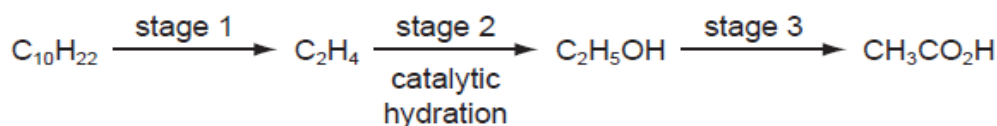


Section A

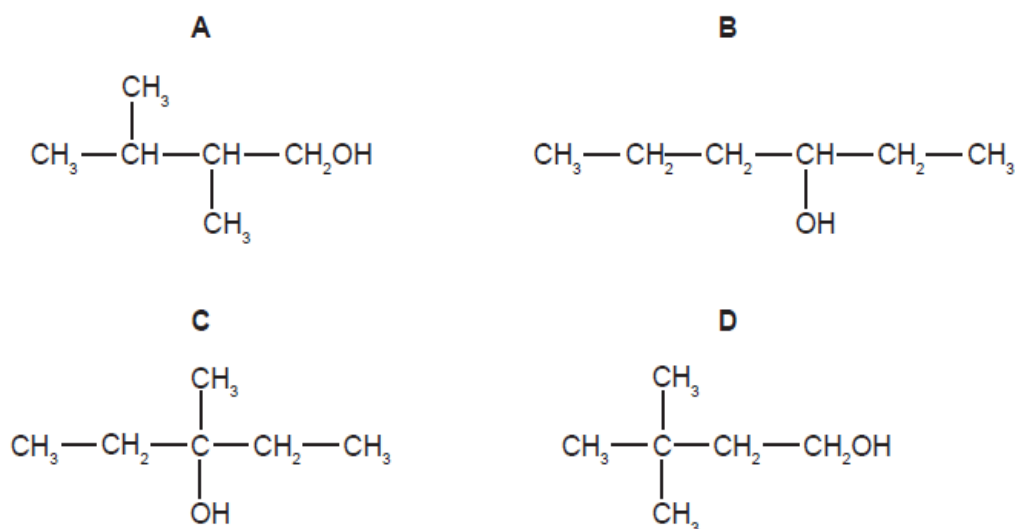
Q1 In the reaction pathway below, an alkane is converted into a carboxylic acid through several stages.



Which processes occur at stage 1 and at stage 3?

	stage 1	stage 3
A	condensation	combustion
B	cracking	dehydration
C	cracking	oxidation
D	dehydration	combustion

Q2 Which isomer of $\text{C}_6\text{H}_{13}\text{OH}$ gives the greatest number of different alkenes when it is dehydrated?



Q3 The functional group in a primary alcohol is $-\text{CH}_2\text{OH}$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

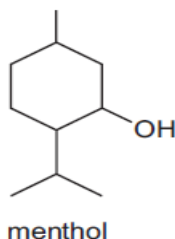
A Al_2O_3

B $\text{CH}_3\text{CO}_2\text{H}$

C HBr

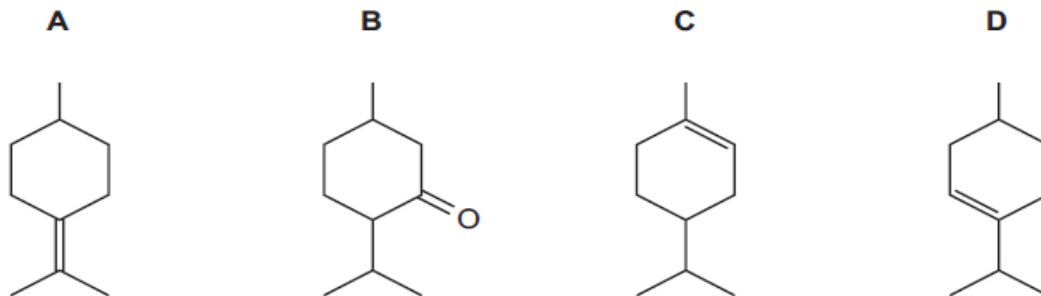
D Na

Q4 The compound shown is menthol, a naturally-occurring alcohol found in peppermint oil.



When menthol is heated with concentrated sulfuric acid it reacts. The products that form include compound T.

What could be the structure of compound T?

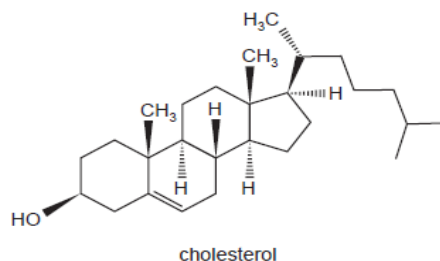


Q5 Which compound gives an organic product with a lower boiling point when it is heated under reflux with an excess of acidified potassium dichromate(VI)?

- A 2-methylbutan-1-ol
B 2-methylbutan-2-ol
C pentan-1-ol
D pentan-2-ol

Q6 This question should be answered by considering the reactions of KMnO_4 with different functional groups under the stated conditions.

The diagram shows the structure of the naturally-occurring molecule cholesterol.



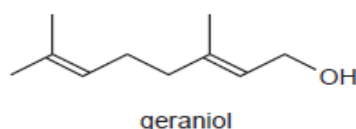
Separate oxidation reactions are carried out using different conditions.

- cold, dilute acidified KMnO_4
- hot, concentrated acidified KMnO_4

Which statements about the products formed are correct?

	cold, dilute acidified KMnO_4 : number of hydroxy groups present	hot, concentrated acidified KMnO_4 : number of 6-membered rings remaining
A	1	2
B	1	3
C	3	2
D	3	3

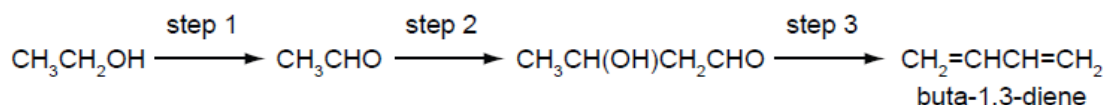
Q7 Geraniol is a constituent of some perfumes.



Which statement about geraniol is not correct?

- A Geraniol causes hot acidified potassium dichromate(VI) to change colour from orange to green.
B Geraniol decolourises bromine water.
C There are three methyl groups and three methylene (CH_2) groups in geraniol.
D There are two pairs of cis-trans isomers of geraniol.

Q8 Buta-1,3-diene is currently obtained from fossil fuel sources. In future it may be obtained from ethanol, which can be produced from non-food agricultural crops. The sequence of reactions is as follows.



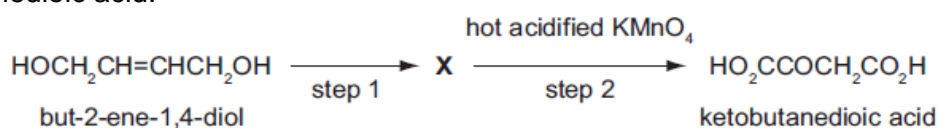
Which term could be used to describe step 1?

- A condensation
 B dehydration
 C dehydrogenation
 D hydrogenation

Q9 How many of the isomeric alcohols with the formula $\text{C}_4\text{H}_9\text{OH}$ will produce an alkene that has cis and trans isomers, on treatment with conc. H_2SO_4 ?

- A 1
 B 2
 C 3
 D 4

Q10 But-2-ene-1,4-diol is converted in two steps through an intermediate X into ketobutanedioic acid.



What could be the reagent for step 1 and the intermediate X?

	reagent for step 1	X
A	cold acidified KMnO_4	$\text{HOCH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$
B	hot acidified KMnO_4	$\text{OHCCH}(\text{OH})\text{CH}_2\text{CHO}$
C	steam and concentrated H_2SO_4	$\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{OH}$
D	warm acidified $\text{K}_2\text{Cr}_2\text{O}_7$	$\text{HO}_2\text{CCH}=\text{CHCO}_2\text{H}$

Q11 Many, but not all, organic reactions need to be heated before reaction occurs. Which reaction occurs at a good rate at room temperature ($20\text{ }^\circ\text{C}$)?

- A $\text{CH}_3\text{OH} + \text{PCl}_5 \rightarrow \text{CH}_3\text{Cl} + \text{POCl}_3 + \text{HCl}$
 B $\text{CH}_3\text{CH}_2\text{Br} + \text{KCN} \rightarrow \text{CH}_3\text{CH}_2\text{CN} + \text{KBr}$
 C $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
 D $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{NH}_3$

Q12 An organic compound X

- is unaffected by hot acidified potassium manganate(VII),
- reacts with ethanoic acid in the presence of concentrated sulfuric acid.

What is compound X?

- A $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$
 B $\text{CH}_3\text{CH}_2\text{COCH}_3$
 C $(\text{CH}_3)_3\text{COH}$
 D $\text{CH}_3\text{CH}_2\text{CHOHCH}_3$

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

Q13 What can be produced when an aqueous solution of butan-2-ol is oxidised under suitable conditions?

- 1 butanone
- 2 butanoic acid
- 3 butanal

Q14 Which compounds will produce ethanoic acid when boiled under reflux with dilute alkali followed by acidification?

- 1 $\text{CH}_3\text{CH}_2\text{Cl}$
- 2 $\text{CH}_3\text{CO}_2\text{CH}_3$
- 3 CH_3CN

1. C
2. B
3. D
4. D
5. D
6. C
7. D
8. C
9. A
10. C
11. A
12. C
13. D
14. C

Q1 Compounds containing the allyl group, $\text{CH}_2=\text{CHCH}_2-$, have pungent smells and are found in onions and garlic.

Allyl alcohol, $\text{CH}_2=\text{CHCH}_2\text{OH}$, is a colourless liquid which is soluble in water.

(a) Allyl alcohol behaves as a primary alcohol and as an alkene.

Give the structural formula of the organic compound formed when allyl alcohol is reacted separately with each of the following reagents.

(i) acidified potassium dichromate(VI), heating under reflux

(ii) bromine in an inert organic solvent

(iii) cold, dilute, acidified potassium manganate(VII)

(iv) hot, concentrated, acidified potassium manganate(VII)

(b) Allyl alcohol undergoes the following reactions.

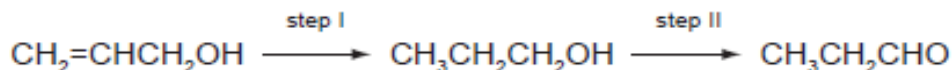
(i) When reacted with concentrated HCl at 100°C , $\text{CH}_2=\text{CHCH}_2\text{Cl}$ is formed.

State as fully as you can what *type of reaction* this is.

.....
 (ii) When reacted with MnO_2 at room temperature, $\text{CH}_2=\text{CHCHO}$ is formed.

What *type of reaction* is this?

.....
 (c) Allyl alcohol can be converted into propanal in two steps.



(i) What reagents and conditions would be used for **each** step?

step I

reagent(s)

condition(s)

step II

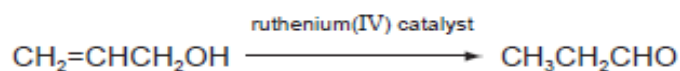
reagent(s)

condition(s)

(ii) Allyl alcohol and propanal are isomers.

What form of isomerism do they display?.....

(d) Allyl alcohol may also be converted into propanal by using a ruthenium(IV) catalyst in water.



Suggest what is unusual about this single step reaction.

.....

Q2 Crotyl alcohol, $\text{CH}_3\text{CH}=\text{CHCH}_2\text{OH}$, is a colourless liquid which is used as a solvent.

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

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

A	Br_2 in an inert organic solvent	
B	PCl_5	
C	H_2 and Ni catalyst	
D	NaBH_4	
E	$\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$ heat under reflux	

(b) Draw the **displayed formula** of the organic compound formed when crotyl alcohol is reacted with cold, dilute acidified potassium manganate(VII).

(c) Draw the **skeletal formula** of the compound formed in reaction E.

(d) Crotyl alcohol is obtained from crotonaldehyde, $\text{CH}_3\text{CH}=\text{CHCHO}$.

(i) Describe one test that would confirm the presence of a small amount of unreacted crotonaldehyde in the crotyl alcohol.

Give the name of the reagent used and state what you would see.

reagent

observation

(ii) What *type of reaction* is the conversion of crotonaldehyde into crotyl alcohol?

.....

(e) Compound **P**, another unsaturated compound, is found in some blue cheeses. The percentage composition by mass of compound **P** is C: 73.7%; H: 12.3%; O: 14.0%. Calculate the empirical formula of compound **P**.

(June 2013 P22)

Q3 Compound **X** has the molecular formula $C_4H_8O_2$.

(a) (i) Treatment of **X** with sodium metal produces a colourless flammable gas. What does this result tell you about the functional groups that could be present in **X**?

.....

(ii) There is no reaction when **X** is treated with sodium hydrogencarbonate, $NaHCO_3$. What does this result tell you about the functional groups that could be present in **X**?

.....

(iii) When **X** is shaken with aqueous bromine the orange colour disappears. What does this result tell you about the functional groups that could be present in **X**?

.....

.....

(b) The molecule of **X** has the following features.

- The carbon chain is unbranched and the molecule is not cyclic.
 - No oxygen atom is attached to any carbon atom which is involved in π bonding.
 - No carbon atom has more than one oxygen atom joined to it.
- There are five possible isomers of **X** which fit these data. Four of these isomers exist as two pairs of stereoisomers.

(i) Draw displayed formulae of **each** of these two pairs.

pair 1		
pair 2		

(ii) These four isomers of **X** show two types of stereoisomerism. State which type of isomerism each pair shows.

pair 1 pair 2

Q4 The fermentation of starch or molasses using the bacterium *Clostridium acetobutylicum*, produces a mixture of propanone and butan-1-ol.

(a) Give the reagent(s) and state what would be observed when **one** test is carried out to confirm the presence of propanone in a mixture of propanone and butan-1-ol.

reagent(s)

observation

(b) What will be observed when a small piece of sodium metal is dropped into a dry sample of butan-1-ol? Write an equation for the reaction that takes place.

observation

equation

The molecular formula $C_5H_{12}O$ represents a number of alcohols.

Three alcohols with molecular formula $C_5H_{12}O$ are straight chain pentanols.

(c) Draw the following formulae.

(i) the **structural** formula of pentan-1-ol

(ii) the **displayed** formula of pentan-2-ol

(iii) the **skeletal** formula of pentan-3-ol

When one of the three pentanols in (c) is dehydrated, alkenes with **two** different structural formulae are formed.

(d) Identify this alcohol and give the structural formula of **each** alkene.

name of alcohol

alkene 1	alkene 2
----------	----------

A number of alcohols with molecular formula $C_5H_{12}O$ are branched chain compounds and may be considered as derivatives of butanol or propanol with alkyl side chains.

(e) (i) Draw the structural formula of the **derivative of propanol** that has the molecular formula $C_5H_{12}O$.

(ii) Draw the structural formula of the organic compound that will be present when the derivative of propanol you have given in (i) is heated under reflux with acidified potassium dichromate(VI).

Q5 Alcohols are widely used as solvents and in the manufacture of esters.

Butan-1-ol, $C_4H_{10}O$, is an example of a primary alcohol.

(a) What is meant by the term *primary alcohol*?

..... [1]
 (b) There are three more alcohols with molecular formula $C_4H_{10}O$ that are **structural** isomers of butan-1-ol.

Complete the table below by drawing displayed formulae of **each** of these three compounds.

For **each** isomer, state whether it is a primary, secondary, or tertiary alcohol.

$ \begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{OH} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array} $			
primary			
butan-1-ol	isomer 2	isomer 3	isomer 4

(c) Butan-1-ol can be oxidised to a carboxylic acid by heating with an acidified solution of potassium dichromate(VI).

(i) What colour change would be seen during this reaction?

from to

(ii) State which of the isomers you have drawn in (b) could also be oxidised to form a carboxylic acid.

.....

(Nov 2005)