17. Carbonyl compounds

17.1 Aldehydes and ketones

Paper 1

Question Paper

1 Compound X:

- does **not** react with Tollens' reagent
- forms a yellow precipitate with alkaline $I_2(aq)$
- does **not** react with sodium.

What could be the identity of X?

A CH_3CHO

B $C_2H_5COCH_3$

C $CH_3COOC_2H_5$

D $CH_3CHOHCH_3$

2 Which compound can undergo nucleophilic addition?

A bromoethane, C_2H_5Br

B ethanal, CH_3CHO

C ethane, C_2H_6

D ethene, C_2H_4

3 Which compound, on reaction with hydrogen cyanide, produces a compound with a chiral centre?

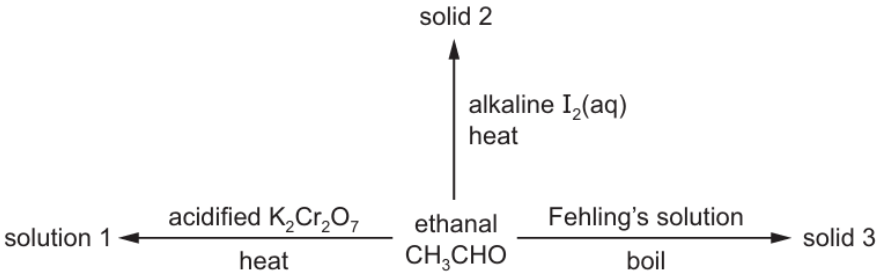
A CH_3CHO

B $CH_3CH_2COCH_2CH_3$

C $CH_3CO_2CH_3$

D HCHO

4 The diagram shows three reactions of ethanal. In each case, an excess of ethanal is used.



Observations are made after each of the three reactions.

What are the colours of solution 1 and solids 2 and 3?

	solution 1	solid 2	solid 3
A	green	yellow	silver mirror
B	green	yellow	red
C	orange	red	silver mirror
D	orange	red	red

5 X is a non-cyclic ketone with a single carbonyl group and no other functional groups. Ketone X has the following properties.

- When ketone X is treated with $NaBH_4$, the organic product has a M_r 2.3256% greater than the M_r of ketone X.
- Ketone X gives a yellow precipitate with alkaline I_2(aq).

How many isomeric ketones could be ketone X?

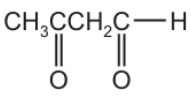
A 1 **B** 2 **C** 3 **D** 4

6 Compound Y:

- changes the colour of acidified $K_2Cr_2O_7$ from orange to green
- has no effect on Fehling's reagent
- produces an orange precipitate with 2,4-dinitrophenylhydrazine reagent.

What is compound Y?

A



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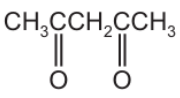

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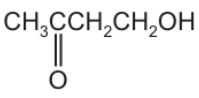

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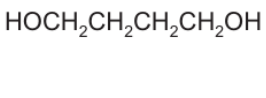


7 In which reaction is the organic compound oxidised?

A $CH_3CH_2CH_2CHO$ + Tollens' reagent

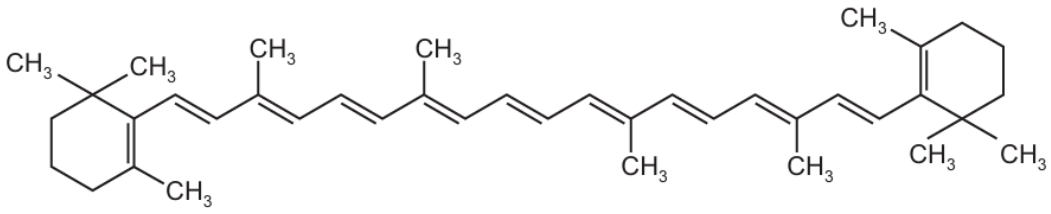
B $CH_3CH_2CH_2CHO$ + $LiAlH_4$

C $CH_3CH_2CH_2OH$ + concentrated H_3PO_4

D $CH_3CO_2C_2H_5$ + dilute H_2SO_4

8 β-carotene is responsible for the orange colour of carrots.

β-carotene



β-carotene is oxidised by hot, concentrated, acidified $KMnO_4$.

When an individual molecule of β-carotene is oxidised in this way, many product molecules are formed.

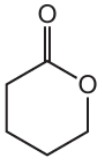
How many of these product molecules contain a ketone functional group?

A 4 **B** 6 **C** 9 **D** 11

9 Which compound will produce a yellow-orange precipitate when added to 2,4-dinitrophenylhydrazine?

A

B



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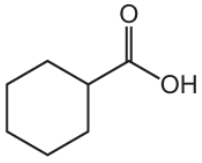

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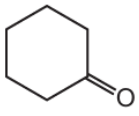


10 Ethanal, CH_3CHO, undergoes an addition reaction with HCN in the presence of CN^- ions.

Which row identifies the type of reaction and the name of the product formed?

	type of reaction	name of product
A	electrophilic addition	2-hydroxypropanenitrile
B	electrophilic addition	2-hydroxyethanenitrile
C	nucleophilic addition	2-hydroxypropanenitrile
D	nucleophilic addition	2-hydroxyethanenitrile

11 The formulae of three compounds are shown.

C_3H_7CHO $C_2H_5COCH_3$ $CH_2CHCH_2CH_2OH$

Only one of these compounds will decolourise bromine water. Only one of these compounds will produce a silver mirror with Tollens' reagent.

Which row shows the correct results?

	decolourises bromine water	forms a silver mirror with Tollens' reagent
A	C_3H_7CHO	$C_2H_5COCH_3$
B	$C_2H_5COCH_3$	C_3H_7CHO
C	$CH_2CHCH_2CH_2OH$	$C_2H_5COCH_3$
D	$CH_2CHCH_2CH_2OH$	C_3H_7CHO

12 Which reaction takes place by a nucleophilic addition mechanism?

A propene reacting with hydrogen bromide

B 2-bromopropane reacting with sodium hydroxide in ethanol

C propanone reacting with hydrogen cyanide

D methane reacting with chlorine

13 Which reagent:

- can confirm the presence of a carbonyl group in an organic compound
- does **not** distinguish between aldehydes and ketones?

A acidified $K_2Cr_2O_7$

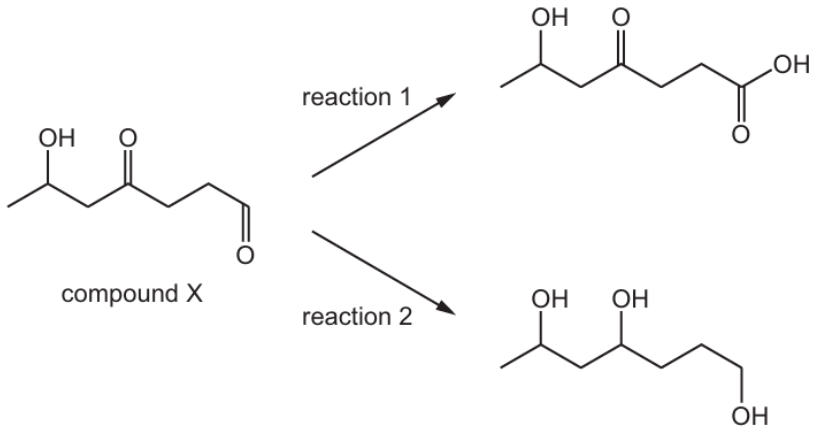
B 2,4-DNPH reagent

C Fehling's reagent

D $LiAlH_4$

14 Two samples of compound X were treated separately with different reagents which were added in excess.

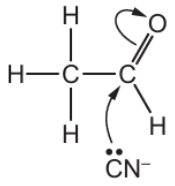
The products of these two reactions are shown.



Which reagents could be used for reaction 1 and reaction 2?

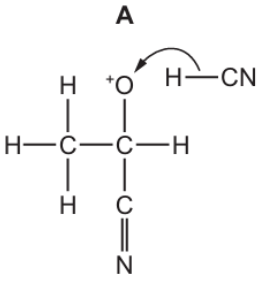
	reaction 1	reaction 2
A	hot acidified sodium dichromate(VI)	Na
B	hot acidified sodium dichromate(VI)	$NaBH_4$
C	Tollens' reagent followed by HCl(aq)	Na
D	Tollens' reagent followed by HCl(aq)	$NaBH_4$

15 The mechanism for the reaction between ethanal and hydrogen cyanide starts with the step shown.



What is the correct structure of the intermediate ion formed, and what is the next step in this mechanism?

A



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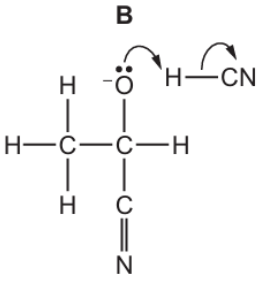

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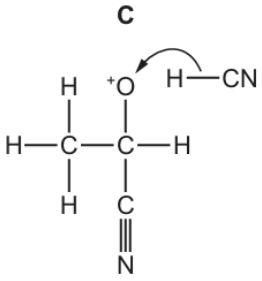

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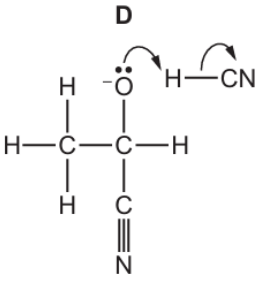


16 Which compound reacts with 2,4-dinitrophenylhydrazine reagent but does **not** react with Tollens' reagent?

A CH_3COCO_2H

B $CH_3CH(OH)CHO$

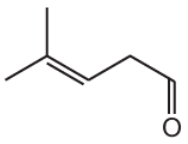
C CH_3COCHO

D $CH_3CH(OH)CH_3$

17 Compound X has stereoisomers and forms a precipitate when warmed with Fehling's reagent.

What could be the structure of compound X?

A



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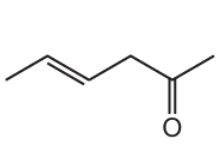

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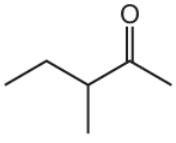

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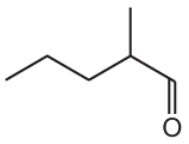


18 Three colourless liquids with the following formulae are contained in separate unlabelled bottles.

$CH_3CH_2CO_2H$ $CH_3CH(OH)CO_2H$ 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

19 W reacts with alkaline $I_2(aq)$ to form a yellow precipitate and $CH_3CH_2CO_2^-$ ions.

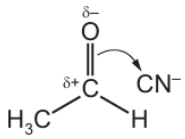
Which row identifies W and the yellow precipitate?

	identity of W	identity of yellow precipitate
A	butanone	CHI_3
B	butanone	CH_3I
C	propanone	CHI_3
D	propanone	CH_3I

20 Ethanal reacts with hydrogen cyanide in the presence of KCN to produce a hydroxynitrile.

What is the first step in the mechanism of this reaction?

A



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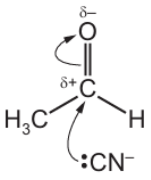

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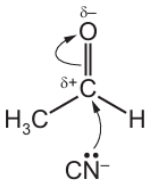

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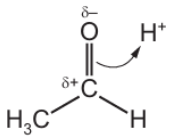
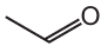
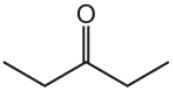


21 The table shows a student's predictions for the reactions of three compounds.

	compound	alkaline $I_2(aq)$	Fehling's reagent	Tollens' reagent
1		✓	✓	✓
2		✓	✗	✗
3		✗	✗	✗

key
✓ = reaction occurs
✗ = no reaction

Which rows show the correct predictions?

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

22 Which mechanism describes the reaction of aldehydes and ketones with HCN + NaCN?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

D nucleophilic substitution

23 The skeletal formulae of two organic compounds are shown.

Which reagents can be used to distinguish these two compounds?

1 alkaline $I_2(aq)$

2 acidified $K_2Cr_2O_7$

3 2,4-dinitrophenylhydrazine (2,4-DNPH reagent)

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

24 A carbonyl compound, X, reacts with HCN in the presence of NaCN to make a compound with M_r 85. Compound X does **not** react with Fehling's reagent.

What is compound X?

A butanal

B butanone

C propanal

D propanone

25 Which reaction has a product that gives a yellow precipitate when treated with alkaline $I_2(aq)$?

A 2-chloropropane is warmed with a dilute aqueous solution of sodium hydroxide.

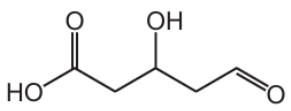
B Ethanal is heated under reflux with acidified potassium dichromate(VI).

C Methyl ethanoate is heated under reflux with dilute sulfuric acid.

D Propanal is reacted with $NaBH_4$, followed by dilute sulfuric acid.

26 The skeletal formula of M is shown.

M



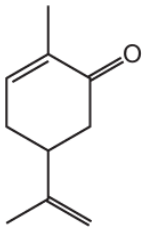
M is reacted with an excess of $LiAlH_4$. Dilute acid is then added.

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** $C_5H_{12}O_3$

27 Which compound forms a precipitate when mixed with 2,4-DNPH reagent and also forms a precipitate when mixed with Fehling's reagent?

A



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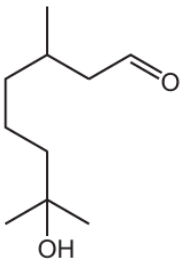

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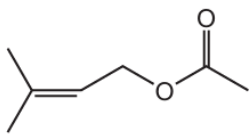

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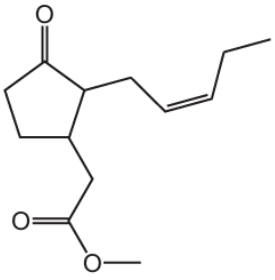


28 $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

A The cyanohydrin product has one chiral centre.

B The cyanohydrin product is formed by electrophilic addition.

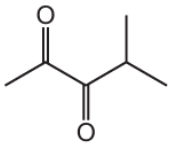
C The cyanohydrin product is formed via an intermediate which contains a C–OH group.

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

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

What could be the identity of compound R?

A



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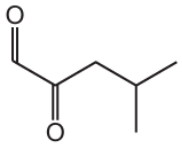

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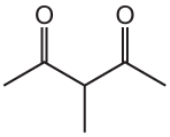

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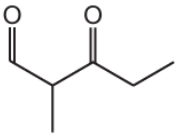


30 Which compound produces a precipitate with 2,4-dinitrophenylhydrazine reagent **and** also with alkaline aqueous iodine?

A butan-2-ol

B butanal

C butanone

D pentan-3-one

31 When an organic compound is oxidised, any oxygen atom gained by the organic molecule is considered to be from a water molecule also producing $2H^+ + 2e^-$. Any hydrogen atom lost may be considered to be lost as $H^+ + e^-$.

These changes can be represented by the following two equations.

$$H_2O \rightarrow [O] + 2H^+ + 2e^-$$

$$[H] \rightarrow H^+ + e^-$$

Compound X is oxidised by heating under reflux with hot, acidified potassium dichromate(VI) for one hour. The half-equation for the reduction reaction is shown.

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

Under these conditions, one mole of potassium dichromate(VI) oxidises three moles of X.

What could X be?

A propanal

B propan-1-ol

C propan-1,2-diol

D propan-1,3-diol

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

A The reaction is catalysed by concentrated H_2SO_4.

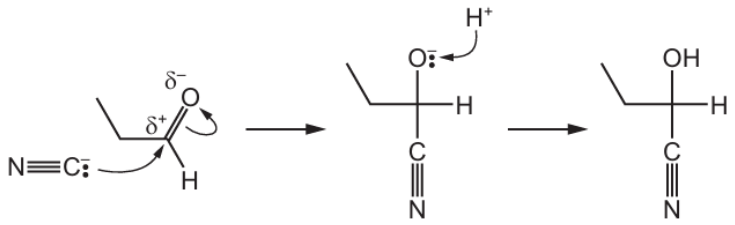
B Pentan-2-one and HCN react to give a chiral product.

C The reaction is a condensation reaction.

D The reaction is nucleophilic substitution.

33 Which reaction mechanism for the formation of $C_2H_5CH(OH)(CN)$ is correct?

A



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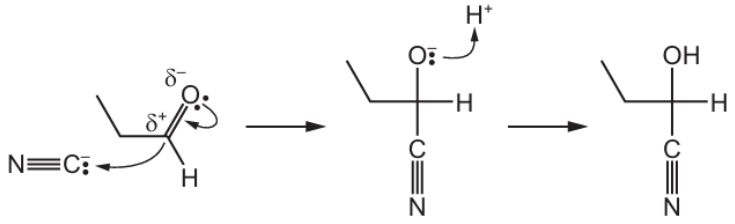

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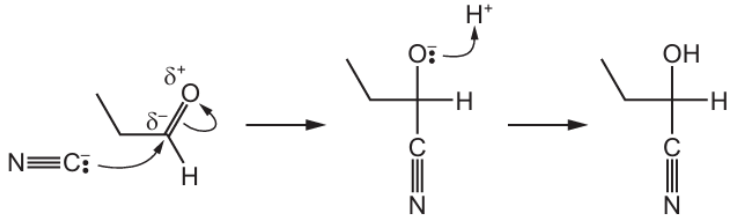

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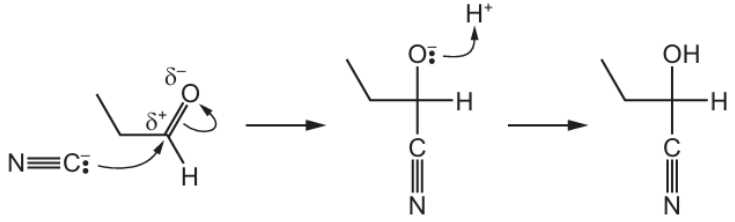


34 An alcohol with the molecular formula $C_5H_{12}O$ decolourises warm acidified potassium manganate(VII). The alcohol also gives a yellow precipitate with alkaline aqueous iodine.

What could be the identity of the alcohol?

A 2-methylbutan-2-ol

B 3-methylbutan-2-ol

C pentan-1-ol

D pentan-3-ol

35 Which pair of test results would prove that a substance, X, is a ketone?

A X has no reaction with Tollens' reagent. X reacts with alkaline aqueous iodine.

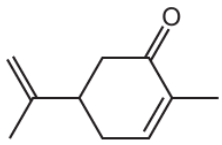
B X is reduced by lithium aluminium hydride. X is oxidised by acidified dichromate(VI).

C X reacts with 2,4-DNPH reagent. X has no reaction with Fehling's reagent.

D X reacts with hydrogen cyanide. X is reduced by lithium aluminium hydride.

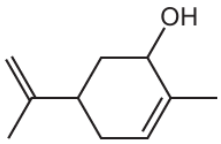
36 Carvone is found in spearmint oil.

carvone



Which product is formed when carvone is reacted with $NaBH_4$?

A



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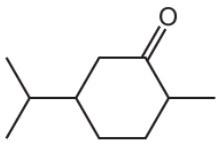

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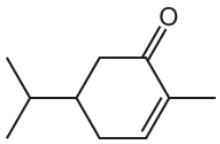
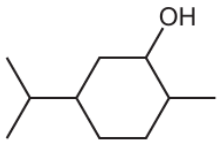
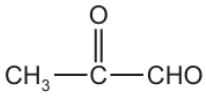


D



37 Compound X contains two functional groups.

compound X



Which reagent will react with **only one** of the functional groups?

A acidified potassium dichromate(VI)

B 2,4-DNPH reagent

C hydrogen cyanide

D $NaBH_4$

38 Diols in which both hydroxy groups are bonded to the same carbon atom can spontaneously eliminate a molecule of water to produce a carbonyl compound.

Which compound, after complete hydrolysis, gives a silver mirror with Tollens' reagent?

A 1,1-dibromobutane

B 1,2-dibromobutane

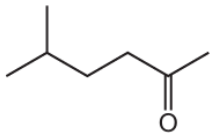
C 1,3-dibromobutane

D 2,2-dibromobutane

39 How many structural isomers are there of molecular formula $C_5H_{10}O$ that give a red precipitate with Fehling's solution?

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

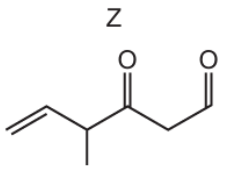
40 The skeletal formula of compound X is shown.



Which row is correct?

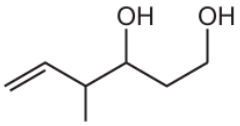
	molecular formula of X	observation on addition of X to Fehling's reagent
A	$C_7H_{14}O$	no change
B	$C_7H_{14}O$	red precipitate forms
C	$C_7H_{16}O$	no change
D	$C_7H_{16}O$	red precipitate forms

41 The diagram shows the structure of compound Z.



What is the product of the reaction between compound Z and an excess of $NaBH_4$?

A



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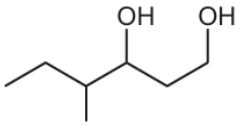
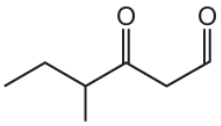


C



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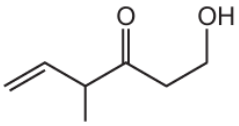


42 Compound Q shows the following reactions.

- It gives an orange precipitate with 2,4-dinitrophenylhydrazine.
- It gives a red-brown precipitate with Fehling's reagent.
- It gives a pale yellow precipitate with alkaline aqueous iodine.

What could be the identity of Q?

A ethanal

B propan-2-ol

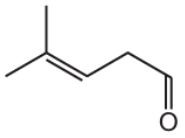
C propanal

D propanone

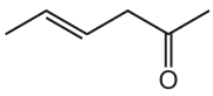
43 Compound X has stereoisomers and forms a precipitate when warmed with Fehling's reagent.

What could be the structure of compound X?

A



B



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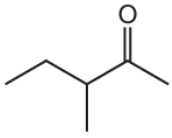

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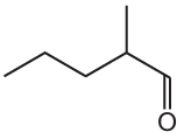
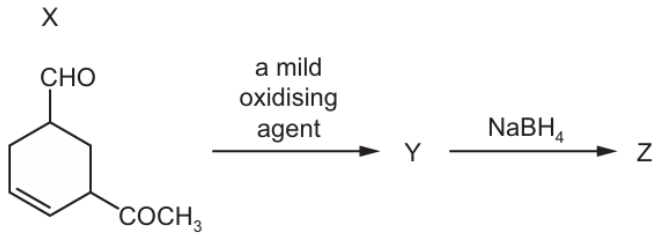
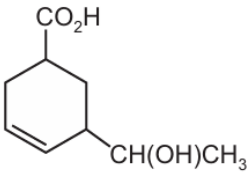


44 Compound X is treated with two reagents successively, forming compound Z.



What could be Z?

A



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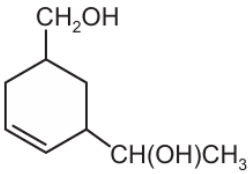

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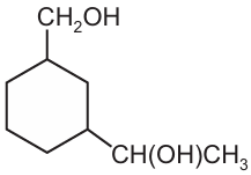

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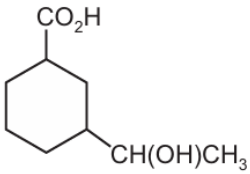


45 Which reagent may be used to distinguish between propanone and ethanol?

A 2,4-dinitrophenylhydrazine

B bromine water

C Fehling's reagent

D Tollens' reagent

46 Which reagent could be used to distinguish between ethanal and propanal?

A 2,4-dinitrophenylhydrazine

B I_2/NaOH(aq)

C $K_2Cr_2O_7/H_2SO_4$(aq)

D Tollens' reagent

47 Which compound shows optical isomerism and gives a positive test with alkaline aqueous iodine?

A $CH_3COCH(OH)CH_3$

B $CH_3COCH_2CH_2OH$

C $HOCH_2CH(CH_3)CHO$

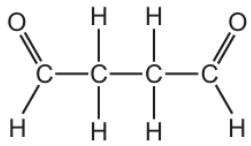
D $(CH_3)_2C(OH)CHO$

48 Compound X has the empirical formula C_2H_3O.

Compound X reacts with 2,4-dinitrophenylhydrazine reagent to give an orange precipitate and also decolourises warmed acidified potassium manganate(VII) solution.

What could be the identity of X?

A



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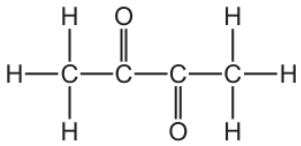

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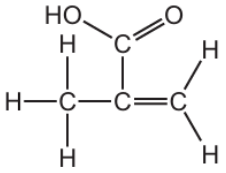

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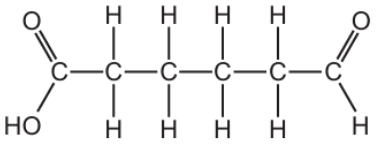


49 Compound Q

- contains a chiral centre,
- gives a positive result with Fehling's reagent,
- gives a positive result with alkaline aqueous iodine.

What could compound Q be?

A 1-hydroxybutanone

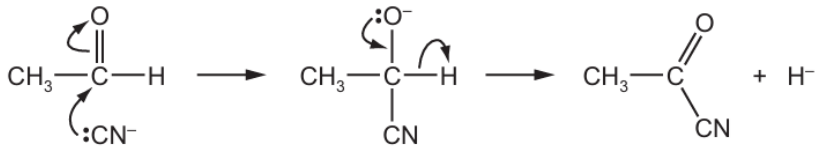
B 2-hydroxybutanal

C 3-hydroxybutanal

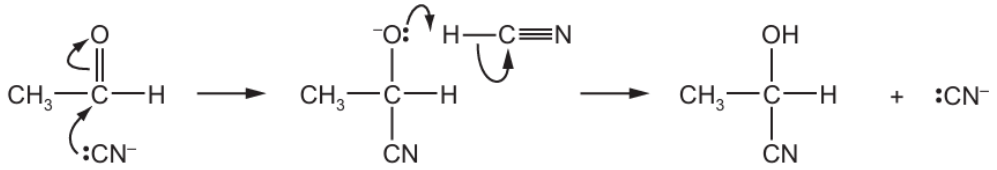
D 3-hydroxybutanone

50 What is the mechanism for the reaction of ethanal, CH_3CHO, with hydrogen cyanide, HCN, in the presence of NaCN?

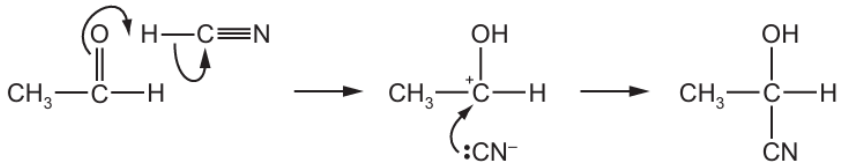
A



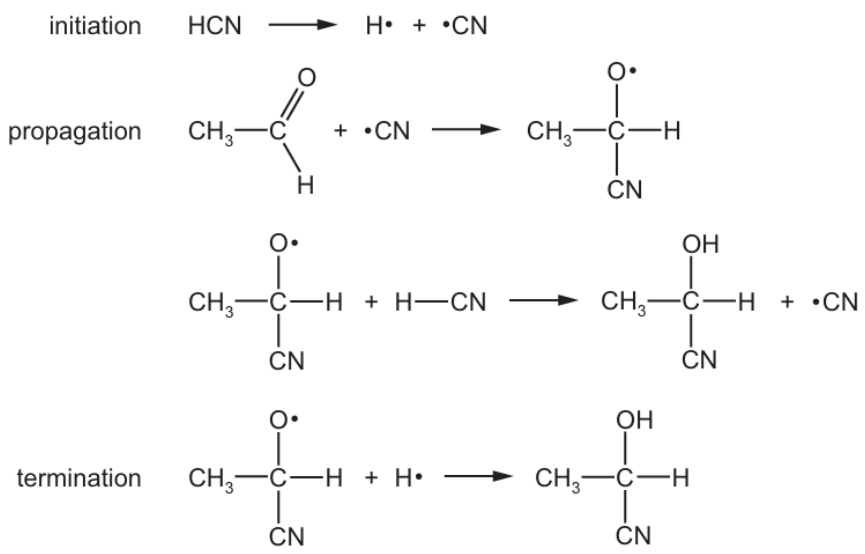
B



C



D



51 Which statement about butanone is correct?

A Butanone can be dehydrated by concentrated sulfuric acid to give $CH_2=CHCH=CH_2$.

B Butanone gives a positive result with Tollens' reagent.

C Butanone reacts with HCN by an electrophilic addition mechanism.

D Butanone reacts with $NaBH_4$ to give a chiral product.