

1 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.

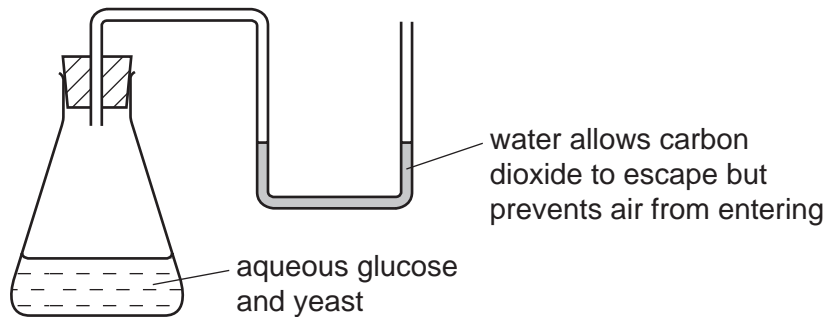
(a) Describe how you could decide from its molecular formula whether a compound is a carbohydrate.

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

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

..... [2]

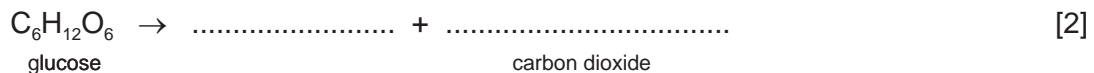
(b) The fermentation of glucose can be carried out in the apparatus shown below. After a few days the reaction stops. A 12% aqueous solution of ethanol has been produced.



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

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

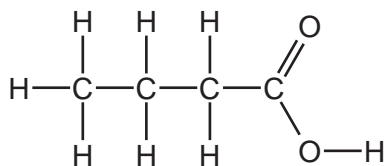
(ii) Complete the equation.



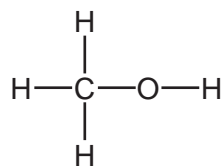
(iii) Why must air be kept out of the flask?

..... [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

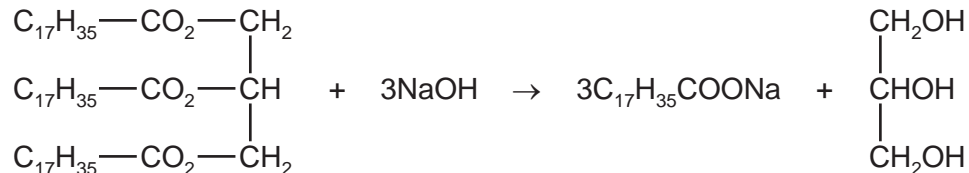


methanol

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, $\text{C}_{17}\text{H}_{35}$, in this ester saturated or unsaturated? Give a reason for your choice.

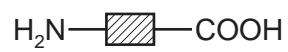
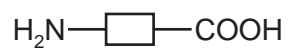
..... [1]

- (iii) What type of compound is represented by the formula $\text{C}_{17}\text{H}_{35}\text{COONa}$?
What is the major use for compounds of this type?

type of compound

use [2]

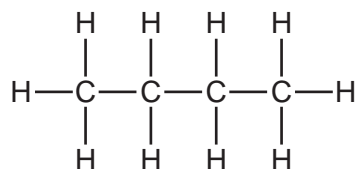
- (e) Proteins are natural macromolecules. Draw the structural formula of a typical protein. Include three monomer units. You may represent amino acids by formulae of the type drawn below.



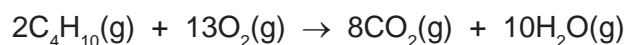
[3]

[Total: 18]

2 Butane is an alkane. It has the following structural formula



(a) The equation for the complete combustion of butane is given below. Insert the two missing volumes.



..... 40 volume of gas/cm³ [2]

(b) Butane reacts with chlorine to form two isomers of chlorobutane.

(i) What type of reaction is this?

..... [1]

(ii) Explain the term *isomer*.

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

(iii) Draw the structural formulae of these two chlorobutanes.

[2]

(c) One of the chlorobutanes reacts with sodium hydroxide to form butan-1-ol. Butan-1-ol can be oxidised to a carboxylic acid.

(i) State a reagent, other than oxygen, which will oxidise butan-1-ol to a carboxylic acid.

..... [1]

(ii) Name the carboxylic acid formed.

..... [1]

(iii) Butan-1-ol reacts with ethanoic acid to form an ester. Name this ester and give its structural formula showing all the individual bonds.

name [1]

structural formula

[2]

[Total: 12]

3 Hydrocarbons are compounds which contain only carbon and hydrogen.

(a) 20 cm³ of a gaseous hydrocarbon was burned in 120 cm³ of oxygen, which is in excess. After cooling, the volume of the gases remaining was 90 cm³. Aqueous sodium hydroxide was added to remove carbon dioxide, 30 cm³ of oxygen remained. All volumes were measured at r.t.p..

(i) Explain why it is essential to use excess oxygen.

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

(ii) Carbon dioxide is slightly soluble in water. Why does it dissolve readily in the alkali, sodium hydroxide?

..... [1]

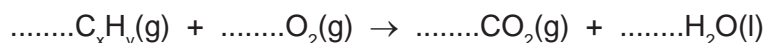
(iii) Complete the following.

volume of gaseous hydrocarbon =cm³

volume of oxygen used =cm³

volume of carbon dioxide formed =cm³ [2]

(iv) Use the above volume ratio to find the mole ratio in the equation below and hence find the formula of the hydrocarbon.



hydrocarbon formula = [2]

(b) Alkanes are hydrocarbons and are generally unreactive. Their reactions include combustion, substitution and cracking.

(i) Chlorine reacts with butane in a substitution reaction.



Give the structural formula of another possible product of this reaction.

[1]

(ii) What is the essential condition for this reaction?

..... [1]

(iii) Explain what is meant by *cracking*. Give an example of a cracking reaction and explain why the process is used.

.....
.....
.....
.....
..... [4]

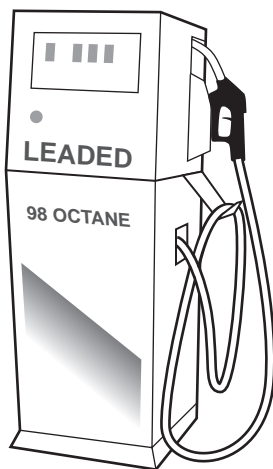
[Total: 13]

4 Petrol is a mixture of hydrocarbons and additives. The combustion of petrol in car engines is a major source of air pollution. This is reduced by catalytic converters.

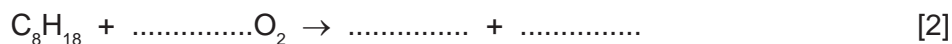
(a) Petrol is obtained from the gasoline fraction, boiling point range 40°C to 100°C, from the distillation of petroleum. Explain the term *fraction*.

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

(b) In many countries, a lead compound of the type $Pb(C_2H_5)_n$ used to be added to petrol to improve its combustion. After combustion, lead oxide was formed.



(i) Octane is a constituent of petrol. Write the equation for the complete combustion of octane.



(ii) Dibromoethane was added to petrol to remove the lead oxide from inside the engine. Lead bromide was formed which escaped into the environment through the exhaust. Leaded petrol cannot be used with a catalytic converter. Give another reason why leaded petrol is no longer used.

..... [1]

(iii) What does each of the following tell you about the structure of dibromoethane?

dibromo

eth

ane [2]

(iv) What additional information is needed to draw the structural formula of dibromoethane?

..... [1]

- (c) An analysis of the compound, $\text{Pb}(\text{C}_2\text{H}_5)_n$, showed that 0.026 moles of Pb was combined with 0.104 moles of C_2H_5 groups.
What is the value of n? Show how you arrived at your answer.

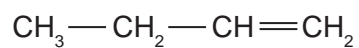
.....
..... [2]

- (d) Some of the pollutants emitted by vehicle exhausts are carbon monoxide, oxides of nitrogen and unburnt hydrocarbons. Explain how the emission of these gases is reduced by a catalytic converter.

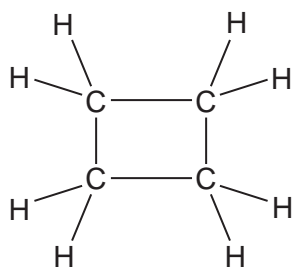
.....
.....
..... [3]

[Total: 13]

5 But-1-ene is a typical alkene. It has the structural formula shown below.



The structural formula of cyclobutane is given below.



(a) These two hydrocarbons are isomers.

(i) Define the term *isomer*.

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

(ii) Draw the structural formula of another isomer of but-1-ene.

[1]

(iii) Describe a test which would distinguish between but-1-ene and cyclobutane.

reagent

result with but-1-ene

.....

result with cyclobutane

..... [3]

(b) Describe how alkenes, such as but-1-ene, can be made from alkanes.

.....

..... [2]

(c) Name the product formed when but-1-ene reacts with:

bromine, [1]

hydrogen, [1]

steam. [1]

[Total: 11]