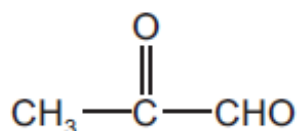


Q8 Burnt sugar has a characteristic smell caused partly by the following compound.



This compound contains two functional groups.

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

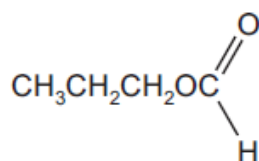
A acidified potassium dichromate(VI)

B 2,4-dinitrophenylhydrazine

C hydrogen cyanide

D sodium hydroxide

Q9 The structural formula of a compound X is shown below.



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
B	methyl propanoate	lower
C	propyl methanoate	higher
D	propyl methanoate	lower

Q10 Which carbonyl compound reacts with hydrogen cyanide to form a product that has no chiral carbon atom?

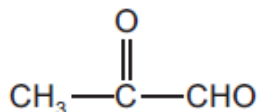
A butanone

B ethanal

C propanal

D propanone

Q11 Burnt sugar has a characteristic smell caused partly by the following compound.



This compound contains two functional groups.

Which reagent will react with both functional groups?

A acidified potassium dichromate(VI)

B Fehling's solution

C hydrogen cyanide

D sodium hydroxide

Q12 Ethanal, CH_3CHO , can be reduced using NaBH_4 in aqueous ethanol.

This is a nucleophilic addition reaction.

What could be the first step of this mechanism?

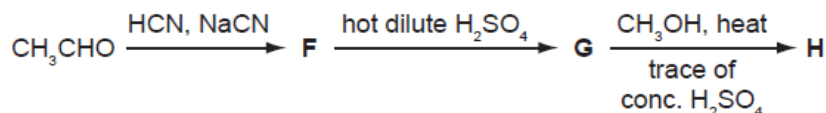
A attack of an H^- ion at the carbon atom of the carbonyl group

B attack of an H^- ion at the oxygen atom of the carbonyl group

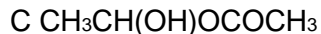
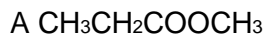
C attack of an H^+ ion at the carbon atom of the carbonyl group

D attack of an H^+ ion at the oxygen atom of the carbonyl group

Q13 In a sequence of reactions, ethanal is converted into a compound H.



What could H be?



Q14 In 1903 Arthur Lapworth became the first chemist to investigate a reaction mechanism. The

reaction he investigated was that of hydrogen cyanide with propanone.

What do we now call the mechanism of this reaction?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

D nucleophilic substitution

Q15 Complete combustion of compound X produces carbon dioxide and water only. X produces

steamy fumes with PCl_5 . X does not give any visible product with 2,4-dinitrophenylhydrazine reagent.

What can be deduced with certainty from this information?

A X is a carboxylic acid.

B X is a hydrocarbon.

C X is an alcohol.

D X is not an aldehyde.

Q16 Which compound is optically active and could also be oxidised to a ketone?

A 2-methylbutan-1-ol

B 3-methylhexan-3-ol

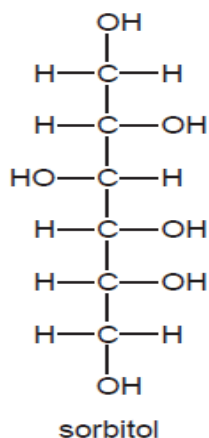
C 3-methylpentan-2-ol

D propan-2-ol

Section B

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

Q17 Sorbitol is an artificial sweetener used to sweeten chocolate which is suitable for diabetics.



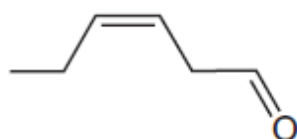
Which functional groups can be produced when this molecule is subjected to oxidation under suitable conditions?

- 1 aldehyde
- 2 carboxylic acid
- 3 ketone

Q18 In the reaction between an aldehyde and HCN, catalysed by NaCN, which statements about the reaction mechanism are correct?

- 1 A new carbon-carbon bond is formed.
- 2 In the intermediate, the oxygen carries a negative charge.
- 3 The last stage involves the formation of a hydrogen-oxygen bond.

Q19 The compound cis-hex-3-enal is responsible for the characteristic smell of cut grass. The human nose is particularly sensitive to this compound, being able to detect 0.25 parts per billion in air.

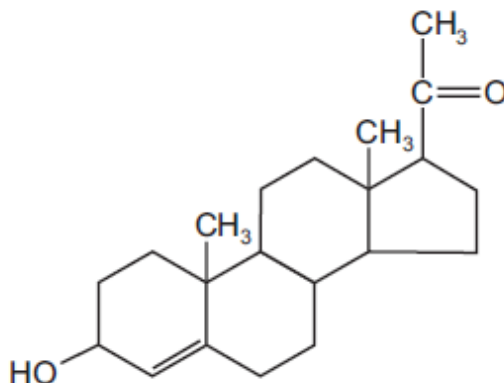


cis-hex-3-enal

Which reagents will react with cis-hex-3-enal?

- 1 sodium
- 2 sodium borohydride
- 3 Fehling's reagent

Q20 The compound shown is a hormone produced during pregnancy to suppress ovulation.



Which reagents would give positive results with this compound?

- 1 aqueous bromine
- 2 2,4-dinitrophenylhydrazine
- 3 Fehling's reagent

Q21 The M_r of compound X is 72. The composition by mass of X is 66.7 % carbon, 11.1 % hydrogen and 22.2 % oxygen. X gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent. X

does not react with Fehling's reagent.

What can be deduced from this information?

- 1 X is a carbonyl compound.
- 2 X is a ketone.
- 3 X is butanone.

Q22 A liquid X is known to be either a single organic compound or a mixture of organic compounds.

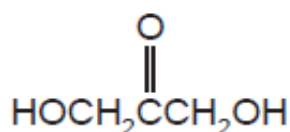
When treated with sodium, X gives off hydrogen gas.

When treated with 2,4-dinitrophenylhydrazine reagent, X gives orange crystals.

Which deductions about X can definitely be made?

- 1 At least one component of X is a carbonyl compound.
- 2 Only one of the components of X is a carbonyl compound.
- 3 At least one component of X is an alcohol.

Q23 DHA is a colourless liquid which reacts with protein in skin to cause it to darken. It has the structure shown.



DHA

Which observations would be made when testing this substance?

- 1 Hydrogen is produced when sodium is added.
- 2 A coloured precipitate is produced when 2,4-dinitrophenylhydrazine reagent is added.
- 3 A silver precipitate is produced when Tollens' reagent is added.

Q24 Compound X has molecular formula $\text{C}_4\text{H}_{10}\text{O}$. Separate samples of X are tested with three different reagents.

Which results could not be obtained?

	Tollens' reagent	2,4-dinitrophenylhydrazine reagent	warm acidified potassium dichromate(VI) solution
1	silver mirror forms	orange precipitate forms	colour changes from orange to green
2	no change	no change	no change
3	no change	no change	colour changes from orange to green

Q25 Which pairs of reagents will react together in a redox reaction?

- 1 CH_3CHO + Fehling's reagent
- 2 CH_4 + Cl_2
- 3 CH_3COCH_3 + Tollens' reagent

Q26 Which changes in bonding occur during the reaction of ethanal and hydrogen cyanide?

- 1 A carbon-carbon bond is formed.
- 2 A carbon-hydrogen bond is broken.
- 3 A carbon-nitrogen bond is broken

1. C
2. D
3. B
4. B
5. B
6. A
7. C
8. A
9. D
10. D
11. C
12. A
13. B
14. C
15. D
16. C
17. A
18. A
19. C
20. B
21. A
22. D
23. B
24. D
25. B
26. B

Q1 Ketones are widely used as solvents and as intermediates in the chemical industry.

Ketones contain the reactive keto group, >C=O .

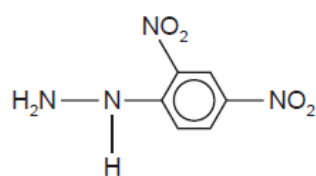
(a) Propanone, CH_3COCH_3 , undergoes a reaction with hydrogen cyanide, HCN .

(i) What type of reaction is this?

.....
 (ii) What reagents are used?

.....
 (iii) Draw a diagram to show the dipole present in the propanone molecule.

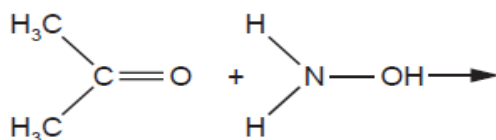
(b) Propanone reacts with 2,4-dinitrophenylhydrazine reagent.



2,4-dinitrophenylhydrazine

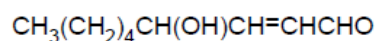
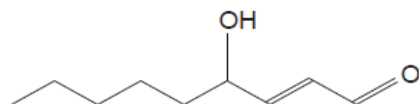
(i) Construct a balanced equation for the reaction between propanone and 2,4-dinitrophenylhydrazine.

(ii) A similar type of reaction occurs between propanone and hydroxylamine, NH_2OH . Draw the displayed formula of the organic product of this reaction.



(June 2011 P21)

Q2 The compound *trans*-4-hydroxy-2-nonenal (HNE) is thought to lead to infections of the lung when cigarettes are smoked.



trans-4-hydroxy-2-nonenal

(a) What is the empirical formula of *trans*-4-hydroxy-2-nonenal?

(b) (i) HNE contains an alkene group. Name as fully as you can **two** other functional groups which are present in the HNE molecule.

.....

(ii) How would you confirm the presence of the alkene group in HNE?
State the reagent used and the observation you would make.

reagent

observation

HNE is a reactive compound.

(c) Give the structural formulae of all of the carbon-containing compounds formed in each case when HNE is reacted separately with the following reagents.

(i) hot concentrated manganate(VII) ions in acid solution

(ii) hot phosphorus trichloride, PCl_3

(iii) sodium tetrahydridoborate(III), $NaBH_4$

(June 2011 P23)

Q3 Organic compounds which contain oxygen may contain alcohol, aldehyde, carboxylic acid, ester or ketone functional groups. The functional groups may be identified by their reactions with specific reagents.

Compound **X** has the empirical formula CH_2O and M_r of 90.

(a) There is no reaction when **X** is treated with $NaHCO_3$.

What functional group does this test show to be **not** present in **X**?.....

(b) When 0.600 g of **X** is reacted with an excess of Na, 160 cm³ of H_2 , measured at room temperature and pressure, is produced.

(i) What functional group does this reaction show to be present in **X**?.....

(ii) Use the data to calculate the amount, in moles, of hydrogen **atoms** produced from 0.600 g of **X**.

(iii) Hence, show that each molecule of **X** contains **two** of the functional groups you have given in (i).

(c) When **X** is warmed with Fehling's reagent, a brick red precipitate is formed.

Treatment of **X** with 2,4-dinitrophenylhydrazine reagent produces an orange solid.

(i) What functional group do these reactions show to be present in **X**?

Draw the displayed formula of this functional group.

(ii) Use your answers to (b)(i), (b)(ii) and (c)(i) to deduce the structural formula of **X**.

(iii) What is the structural formula of the organic product of the reaction of **X** with Fehling's reagent?

(d) Compound **X** can be both oxidised and reduced.

(i) Give the structural formula of the compound formed when **X** is reacted with NaBH_4 under suitable conditions.

(ii) Give the structural formula of the compound formed when **X** is heated under reflux with acidified $\text{K}_2\text{Cr}_2\text{O}_7$.

(June 2012 P21)

Q4 Oxygen-containing organic compounds may contain a number of different functional groups including alcohol, aldehyde, carboxylic acid, ester or ketone functional groups. These functional groups may be identified by their reactions with specific reagents.

(a) On treating compounds containing each of these functional groups with the reagents below, only five reactions occur. Complete the table by placing a tick (\square) in each box where you believe a reaction will occur. You should place **no more** than five ticks in the table.

reagent	alcohol R_2CHOH	aldehyde RCHO	carboxylic acid RCO_2H	ester $\text{RCO}_2\text{R}'$	ketone RCOR'
NaHCO_3					
Na					
$\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$					

Compound **G** has the empirical formula CH_2O and M_r of 90.

An aqueous solution of **G** is neutral. There is no reaction when **G** is treated with NaHCO_3 .

When 0.30 g of pure **G** is reacted with an excess of Na, 80 cm³ of H_2 , measured at room temperature and pressure, is produced.

(b) (i) What functional group do these two reactions show to be present in **G**.....

(ii) Use the data to calculate the amount, in moles, of hydrogen atoms produced from 0.30 g of **G**.

(iii) Hence, show that each molecule of **G** contains **two** of the functional groups you have given in (i).

(c) Treatment of **G** with 2,4-dinitrophenylhydrazine reagent produces an orange solid. When **G** is warmed with Fehling's reagent, no reaction occurs.

(i) What functional group do these reactions show to be present in **G**? Draw the displayed formula of this functional group.

(ii) Use your answers to (b)(i) and (c)(i) to deduce the structural formula of **G**.

(d) Compound **G** can be both oxidised and reduced.

(i) When **G** is heated under reflux with acidified $K_2Cr_2O_7$, compound **H** is formed. Give the structural formula of compound **H**.

(ii) When **G** is reacted with $NaBH_4$ under suitable conditions, compound **J** is formed. Give the structural formula of compound **J**.

(June 2012 P22)

Q5 Astronomers using modern telescopes of various types have found many molecules in the dust clouds in space. Many of these molecules are those of organic compounds and astronomers constantly look for evidence that amino acids such as aminoethanoic acid, $H_2NCH_2CO_2H$, are present.

One molecule that has been found in the dust clouds is hydroxyethanal, $HOCH_2CHO$.

(a) Hydroxyethanal contains two functional groups.

(i) Name, **as fully as you can**, each of the functional groups present in hydroxyethanal.

1 2.....

(ii) For **each** functional group, identify a reagent that will react with this group and **not** react with the other functional group present.

In each case, describe what would be observed when this reaction is carried out.

functional group 1

reagent observation.....

functional group 2

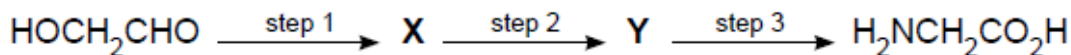
reagent observation.....

(b) Give the **skeletal** formulae of the organic compounds formed when hydroxyethanal is reacted separately with the following.

(i) $NaBH_4$

(ii) $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ under reflux conditions

In a school or college laboratory, it is possible to convert a sample of hydroxyethanal into aminoethanoic acid in a three-step process.



By considering the possible reactions of the functional groups present in hydroxyethanal, you are to deduce a possible route for this conversion.

(c) (i) In the boxes below, draw the structural formulae of your suggested intermediates X and Y.

X	Y
---	---

(ii) State the reagents for **each** of the three steps you have chosen.

step 1.....step 2.....step 3.....
(Nov 2011 P21)

Q6 Many organic compounds, including alcohols, carbonyl compounds, carboxylic acids and esters, contain oxygen.

(a) The table below lists some oxygen-containing organic compounds and some common laboratory reagents.

(i) Complete the table as fully as you can.

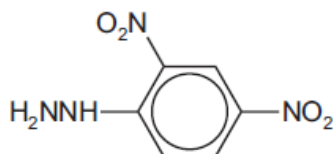
If you think no reaction occurs, write 'no reaction' in the box for the structural formula(e).

reaction	organic compound	reagent	structural formula(e) of organic product(s)
A	$(\text{CH}_3)_3\text{COH}$	$\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ heat under reflux	
B	$\text{CH}_3\text{CH}_2\text{CHO}$	Fehling's reagent warm	
C	$\text{HCO}_2\text{CH}(\text{CH}_3)_2$	$\text{NaOH}(\text{aq})$ warm	
D	$\text{CH}_2=\text{CHCHO}$	NaBH_4	
E	$(\text{CH}_3)_3\text{COH}$	NaBH_4	
F	$\text{CH}_3\text{CH}_2\text{COCH}_3$	$\text{MnO}_4^-/\text{H}^+$ heat under reflux	

(ii) During some of the reactions in (i) a colour change occurs. Complete the table below for any such reactions, stating the letter of the reaction and what the colour change is.

reaction	colour at the beginning of the reaction	colour at the end of the reaction

(b) Some oxygen-containing compounds react with 2,4-dinitrophenylhydrazine.



2,4-dinitrophenylhydrazine

(i) Draw the structural formula of the organic compound formed when $\text{HOCH}_2\text{CH}_2\text{CHO}$ reacts with 2,4-dinitrophenylhydrazine reagent.

(ii) Suggest the colour of the organic product.....

Q7 Many organic compounds, including alcohols, carbonyl compounds, carboxylic acids and esters, contain oxygen.

(a) The table below lists some oxygen-containing organic compounds and some common laboratory reagents.

(i) Complete the table as fully as you can.

If you think no reaction occurs, write 'no reaction' in the box for the structural formula(e).

reaction	organic compound	reagent	structural formula(e) of organic product(s)
A	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$	NaBH_4	
B	CH_3COCH_3	Tollens' reagent warm	
C	$\text{CH}_3\text{CO}_2\text{CH}(\text{CH}_3)_2$	$\text{KOH}(\text{aq})$ warm	
D	$(\text{CH}_3)_3\text{COH}$	$\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ heat under reflux	
E	CH_3COCH_3	NaBH_4	
F	$(\text{CH}_3)_3\text{COH}$	PCl_5	
G	$\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH}$	$\text{MnO}_4^-/\text{H}^+$ heat under reflux	

(ii) During some of the reactions in (i) a colour change occurs.

Complete the table below for any such reactions, stating the letter of the reaction and what the colour change is.

reaction	colour at the beginning of the reaction	colour at the end of the reaction

Q8 Crotonaldehyde, $\text{CH}_3\text{CH}=\text{CHCHO}$, occurs in soybean oils.

(a) In the boxes below, write the **structural formula** of the organic compound formed when crotonaldehyde is reacted separately with each reagent under suitable conditions.

If you think no reaction occurs, write 'NO REACTION' in the box.

reaction	reagent	product
A	Br_2 in an inert organic solvent	
B	PCl_3	
C	H_2 and Ni catalyst	
D	NaBH_4	
E	$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$	

(b) Crotonaldehyde exists in more than one stereoisomeric form.

Draw the **displayed formulae** of the **stereoisomers** of crotonaldehyde.

Label **each** isomer.

(c) Draw the **skeletal formula** of crotonaldehyde.

(d) The product of reaction E in the table opposite will react with a solution containing acidified manganate(VII) ions.

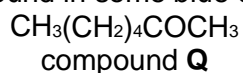
Draw the **structural formulae** of the organic products when the reagent is

(i) cold, dilute;

(ii) hot, concentrated.

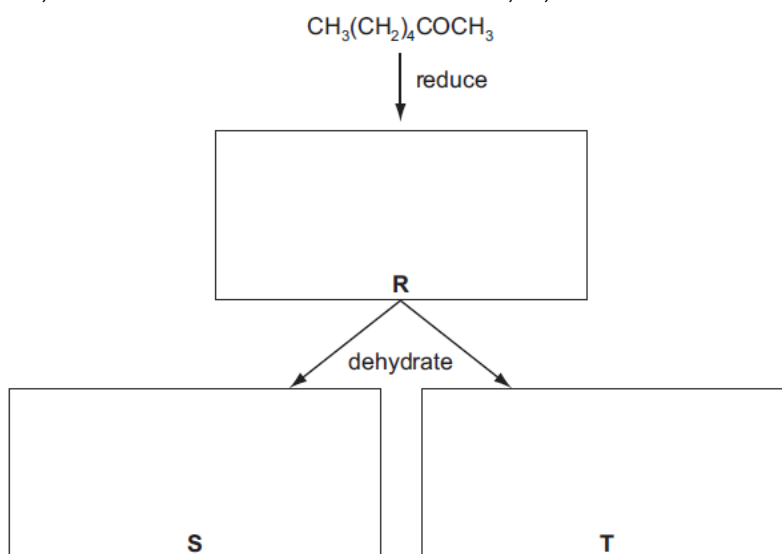
(June 2013 P21)

Q9 Compound **Q**, heptan-2-one, is found in some blue cheeses.



(a) Compound **Q** may be reduced to **R**.

Compound **R** may be dehydrated to give two different products, **S** and **T**.
In the boxes below, draw the **structural formulae** of **R**, **S**, and **T**.



(ii) State the reagents that would be used for **each** of these reactions in a school or college laboratory.

reduction

dehydration

(b) In the boxes below, write the **structural formula** of the organic compound formed when **Q** is reacted separately with each reagent under suitable conditions.

If you think no reaction occurs, write 'NO REACTION' in the box.

Tollens' reagent	
HCN	
$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$	

(June 2013 P23)