Organic Chemistry

Question Paper 2

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Organic Chemistry
Booklet	Question Paper 2

Time Allowed: **28 minutes**

Score: **/23**

Percentage: **/100**

Grade Boundaries:

Carboxyl Groups

1. Compound **K** is a nitrile. Reduction of **K** produces the compound $C_3H_7NH_2$.

   Hydrolysis of **K** by warm HC*l*(aq) produces compound **L**.

   What is **L**?

   A $CH_3CH_2NH_2$

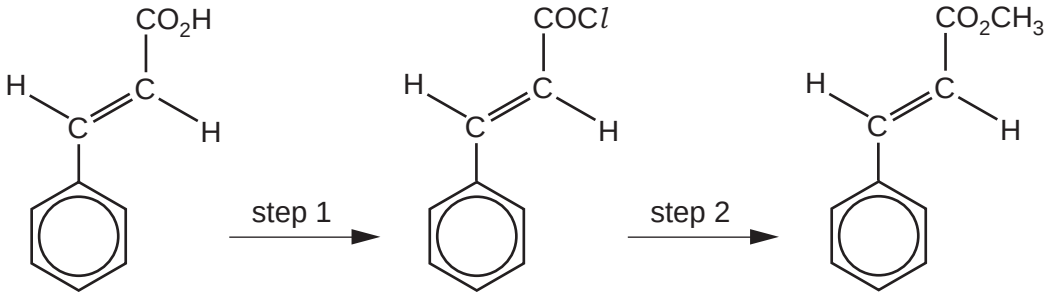
   B CH_3CH_2OH

   C $CH_3CH_2CO_2H$

   D $CH_3CH_2CH_2CO_2H$

2. Methyl cinnamate is responsible for the spicy aroma of the matsutake mushroom added to many Japanese foods.

   It can be prepared as shown.



methyl cinnamate

Which reagents could be used?

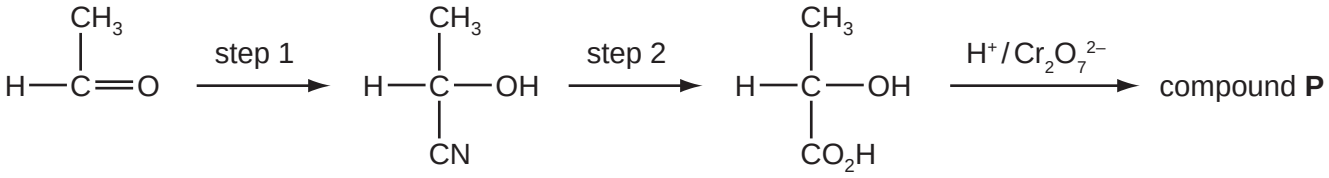
	step 1	step 2
A	HC*l*	CH_3OH
B	HC*l*	CH_3CO_2H
C	PCl_5	CH_3OH
D	PCl_5	CH_3CO_2H

3. The molecule H_2NCH_2CN has been detected in interstellar space.

What is the functional group level of the CN carbon, and what is the hydrolysis product of this molecule?

	functional group level of CN carbon	hydrolysis product
A	alcohol	$HOCH_2CH_2OH$
B	alcohol	$H_2NCH_2CO_2H$
C	carboxylic acid	$HOCH_2CH_2OH$
D	carboxylic acid	$H_2NCH_2CO_2H$

4. The diagram shows a reaction scheme.



Which statement about this reaction scheme is **not** correct?

A Step 1 involves addition.

B Step 2 involves hydrolysis.

C **P** contains two carbon atoms with the same functional group level.

D **P** has the molecular formula $C_3H_4O_3$.

5. Ethanoic acid forms a double molecule or dimer of molecular formula $C_4H_8O_4$.

This dimer contains an 8-membered ring containing two hydrogen bonds.

How many carbon, hydrogen and oxygen atoms are present in this ring?

	C	H	O
A	2	2	4
B	2	4	2
C	4	0	4
D	4	2	2

6. Sulfuric acid is involved in reactions X, Y and Z.

X $2NaBr + 2H_2SO_4 \longrightarrow Na_2SO_4 + Br_2 + SO_2 + 2H_2O$

Y $C_2H_5OH + CH_3COOH \xrightarrow{H_2SO_4} CH_3COOCH_2CH_3 + H_2O$

Z $2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$

What is the best description of the action of sulfuric acid in each of these reactions?

	X	Y	Z
A	acid	catalyst	oxidising agent
B	acid	dehydrating agent	oxidising agent
C	dehydrating agent	oxidising agent	acid
D	oxidising agent	catalyst	acid

7. Which functional group **cannot** be turned into an alcohol in a single reaction?

A alkene

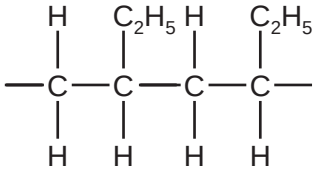
B carbonyl

C halogenoalkane

D nitrile

8. An alcohol, **X**, can be dehydrated producing a hydrocarbon.

Polymerisation of this hydrocarbon gives the polymer shown.



What is **X**?

A 2-methylpropan-1-ol

B butan-1-ol

C ethanol

D propan-1-ol

Carbon dioxide

9. Iodine pentoxide, I_2O_5, is a colourless crystalline solid. Carbon monoxide, CO, is a reducing agent.

   When an excess of CO is reacted with I_2O_5, there is no change in gaseous volume after cooling to the original temperature. A grey-black solid is produced. When this solid is heated separately, it produces a purple vapour.

   In which molar ratio do CO and I_2O_5 react?

   A 1 : 1 **B** 2 : 5 **C** 5 : 1 **D** 5 : 2

Mechanisms

10. Which steps are involved in the mechanism of the reaction between 2-chloro-2-methylbutane and aqueous sodium hydroxide?

	first step	second step
A	heterolytic bond fission	attack of an electrophile on a carbanion
B	heterolytic bond fission	attack of a nucleophile on a carbocation
C	homolytic bond fission	attack of an electrophile on a carbanion
D	homolytic bond fission	attack of a nucleophile on a carbocation

11. Methane is a greenhouse gas but is destroyed in the troposphere by the action of hydroxyl radicals.

$$\bullet OH + CH_4 \rightarrow \bullet CH_3 + H_2O$$

Which statement about this reaction is correct?

A The reaction involves heterolytic fission and σ bond formation.

B The reaction involves homolytic fission and σ bond formation.

C The reaction involves homolytic fission and π bond formation.

D The total number of electrons in the two reacting species is 20.

12. What causes carbonyl groups, C=O, to react by a nucleophilic mechanism while alkene groups, C=C, react by an electrophilic mechanism?

A oxygen is more reactive than carbon

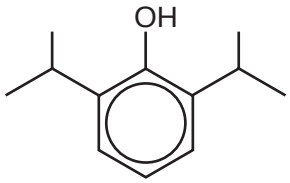
B the different lengths of the double bonds

C the electronegativity difference between the carbon and oxygen atoms in the carbonyl group

D the relative strengths of the double bonds

Aromatics

13. The diagram shows the structure of propofol, a short-acting intravenous anaesthetic used for both adults and children, and also in veterinary medicine.



When reacted with a very dilute solution of Cl_2 a chlorine atom may substitute for a hydrogen atom on the benzene ring but **not** for a hydrogen atom on the alkyl branches or in the –OH group.

Given that any number of the benzene hydrogens may be substituted, how many possible products of the reaction are there?

A 3 **B** 4 **C** 5 **D** 6

Acidity and Basicity

14. Which statement explains why phenylamine is a weaker base than methylamine?

A Phenylamine is less volatile than methylamine.

B The benzene ring in phenylamine is electron releasing.

C The lone pair of electrons on the nitrogen in phenylamine is delocalised over the benzene ring.

D The methyl group is smaller than the phenyl group.

15. Which of the following, in aqueous solutions of equal concentration, has the lowest pH?

A $Cl CH_2CO_2H$

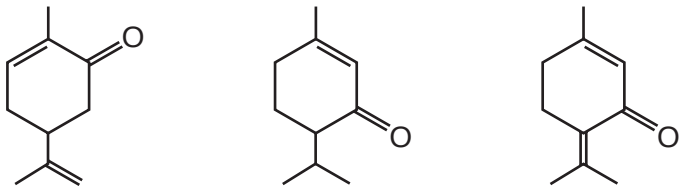
B CH_3CO_2H

C $C_2H_5NH_2$

D C_6H_5OH

Stereochemistry

16. Carbonyl derivatives of cyclohexene are present in plant oils. The structures show three such derivatives.



P **Q** **R**

Which of these molecules have a chiral centre?

A **P**, **Q** and **R**

B **P** and **Q** only

C **P** and **R** only

D **Q** and **R** only

17. Which forms of isomerism will be shown by the molecule 2,4-dimethylhex-2-ene?

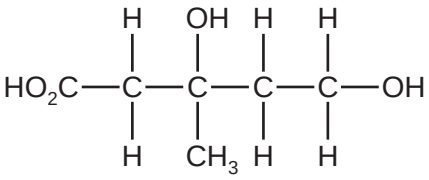
A both geometric and optical isomerism

B geometric isomerism only

C optical isomerism only

D neither geometric nor optical isomerism

18. Mevalonic acid is involved in the biosynthesis of cholesterol.



mevalonic acid

When mevalonic acid is heated under reflux with acidified potassium dichromate(VI) an organic compound **X** is produced.

Which row is correct for **X**?

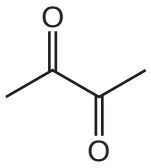
	number of chiral carbon atoms in one molecule of **X**	number of peaks in the carbon-13 NMR spectrum of **X**
A	0	4
B	0	6
C	1	4
D	1	6

19. Ethoxyethane, $C_2H_5OC_2H_5$, is the most well known of a class of compounds called ethers. Ethers have the general formula $R_1–O–R_2$ where R_1 and R_2 are hydrocarbon groups.

What is the lowest number of carbon atoms a non-cyclic ether molecule needs to have a chiral carbon atom?

A 4 **B** 5 **C** 6 **D** 7

20. The diagram shows butane-2,3-dione, a butter-flavoured molecule.

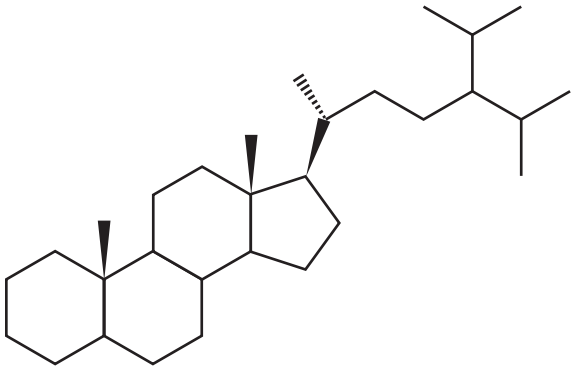


The two carbonyl groups in the molecule are reduced to alcohols.

How many chiral centres are there in the product, and what is the molecular formula of the product?

	number of chiral centres	molecular formula of the product
A	0	$C_4H_8O_2$
B	0	$C_4H_{10}O_2$
C	2	$C_4H_8O_2$
D	2	$C_4H_{10}O_2$

21. The molecule 24-isopropylcholestane, which has been isolated from a class of sponge, can serve as a biomarker and has determined the first evolutionary appearances of some species.

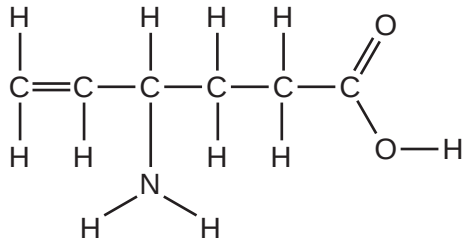


Carbon atoms in a molecule are classified as primary, secondary, tertiary or quaternary, depending on whether they are directly bonded to one, two, three or four other carbon atoms.

How many tertiary carbons and how many chiral carbons are there in this molecule?

	tertiary carbons	chiral carbons
A	9	4
B	9	8
C	11	4
D	11	8

22. The diagram shows the molecular structure of Vigabatrin®, a compound used in the treatment of epilepsy.



Which types of stereoisomerism are present in the Vigabatrin® molecule?

A geometric and optical

B geometric only

C optical only

D none

23. Four isomers of $C_3H_6OCl_2$ are separately subjected to hydrolysis using aqueous sodium hydroxide.

Which isomer produces an organic product with a different molecular formula than the other three isomers?

A $CH_3CCl_2CH_2OH$

B $CH_2ClCHClCH_2OH$

C $CH_2ClCH_2CH(OH)Cl$

D $CHCl_2CH_2CH_2OH$