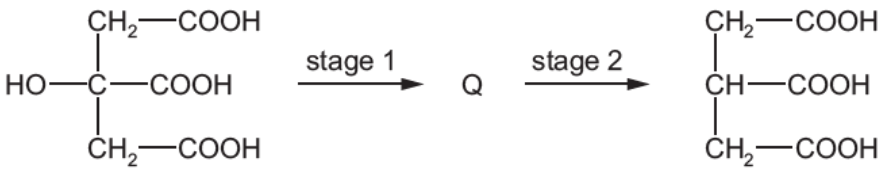
C Only J reacts.

D Neither tartaric acid nor J react.

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20. March/2023/Paper_9701/12/No.33

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



citric acid tricarballylic acid

Which reagents are needed for each stage?

	stage 1	stage 2
A	concentrated H_2SO_4	$H_2(g)$ and Ni
B	concentrated H_2SO_4	$LiAlH_4$
C	$LiAlH_4$	$H_2SO_4(aq)$
D	NaOH(aq)	$H_2(g)$ 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 $CH_3CH_2CH_2CO_2Na$

B CH_3CO_2Na

C CH_3CH_2ONa

D H_2O

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 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

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