Carbonyl compounds – 2021 AS

1. Nov/2021/Paper_11/No.24

When an organic compound, Q, is treated with phosphorus pentachloride, fumes of hydrogen chloride are evolved. When Q is warmed with acidified aqueous potassium dichromate(VI), the solution turns green.

What is Q?

A CH_3CH_2CHO

B $CH_3CH_2CO_2H$

C $CH_3CH(OH)CH_3$

D $(CH_3)_3COH$

2. Nov/2021/Paper_11/No.25

Alcohol Y gives a yellow precipitate with alkaline aqueous iodine. It can be oxidised to give a mixture of products including substance Z. Substance Z gives a red-brown precipitate with Fehling's solution.

Which alcohol could be Y?

A $CH_3CH(OH)CH(CH_3)CH_2OH$

B $CH_3C(OH)(CH_3)CH_2CH_2OH$

C $CH_3CH(OH)CH_2CH(OH)CH_3$

D $CH_2(OH)CH_2CH(OH)CH_2CH_3$

3. Nov/2021/Paper_11/No.26

$CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

A The cyanohydrin product has one chiral centre.

B The cyanohydrin product is formed by electrophilic addition.

C The cyanohydrin product is formed via an intermediate which contains a C–OH group.

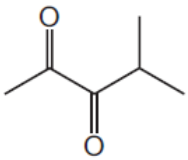
D The formation of the cyanohydrin product requires the use of cyanide ions as a catalyst.

4. Nov/2021/Paper_11/No.27

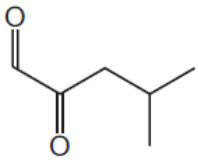
Reduction of compound R with $LiAlH_4$ gives the compound 4-methylpentane-2,3-diol.

What could be the identity of compound R?

A



B



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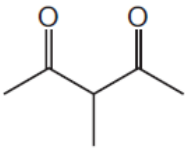
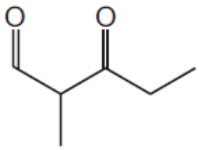


D



5. Nov/2021/Paper_11/No.28

Citric acid is found in lemon juice.

citric acid

$HO_2CCH_2C(OH)(CO_2H)CH_2CO_2H$

Which volume of 0.40 mol dm^{-3} sodium hydroxide solution is required to neutralise a solution containing 0.0050 mol of citric acid?

A 12.5 cm^3 **B** 25.0 cm^3 **C** 37.5 cm^3 **D** 50.0 cm^3

6. Nov/2021/Paper_11/No.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

7. Nov/2021/Paper_12/No.28

Which compound produces a precipitate with 2,4-dinitrophenylhydrazine reagent **and** also with alkaline aqueous iodine?

A butan-2-ol

B butanal

C butanone

D pentan-3-one

8. Nov/2021/Paper_12/No.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

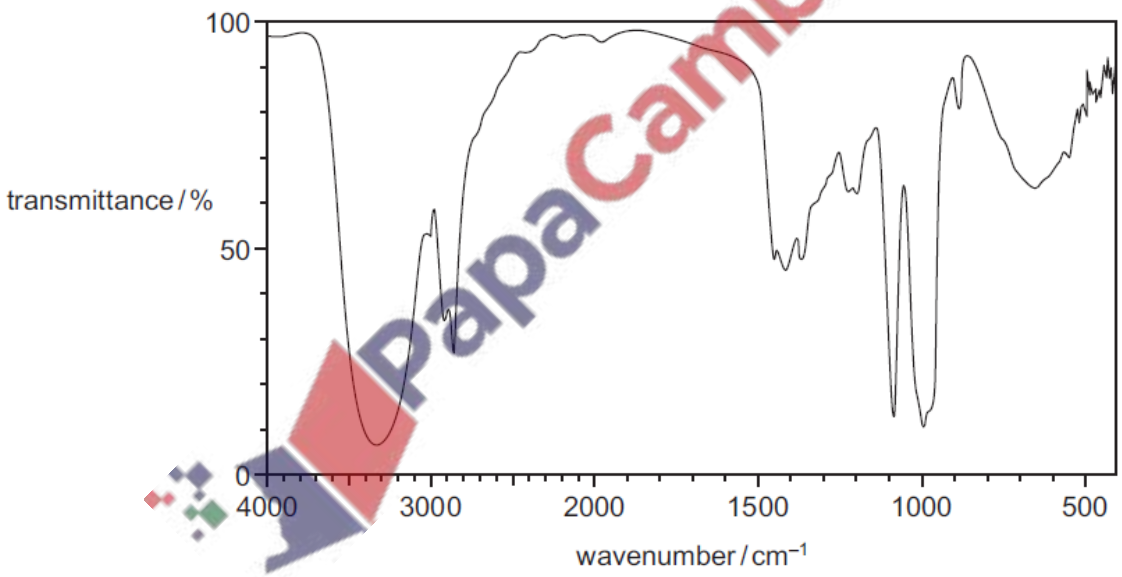
B 2-hydroxy-2-methylpropanoic acid

C 3-hydroxy-2-methylbutanoic acid

D 3-hydroxy-2-methylpropanoic acid

9. Nov/2021/Paper_12/No.30

The infra-red spectrum of Y is shown.



What could Y be?

A $CH_3CO_2C_2H_5$

B $CH_2(OH)CH{=}CHCH_2OH$

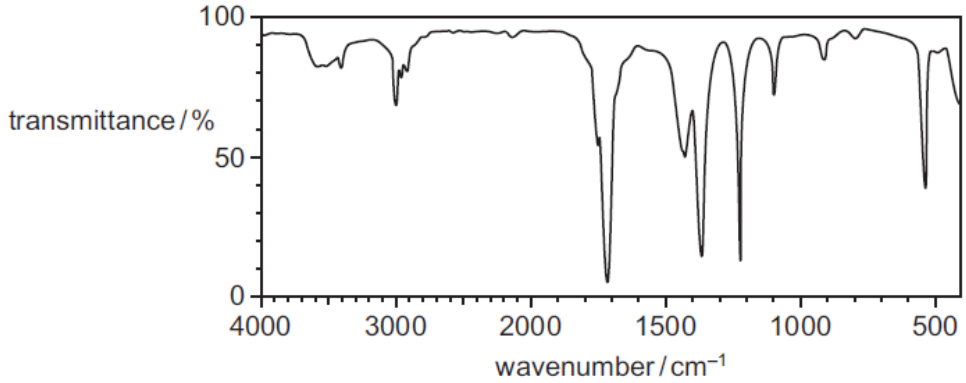
C $CH_3(CH_2)_2CO_2H$

D $CH_2(OH)(CH_2)_2CHO$

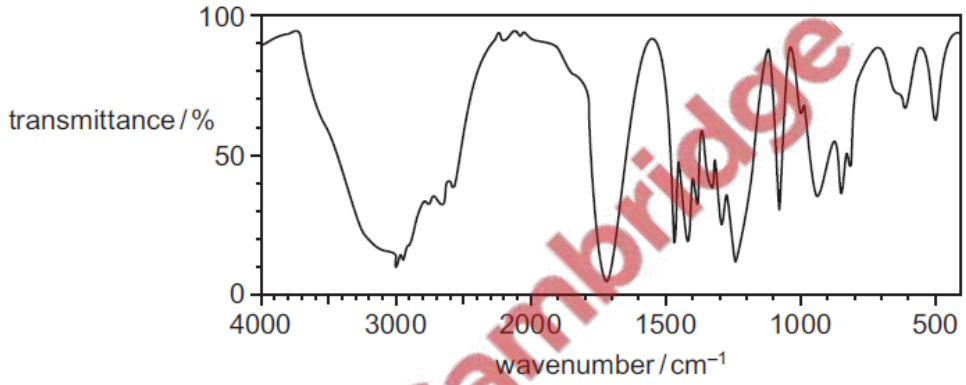
10. Nov/2021/Paper_13/No.30

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

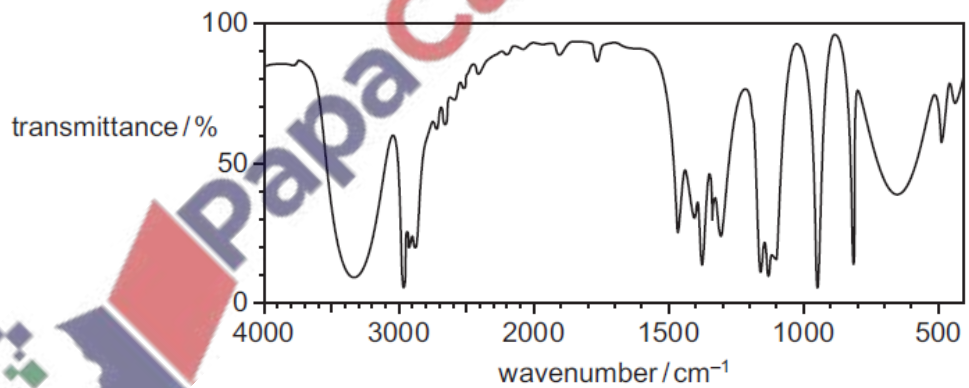
spectrum 1



spectrum 2



spectrum 3



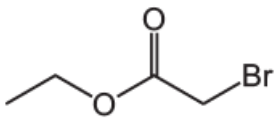
What could the three compounds be?

	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

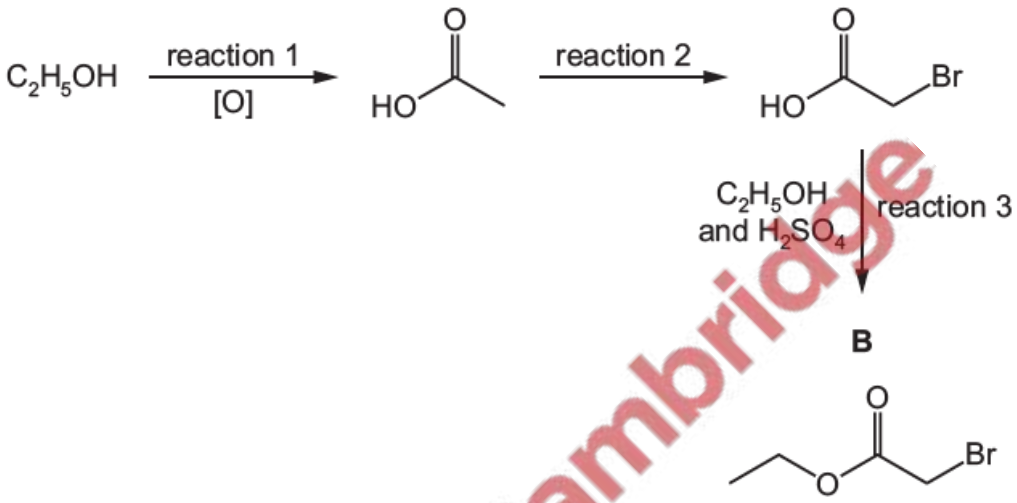
11. Nov/2021/Paper_23/No.4

Compound **B** is a liquid with a fruity smell.

B



The reaction scheme shows how **B** can be made from ethanol, C_2H_5OH.



(a) (i) Reaction 1 is an oxidation reaction.

Give the reagent(s) and conditions required for reaction 1.

reagent(s) .....

conditions .....

.....

[2]

(ii) Construct an equation to represent reaction 1.

Use [O] to represent an oxygen atom from the oxidising agent in this reaction.

..... [1]

(iii) Suggest the type of reaction that occurs in reaction 2.

..... [1]

(iv) H_2SO_4 acts as a homogeneous catalyst in reaction 3.

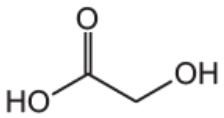
Explain why H_2SO_4 is described as *homogeneous*.

.....

..... [1]

(b) Reaction 2 needs to take place in the absence of water to prevent formation of compound **C**.

C



If **C** is present in the reaction mixture of reaction 3, a different compound, compound **D**, will also form. Compound **D** has two identical functional groups.

The infrared spectrum of **D** shows strong absorptions at 1100 cm^{-1} and 1720 cm^{-1}, but no absorption due to O–H bonds.

Use the *Data Booklet* to identify the functional group present in **D**.

Explain your answer as fully as you can.

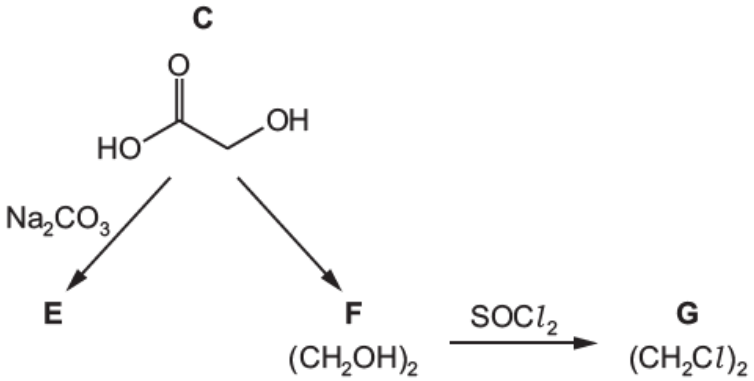
.....

.....

.....

..... [3]

(c) Some other reactions of **C** are shown.



(i) Draw the structure of **E**.

[1]

(ii) Suggest why $NaBH_4$ is not a suitable reagent to make **F**, $(CH_2OH)_2$, from **C**.
Explain your answer.

.....

..... [1]

(iii) Construct an equation for the reaction of $(CH_2OH)_2$ with $SOCl_2$ to form **G**, $(CH_2Cl)_2$.

..... [1]

(d) Explain why **C** is very soluble in water.

.....

.....

..... [1]

[Total: 12]

12. March/2021/Paper_12/No.24

Which compound produces a ketone when refluxed with an acidified solution of potassium dichromate(VI)?

A pentan-1-ol

B 2-methylbutan-1-ol

C 2-methylbutan-2-ol

D 3-methylbutan-2-ol

13. March/2021/Paper_12/No.27

In this question you can assume that ^{1}H and ^{3}H have the same chemical properties.

A sample of ethanal contains only one isotope of hydrogen, ^{1}H.

It is reduced to compound Z, C_2H_6O, in a nucleophilic addition reaction using $NaBH_4$. All the hydrogen atoms in the $NaBH_4$ are the ^{3}H isotope.

$$CH_3CHO \xrightarrow{NaBH_4} \underset{\text{compound Z}}{C_2H_6O}$$

Compound Z is then oxidised back to ethanal and water.

$$C_2H_6O + [O] \rightarrow CH_3CHO + H_2O$$

Which statement about the final mixture of products is correct?

A Both ethanal and water contain ^{3}H atoms.

B Ethanal is the only product containing ^{3}H atoms.

C Neither ethanal nor water contain ^{3}H atoms.

D Water is the only product containing ^{3}H atoms.

14. March/2021/Paper_12/No.39

Two carbonyl compounds have the molecular formula C_3H_6O.

Which reagents give **different** observations with these two compounds?

1 acidified aqueous potassium manganate(VII)

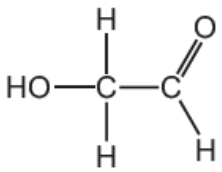
2 Fehling's reagent

3 alkaline aqueous iodine

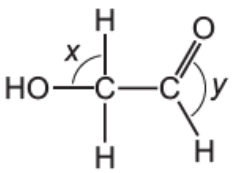
15. March/2021/Paper_22/No.4

Hydroxyethanal, $HOCH_2CHO$, has been observed in dust clouds near the centre of our galaxy.

hydroxyethanal



(a) Predict the bond angles labelled *x* and *y* in the diagram of hydroxyethanal.



x = ... °

y = ... °

[2]

(b) Hydroxyethanal reacts separately with 2,4-dinitrophenylhydrazine (2,4-DNPH) and with Tollens' reagent.

State what you would observe in each reaction.

reaction with 2,4-DNPH .....

reaction with Tollens' reagent .....

[2]

(c) Hydroxyethanal is converted to ethanedioic acid, $(CO_2H)_2$, when it reacts with excess acidified dichromate(VI) ions, $Cr_2O_7^{2-}$.

(i) State the role of acidified $Cr_2O_7^{2-}$ in this reaction.

..... [1]

(ii) State and explain any other necessary conditions for this reaction to be successful.

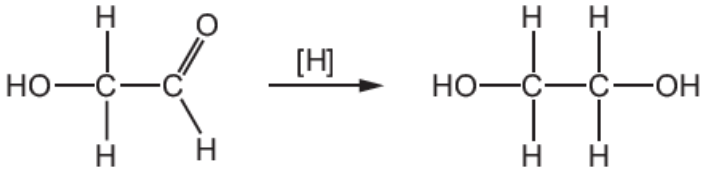
.....

.....

..... [2]

(d) Hydroxyethanal can be reduced to ethane-1,2-diol, $(CH_2OH)_2$, as shown.

hydroxyethanal ethane-1,2-diol



(i) Write an equation for the reduction of hydroxyethanal to $(CH_2OH)_2$.

Use [H] to represent an atom of hydrogen from the reducing agent.

..... [1]

(ii) Identify a reagent for this reduction reaction.

..... [1]

(iii) $(CH_2OH)_2$ also forms when an alkene **A** reacts with cold, dilute, acidified manganate(VII) ions.

Name **A**.

..... [1]

[Total: 10]

16. June/2021/Paper_11/No.28

Which statement is correct for the reaction of carbonyl compounds with HCN?

A The reaction is catalysed by concentrated H_2SO_4.

B Pentan-2-one and HCN react to give a chiral product.

C The reaction is a condensation reaction.

D The reaction is nucleophilic substitution.

17. June/2021/Paper_11/No.31

Ethanol combines with ethanoic acid to form ethyl ethanoate according to the following reaction.

$$C_2H_5OH(l) + CH_3CO_2H(l) \rightleftharpoons CH_3CO_2C_2H_5(l) + H_2O(l) \qquad \Delta H^{\ominus} = -6\,kJ\,mol^{-1}$$

9.2 g ethanol, 12 g ethanoic acid and 8.8 g ethyl ethanoate are mixed and allowed to stand at 298 K, until equilibrium is reached.
(M_r: C_2H_5OH, 46; CH_3CO_2H, 60; $CH_3CO_2C_2H_5$, 88)

The resulting equilibrium mixture is found to contain 4.8 g ethanoic acid.

The experiment is repeated at 323 K.

Which statements are correct?

1 There are 0.22 moles of ethyl ethanoate in the mixture at equilibrium at 298 K.

2 The equilibrium mixture at 323 K will contain more than 4.8 g of ethanoic acid.

3 If a small amount of water is added at the start of either experiment the value of K_c would not be affected.

18. June/2021/Paper_11/No.38

Which pairs of compounds may be distinguished by testing with alkaline aqueous iodine?

1 butanal and butanone

2 pentan-2-one and pentan-3-ol

3 propanone and propan-2-ol

19. June/2021/Paper_11/No.39

Which reactions have a coloured organic product?

1 ethanal + 2,4-dinitrophenylhydrazine reagent

2 ethanol + acidified potassium dichromate(VI)

3 ethene + cold dilute acidified potassium manganate(VII)

20. June/2021/Paper_11/No.40

Propanoic acid is reacted with an excess of lithium aluminium hydride. The organic product of this reaction is reacted with ethanoic acid in the presence of concentrated sulfuric acid, forming product X.

What are major commercial uses of X?

1 fuel

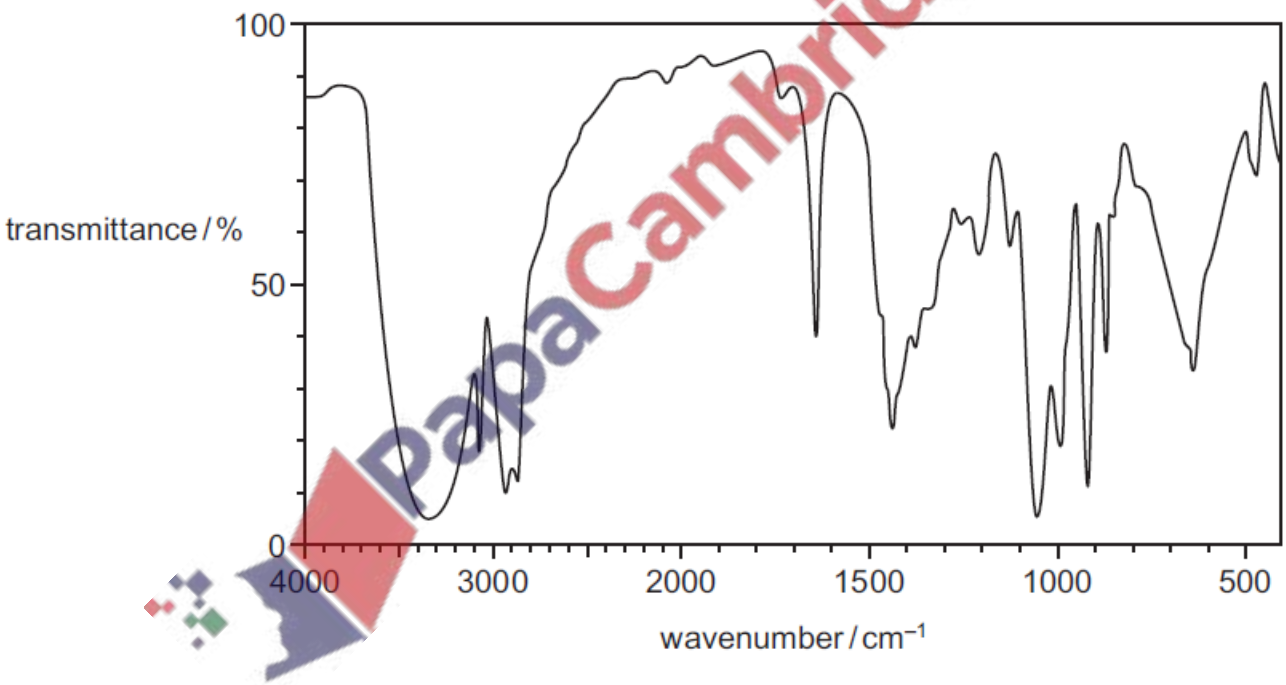
2 solvent

3 flavouring

21. June/2021/Paper_12/No.30

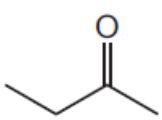
The molecular formula of Z is C_4H_8O.

The infra-red spectrum of Z is shown.

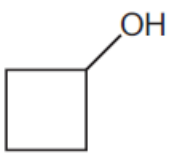


What could be Z?

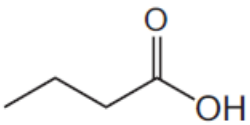
A



B



C

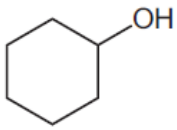


D

22. June/2021/Paper_12/No.39

Which alcohols can be oxidised to form an organic compound which will give coloured precipitates with both 2,4-dinitrophenylhydrazine reagent and alkaline aqueous iodine?

1



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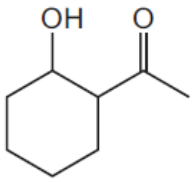

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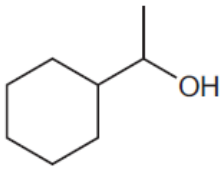


23. June/2021/Paper_13/No.21

Two carbon-containing products result from the reaction of alkene Z with a hot, concentrated, acidified solution of potassium manganate(VII).

One product forms an orange precipitate with 2,4-dinitrophenylhydrazine reagent. The other product is a gas which gives a white precipitate with aqueous calcium hydroxide.

Which alkene could be alkene Z?

A but-2-ene

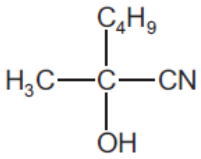
B 2-methylpropene

C 2-methylbut-2-ene

D propene

24. June/2021/Paper_13/No.27

The diagram shows the structure of a compound formed by the reaction of HCN with a carbonyl compound, X.



What is the mechanism of this reaction and what is the functional group in X?

	mechanism of reaction	functional group in X
A	electrophilic addition	aldehyde
B	electrophilic addition	ketone
C	nucleophilic addition	aldehyde
D	nucleophilic addition	ketone

25. June/2021/Paper_13/No.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

26. June/2021/Paper_13/No.29

Two reactions are shown.

$$(CH_3)_2CHCO_2H \xrightarrow{LiAlH_4} \text{alcohol P}$$

$$CH_3CO_2CH(CH_3)_2 \xrightarrow{\text{hydrolysis}} \text{alcohol Q + acid R}$$

To which classes of alcohol do P and Q belong?

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

27. June/2021/Paper_13/No.39

Three compounds, X, Y and Z, are shown.

X	Y	Z
$C_2H_5COCH_3$	C_2H_5CHO	CH_3CO_2H

Which statements about X, Y and Z are correct?

1 X reacts with alkaline aqueous iodine.

2 Y reacts with Tollens' reagent.

3 Z does **not** react with alkaline aqueous iodine.

28. June/2021/Paper_22/No.4(d)

(d) Alcohol **Y** reacts completely when warmed with acidified $Cr_2O_7^{2-}$ to form **Z**.

Z is distilled from the reaction mixture as soon as it is made.

Tollens' reagent is added to a sample of **Z** and warmed. A silver mirror forms.

(i) Name the type of reaction that occurs when **Y** reacts to form **Z**.

..... [1]

(ii) Identify with a tick (✓) the functional group(s) present in **Z**.

functional group	present in **Z**
aldehyde	
ketone	
carboxylic acid	

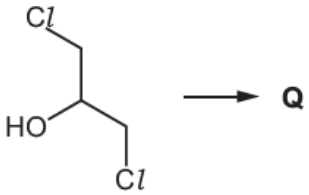
[1]

29. June/2021/Paper_23/No.4(b)

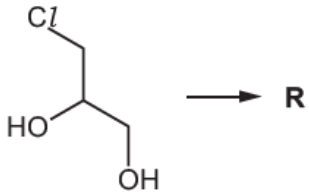
(b) Separate samples of 1,3-dichloropropan-2-ol and 3-chloropropane-1,2-diol are heated with excess acidified $Cr_2O_7^{2-}$ until there is no further reaction.

In each reaction, a different organic product, **Q** or **R**, is made.

1,3-dichloropropan-2-ol



3-chloropropane-1,2-diol



Q and **R** are tested separately with 2,4-dinitrophenylhydrazine solution, 2,4-DNPH, and sodium carbonate solution, $Na_2CO_3(aq)$.

Complete the table to give any relevant observations.

If no reaction occurs, write 'no visible change'.

reagent	observation with **Q**	observation with **R**
2,4-DNPH		
$Na_2CO_3(aq)$		

[4]