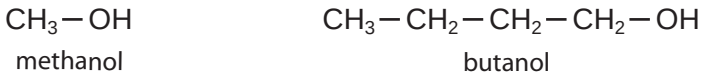
1 The alcohols form a homologous series. The first member is methanol and the fourth is butanol.



(a) Give **two** general characteristics of a homologous series.

.....

.....

..... [2]

(ii) Calculate the mass of one mole of the C_8 alcohol.

.....

..... [2]

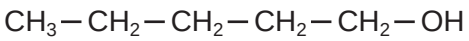
(b) Give the name and structural formula of the third member of this series.

name ..... [1]

structural formula

[1]

(c) The structural formula of the fifth member, pentan-1-ol, is drawn below.



(i) Draw the structural formula of an isomer of this alcohol.

[1]

(ii) Predict the names of the product(s) formed when pentan-1-ol

- reacts with an excess of oxygen,

  ..... and ..... [1]

- is dehydrated to form an alkene,

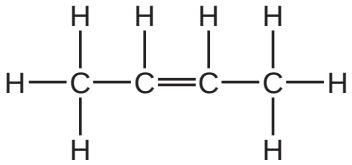
  ..... [1]

- is oxidised by acidified potassium dichromate(VI).

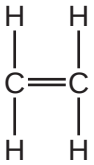
  ..... [1]

2 The structures of six organic compounds are shown.

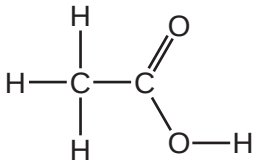
A



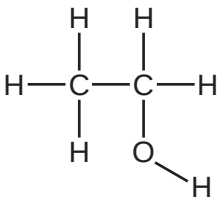
B



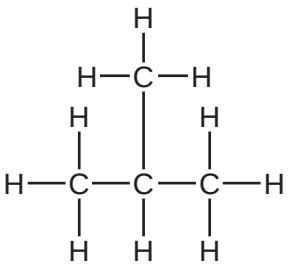
C



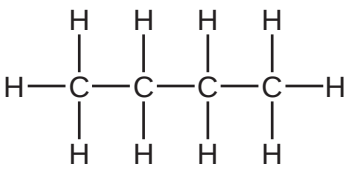
D



E



F



(a) Give the name of **F**.

..... [1]

(b) Identify **two** of the compounds that are members of the same homologous series.
Give the general formula of this homologous series.

compounds .....

general formula .....
[2]

(c) Which **two** compounds are isomers of each other?
Explain why they are isomers.

compounds .....

explanation .....

.....
[3]

(d) Explain why **B** is an unsaturated hydrocarbon.

.....

.....

..... [2]

(e) Describe how **D** is manufactured from **B**. Give a chemical equation for the reaction.

.....

.....

..... [3]

(f) Compound **A** forms an addition polymer.

Draw **two** repeat units of the addition polymer formed from **A**.

[2]

[Total: 13]

3 Ethanol is manufactured from glucose, $C_6H_{12}O_6$, by fermentation according to the following equation. $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

(a) State the conditions required for this reaction.

.....

..... [2]

(b) In an experiment, 30.0 g of glucose was fermented.

(i) Calculate the number of moles of glucose in 30.0 g.

..... mol [2]

(ii) Calculate the maximum mass of ethanol that could be obtained from 30.0 g of glucose.

..... g [2]

(iii) Calculate the volume of carbon dioxide at room temperature and pressure that can be obtained from 30.0 g of glucose.

..... dm^3 [1]

(c) Ethanol can also be manufactured from ethene.

(i) Name the raw material which is the source of ethene.

..... [1]

(ii) Write a balanced equation for the manufacture of ethanol from ethene.

..... [1]

[Total: 9]

4 Sulfuric acid and malonic acid are both dibasic acids. One mole of a dibasic acid can form two moles of hydrogen ions.

$$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$$

Dibasic acids can form salts of the type Na_2X and CaX.

(a) Malonic acid is a white crystalline solid which is soluble in water. It melts at 135 °C. The structural formula of malonic acid is given below. It forms salts called malonates.

$$CH_2(COOH)_2 \text{ or } HOOC-CH_2-COOH$$

(i) How could you determine if a sample of malonic acid is pure?

technique used .....

result if pure ..... [2]

(ii) What is the molecular formula of malonic acid?

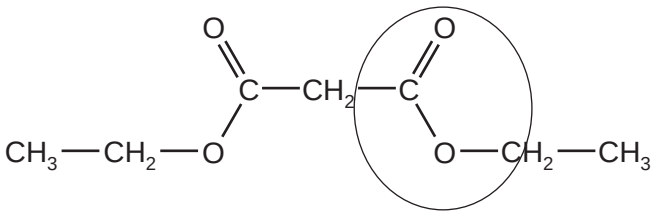
..... [1]

(iii) When malonic acid is heated there are two products, carbon dioxide and a simpler carboxylic acid. Deduce the name and molecular formula of this acid.

.....

..... [2]

(iv) Malonic acid reacts with ethanol to form a colourless liquid which has a 'fruity' smell. Its structural formula is given below.



What type of compound contains the group which is circled?

..... [1]

(b) **(i)** Suggest why a solution of malonic acid, concentration 0.2 mol / dm^3, has a higher pH than one of sulfuric acid of the same concentration.

..... [1]

(ii) Describe a test, other than measuring pH, which can be carried out on both acid solutions to confirm the explanation given in **(b)(i)** for the different pH values of the two acids.

.....

..... [2]

(c) Complete the following equations for reactions of these two acids.

(i) sodium hydroxide + malonic acid $\rightarrow$ ..... + ... [1]

.....

(ii) $CuO + H_2SO_4 \rightarrow$ ..... + ... [2]

(iii) $Mg + CH_2(COOH)_2 \rightarrow$ ..... + ... [2]

(iv) $K_2CO_3 + H_2SO_4 \rightarrow$ ..... + ... + ... [2]

[Total: 16]

Alcohols & Carboxylic Acids

Question Paper 6

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Organic Chemistry
Sub-Topic	Alcohols & Carboxylic Acids
Paper	(Extended) Theory
Booklet	Question Paper 6

TimeAllowed **75 minutes**

: Score: **/62**

Percentage: **/100**

1 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have the same chemical properties.
They undergo addition reactions and are easily oxidised.

(a) The following hydrocarbons are isomers.

(i) Explain why these two hydrocarbons are isomers.

.....

..... [2]

(ii) Give the structural formula of another hydrocarbon which is isomeric with the above.

[1]

(b) Give the structural formula and name of each of the products of the following addition reactions.

(i) ethene and bromine

structural formula of product

name of product ..... [2]

(ii) propene and hydrogen

structural formula of product

name of product ..... [2]

(iii) but-1-ene and water

structural formula of product

name of product ..... [2]

(c) Alkenes can be oxidised to carboxylic acids.

(i) For example, propene, $CH_3-CH=CH_2$, would produce ethanoic acid, CH_3-COOH, and methanoic acid, $H-COOH$. Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

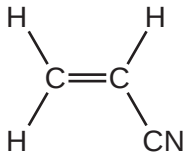
only ethanoic acid

[2]

(ii) Describe the colour change you would observe when an alkene is oxidised with acidified potassium manganate(VII).

..... [2]

(d) Alkenes polymerise to form addition polymers.
Draw the structural formula of poly(cyanoethene), include at least **two** monomer units.
The structural formula of the monomer, cyanoethene, is given below.



[3]

[Total: 16]

2 Plants can make complex molecules from simple starting materials, such as water, carbon dioxide and nitrates. Substances produced by plants include sugars, more complex carbohydrates, esters, proteins, vegetable oils and fats.

(a) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

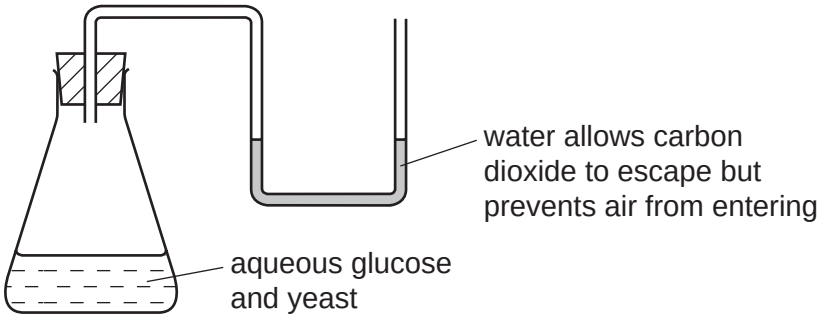
.....

..... [2]

(ii) Plants can change the sugar, glucose, into starch which is a more complex carbohydrate. What type of reaction is this?

..... [2]

(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



(i) The enzyme, zymase, catalyses the anaerobic respiration of the yeast. Explain the term *respiration*.

.....

..... [2]

(ii) Complete the equation.

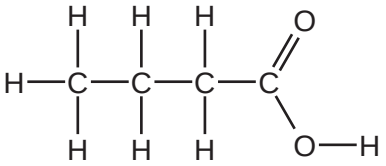
$C_6H_{12}O_6 \rightarrow$ ..... + ... [2]

glucose carbon dioxide

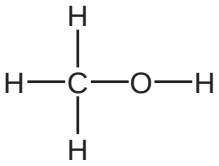
(iii) Why must air be kept out of the flask?

..... [1]

(c) The ester methyl butanoate is found in apples. It can be made from butanoic acid and methanol. Their structural formulae are given below.



butanoic acid

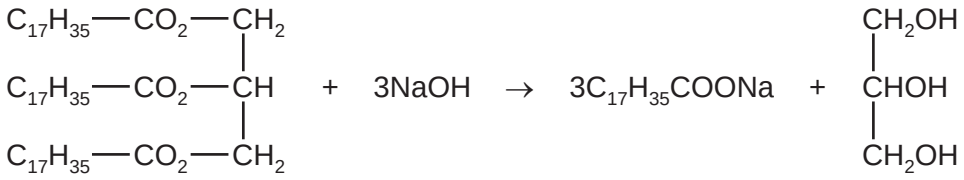


methanol

Use the information given above to deduce the structural formula of methyl butanoate showing all the bonds.

[2]

(d) The equation represents the hydrolysis of a naturally occurring ester.



(i) Which substance in the equation is an alcohol? Put a ring around this substance in the equation above. [1]

(ii) Is the alkyl group, $C_{17}H_{35}$, in this ester saturated or unsaturated? Give a reason for your choice.

..... [1]

(iii) What type of compound is represented by the formula $C_{17}H_{35}COONa$?
What is the major use for compounds of this type?

type of compound .....

use ..... [2]

(e) Proteins are natural macromolecules. Draw the structural formula of a typical protein. Include three monomer units. You may represent amino acids by formulae of the type drawn below.

[3]

[Total: 18]

3 The alcohols form a homologous series. The first five members are given in the table below.

(a)

alcohol	formula	heat of combustion in kJ / mol
methanol	CH_3OH	730
ethanol	$CH_3–CH_2–OH$	1380
propan-1-ol		
butan-1-ol	$CH_3–CH_2–CH_2–CH_2–OH$	2680
pentan-1-ol	$CH_3–CH_2–CH_2–CH_2–CH_2–OH$	3350

(i) Complete the table. [2]

(ii) Complete the equation for the combustion of pentan-1-ol in excess oxygen.

$$C_5H_{11}OH + ...O_2 \rightarrow ..... + ...$$ [1]

(b) State **three** characteristics of a homologous series other than the variation of physical properties down the series.

.....

.....

..... [3]

(c) The following alcohols are isomers.

$$CH_3–CH_2–CH_2–CH_2–OH \quad \text{and} \quad (CH_3)_2CH–CH_2–OH$$

(i) Explain why they are isomers.

.....

.....

..... [2]

(ii) Draw the structural formula of another isomer of the above alcohols.

[1]

(d) Alcohols can be made by fermentation and from petroleum.

(i) Ethanol is made from sugars by fermentation.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

The mass of one mole of glucose, $C_6H_{12}O_6$, is 180 g.
Calculate the maximum mass of ethanol which could be obtained from 72 g of glucose.

.....

.....

.....

..... [3]

(ii) Describe how ethanol is made from petroleum.

petroleum (alkanes) → ethene → ethanol

.....

.....

.....

..... [3]

[Total: 15]

4 The alkenes are unsaturated hydrocarbons. They form a homologous series, the members of which have similar chemical properties:

- easily oxidised
- addition reactions
- polymerisation
- combustion.

(a) All the alkenes have the same empirical formula.

(i) State their empirical formula.

..... [1]

(ii) Why is the empirical formula the same for all alkenes?

..... [1]

(b) Alkenes can be oxidised to carboxylic acids by boiling with aqueous potassium manganate(VII).

(i) Pent-2-ene, $CH_3–CH_2–CH=CH–CH_3$, oxidises to $CH_3–CH_2–COOH$ and CH_3COOH. Name these two acids.

$CH_3–CH_2–COOH$ .....

CH_3COOH ..... [2]

(ii) Most alkenes oxidise to two carboxylic acids. Deduce the formula of an alkene which forms only one carboxylic acid.

[1]

(c) Complete the following equations for the addition reactions of propene.

(i) $CH_3–CH=CH_2 + Br_2 \rightarrow$ ..... [1]

(ii) $CH_3–CH=CH_2 + H_2O \rightarrow$ ..... [1]

(d) Draw the structural formula of poly(propene)

(e) 0.01 moles of an alkene needed 2.4 g of oxygen for complete combustion. 2.2 g of carbon dioxide were formed. Determine the following mole ratio.

moles of alkene **:** moles of O_2 **:** moles of CO_2

From this ratio determine the formula of the alkene.

..... [3]

Write an equation for the complete combustion of this alkene.

..... [1]

[Total: 13]

Alcohols & Carboxylic Acids

Question Paper 7

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Organic Chemistry
Sub-Topic	Alcohols & Carboxylic Acids
Paper	(Extended) Theory
Booklet	Question Paper 7

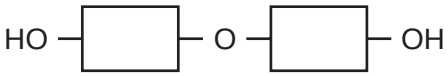
TimeAllowed **65 minutes**

: Score: **/54**

Percentage: **/100**

1 The three types of food are carbohydrates, proteins and fats.

(a) Aqueous starch is hydrolysed to maltose by the enzyme amylase.
The formula of maltose is:



Starch is hydrolysed by dilute sulphuric acid to glucose.

(i) What is an enzyme?

.....

[1]

(ii) Draw the structure of starch.

[1]

(iii) Name the technique that would show that the products of these two hydrolyses are different.

.....

[1]

(b) Proteins have the same linkage as nylon but there is more than one monomer in the macromolecule.

(i) Draw the structure of a protein.

[2]

(ii) What class of compound is formed by the hydrolysis of proteins?

.....

[1]

(c) Fats are esters. Some fats are saturated, others are unsaturated.

(i) Write the word equation for the preparation of the ester, propyl ethanoate.

..... [2]

(ii) Deduce the structural formula of this ester showing each individual bond.

[2]

(iii) How could you distinguish between these two fats?
Fat 1 has the formula

$CH_2 - CO_2 - C_{17}H_{33}$
|
$CH - CO_2 - C_{17}H_{33}$
|
$CH_2 - CO_2 - C_{17}H_{33}$

Fat 2 has the formula

$CH_2 - CO_2 - C_{17}H_{35}$
|
$CH - CO_2 - C_{17}H_{35}$
|
$CH_2 - CO_2 - C_{17}H_{35}$

test .....

result with fat 1 .....

result with fat 2 ..... [3]

(iv) Both of these fats are hydrolysed by boiling with aqueous sodium hydroxide. What type of compounds are formed?

..... and ..... [2]

2 A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(a) Give the structural formula of the monomer.

[1]

(ii) Draw the structural formula of the polymer.

[2]

(iii) Suggest which one, monomer or polymer, will react with aqueous bromine and why?

.....

..... [2]

(b) To show that the polymer contains silver the following test was carried out.

The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered. Aqueous sodium chloride was added to the filtrate and a white precipitate formed.

(i) Why was the mixture filtered?

..... [1]

(ii) Explain why the change of silver atoms to silver ions is oxidation.

..... [1]

(iii) Give the name of the white precipitate.

..... [1]

(c) The unpleasant smell is caused by carboxylic acids. Bacteria cause the fats on the skin to be hydrolysed to these acids. Silver kills the bacteria and prevents the hydrolysis of the fats.

(i) Fats are esters. Give the name and structural formula of an ester.

name ..... [1]

structural formula

[1]

(ii) Complete the word equation.

Ester + water ⟶ carboxylic acid + ... [1]

(d) Propanoic acid is a weak acid.

(i) The following equation represents its reaction with ammonia.

$CH_3-CH_2-COOH + NH_3 \longrightarrow CH_3-CH_2-COO^- + NH_4^+$

Explain why propanoic acid behaves as an acid and ammonia as a base.

.....

..... [3]

(ii) Explain the expression *weak acid.*

..... [1]

3 Chemists use the concept of the mole to calculate the amounts of chemicals involved in a reaction.

(a) Define *mole*.

.....

[1]

(b) 3.0 g of magnesium was added to 12.0 g of ethanoic acid.

$Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$

The mass of one mole of Mg is 24 g.

The mass of one mole of CH_3COOH is 60 g.

(i) Which one, magnesium or ethanoic acid, is in excess? You must show your reasoning.

.....

.....

.....

[3]

(ii) How many moles of hydrogen were formed?

.....

[1]

(iii) Calculate the volume of hydrogen formed, measured at r.t.p.

.....

[2]

(c) In an experiment, 25.0 cm^3 of aqueous sodium hydroxide, 0.4 mol / dm^3, was neutralised by 20.0 cm^3 of aqueous oxalic acid, $H_2C_2O_4$.

$$2NaOH + H_2C_2O_4 \rightarrow Na_2C_2O_4 + 2H_2O$$

Calculate the concentration of the oxalic acid in mol / dm^3.

(i) Calculate the number of moles of NaOH in 25.0 cm^3 of 0.4 mol / dm^3 solution.

.....

[1]

(ii) Use your answer to **(i)** and the mole ratio in the equation to find out the number of moles of $H_2C_2O_4$ in 20 cm^3 of solution.

.....

[1]

(iii) Calculate the concentration, mol / dm^3, of the aqueous oxalic acid.

.....

[2]

4 The simplest alcohol is methanol.

(a) It is manufactured by the following reversible reaction.

$$CO\ (g) + 2H_2\ (g) \rightleftharpoons CH_3OH\ (g)$$
$$300\,^{o}C$$
$$30atm$$

(i) Reversible reactions can come to equilibrium. Explain the term *equilibrium*.

.....

[1]

(ii) At 400 °C, the percentage of methanol in the equilibrium mixture is lower than at 300 °C. Suggest an explanation.

.....

[2]

(iii) Suggest two advantages of using high pressure for this reaction.
Give a reason for each advantage.

advantage .....

reason .....

advantage .....

reason .....

[5]

(b) **(** Complete the equation for the combustion of methanol in an excess of oxygen.

$$\square\ CH_3OH + \square\ O_2 \longrightarrow \square + \square$$ [2]

(ii) Complete the word equation.

methanol + ethanoic acid ⟶ ..... + ... [2]

(iii) Methanol can be oxidised to an acid. Name this acid.

..... [1]