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

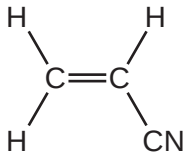
only ethanoic acid

[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.

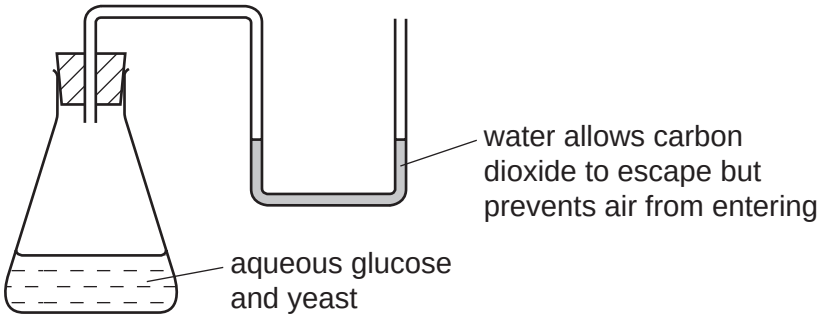
.....

..... [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.

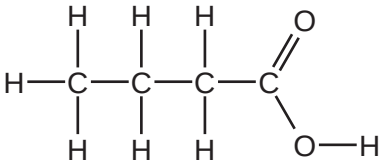
$C_6H_{12}O_6 \rightarrow$ ..... + ... [2]

glucose carbon dioxide

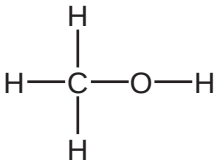
(iii) Why must air be kept out of the flask?

..... [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

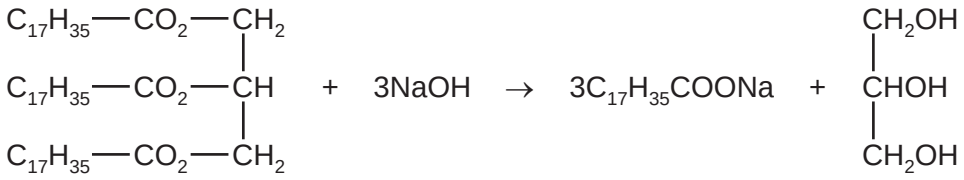


methanol

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]