1 The alcohols form a homologous series. Two characteristics of a homologous series are that the physical properties of the members vary in a predictable way and they have similar chemical properties.

(a) Complete the table.

name	formula	mass of one mole / g	boiling point / °C
methanol	CH_3-OH	32	64
ethanol	CH_3-CH_2-OH	46	78
propan-1-ol	$CH_3-CH_2-CH_2-OH$	60	98
butan-1-ol	$CH_3-CH_2-CH_2-CH_2-OH$	74	118
pentan-1-ol			138
hexan-1-ol	$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-OH$	102	

[3]

(b) Give **two** other characteristics of a homologous series.

.....

..... [2]

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound methanol.
Use x to represent an electron from a carbon atom.
Use o to represent an electron from an oxygen atom.
Use ● to represent an electron from a hydrogen atom.

[3]

(d) Alcohols can be oxidised to carboxylic acids by heating with acidic potassium manganate(VII).

(i) Draw the structural formula of the carboxylic acid formed by the oxidation of propan-1-ol. Show all the bonds.

[1]

(ii) Describe how ethanol could be oxidised to ethanoic acid by fermentation.

.....

..... [2]

(e) Propan-1-ol and ethanoic acid react together to form an ester. Give its name and structural formula.

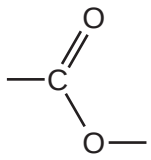
name ..... [1]

formula

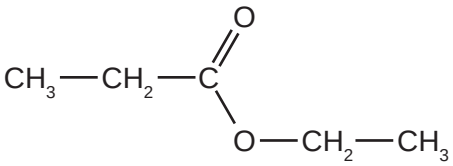
[1]

[Total: 13]

2 Hydrolysis is used in chemistry to break down complex molecules into simpler ones.

(a) Compounds containing the group  or —COO—

(i) Give the names and formulae of the two compounds formed when the ester ethyl propanoate is hydrolysed.

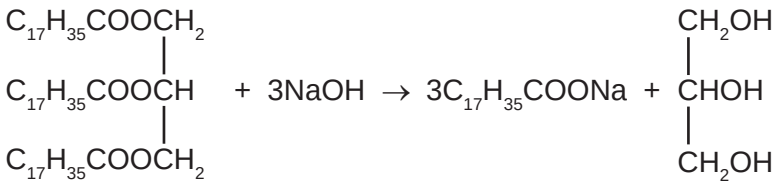


name ..... name .....

formula formula

[4]

(ii) Fats are naturally occurring esters. They can be hydrolysed by boiling with aqueous sodium hydroxide.



fat

What type of compound has the formula $C_{17}H_{35}COONa$ and what is its main use?

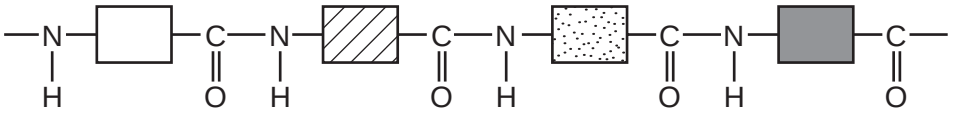
type of compound ..... [1]

use ..... [1]

(iii) Name a synthetic polyester.

..... [1]

(b) The structure of a typical protein is drawn below.



(i) What is the name of the polymer linkage?

..... [1]

(ii) Draw the structural formula of a man-made polymer with the same linkage.

[3]

(iii) A protein can be hydrolysed to a mixture of amino acids which are colourless. Individual amino acids can be identified by chromatography. The R_f value of the amino acid glycine is 0.5. Describe how you could show that glycine was present on a chromatogram.

.....

.....

..... [3]

[Total: 14]

3 Methanoic acid is the first member of the homologous series of carboxylic acids.

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

.....

.....

..... [2]

(b) In some areas when water is boiled, the inside of kettles become coated with a layer of calcium carbonate. This can be removed by adding methanoic acid.

(i) Complete the equation.

..... $HCOOH + CaCO_3 \rightarrow Ca(HCOO)_2 +$ ..... + ...

[2]

(ii) Methanoic acid reacts with most metals above hydrogen in the reactivity series. Complete the word equation.

zinc + methanoic acid $\rightarrow$ ..... + ...

[2]

(iii) Aluminium is also above hydrogen in the reactivity series.
Why does methanoic acid not react with an aluminium kettle?

.....

..... [1]

(c) Give the name, molecular formula and empirical formula of the fourth acid in this series.

name ..... [1]

molecular formula ..... [1]

empirical formula ..... [1]

[Total: 10]

4 The alcohols form an homologous series.

(a) Give **three** characteristics of an homologous series.

.....

.....

.....

..... [3]

(b) The following two alcohols are members of the series and they are isomers.

$CH_3—CH_2—CH_2—CH_2—OH$ and $(CH_3)_2CH—CH_2OH$

(i) Explain why they are isomers.

.....

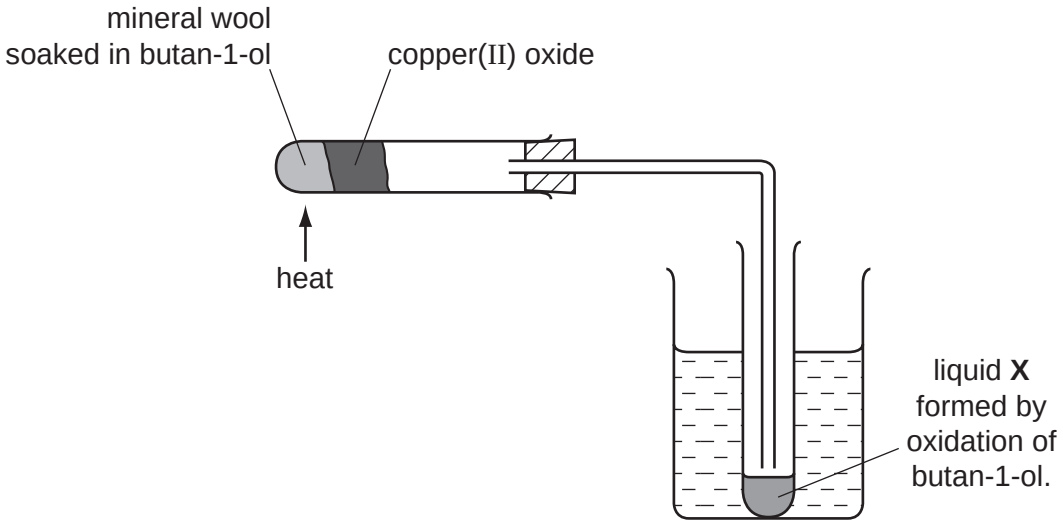
.....

..... [2]

(ii) Give the structural formula of another alcohol which is also an isomer of these alcohols.

[1]

(c) Copper(II) oxide can oxidise butan-1-ol to liquid **X** whose pH is 4.



(i) Name another reagent which can oxidise butan-1-ol.

..... [1]

(ii) What type of compound is liquid **X** and what is its formula?

type of compound ..... [1]

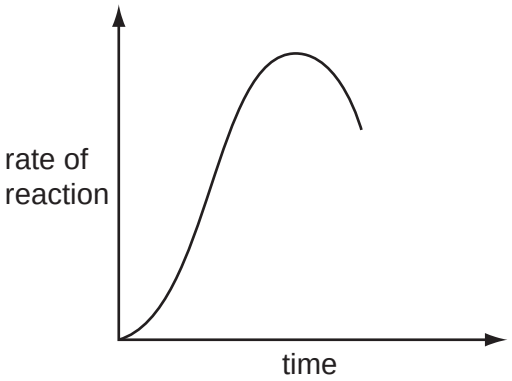
formula of liquid **X**

[1]

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Carbon dioxide is given off and the mixture becomes warm as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.



(i) Suggest a method of measuring the rate of this reaction.

.....

..... [2]

(ii) Why does the rate increase initially?

.....

..... [1]

(iii) Suggest **two** reasons why the rate eventually decreases.

.....

..... [2]

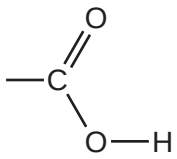
(iv) Why is fermentation carried out in the absence of air?

.....

..... [1]

[Total: 15]

5 Carboxylic acids contain the group

 or —COOH.

(a) Ethanoic acid is a typical carboxylic acid. It forms ethanoates.

(i) Complete the following equations.

Mg + ...CH_3COOH → ..... + ...

[2]

sodium hydroxide + ethanoic acid → ..... + ...
.....

[1]

(ii) Ethanoic acid reacts with ethanol to form an ester. Give the name of the ester and draw its structural formula. Show all of the bonds.

name .....

structural formula

[2]

(b) Maleic acid is an unsaturated acid. 5.8 g of this acid contained 2.4 g of carbon, 0.2 g of hydrogen and 3.2 g of oxygen.

(i) How do you know that the acid contained only carbon, hydrogen and oxygen?

.....

..... [1]

(ii) Calculate the empirical formula of maleic acid.

Number of moles of carbon atoms = ...

Number of moles of hydrogen atoms = ...

Number of moles of oxygen atoms = ...

The empirical formula is ..... [3]

(iii) The mass of one mole of maleic acid is 116 g. What is its molecular formula?

..... [2]

(iv) Maleic acid is dibasic. One mole of acid produces two moles of H^+. Deduce its structural formula.

[2]

[Total: 13]