

- 1 Islay is an island off the west coast of Scotland. The main industry on the island is making ethanol from barley.

Barley contains the complex carbohydrate, starch. Enzymes catalyse the hydrolysis of starch to a solution of glucose.

- (a) (i) Draw the structure of the starch.

Glucose can be represented by $\text{HO}-\square-\text{OH}$

(ii) Enzymes can catalyse the hydrolysis of starch. Name another catalyst for this reaction.

..... [1]

(iii) Both starch and glucose are carbohydrates. Name the elements found in all carbohydrates.

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

(b) Yeast cells are added to the aqueous glucose. Fermentation produces a solution containing up to 10% of ethanol.

(i) Complete the word equation for the fermentation of glucose.

glucose → + [1]

(ii) Explain why is it necessary to add yeast and suggest why the amount of yeast in the mixture increases.

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

(iii) Fermentation is carried out at 35°C. For many reactions a higher temperature would give a faster reaction. Why is a higher temperature not used in this process?

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

(c) The organic waste, the residue of the barley and yeast, is disposed of through a pipeline into the sea. In the future this waste will be converted into biogas by the anaerobic respiration of bacteria. Biogas, which is mainly methane, will supply most of the island's energy.

(i) Anaerobic means in the absence of oxygen. Suggest an explanation why oxygen must be absent.

..... [1]

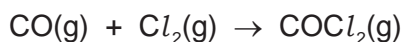
(ii) The obvious advantage of converting the waste into methane is economic. Suggest **two** other advantages.

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

[Total: 12]

2 Carbonyl chloride, COCl_2 , is widely used in industry to make polymers, dyes and pharmaceuticals.

(a) Carbonyl chloride was first made in 1812 by exposing a mixture of carbon monoxide and chlorine to bright sunlight. This is a photochemical reaction.



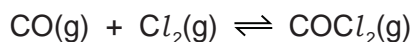
(i) Explain the phrase *photochemical reaction*.

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

(ii) Give another example of a photochemical reaction and explain why it is important either to the environment or in industry.

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

(b) Carbonyl chloride is now made by the reversible reaction given below.



The forward reaction is exothermic.

The reaction is catalysed by carbon within a temperature range of 50 to 150 °C.

(i) Predict the effect on the yield of carbonyl chloride of increasing the pressure. Explain your answer.

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

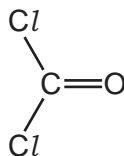
(ii) If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

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

(iii) Explain why a catalyst is used.

..... [1]

(c) The structural formula of carbonyl chloride is given below.



Draw a diagram showing the arrangement of the outer (valency) electrons in one molecule of this covalent compound.

Use o to represent an electron from a carbon atom.

Use x to represent an electron from a chlorine atom.

Use ● to represent an electron from an oxygen atom.

[3]

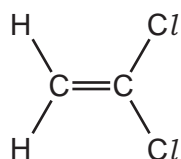
[Total: 13]

3 There are two types of polymerisation - addition and condensation.

(a) Explain the difference between them.

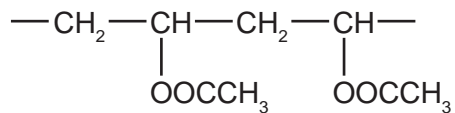
.....
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..... [2]

(b) Poly(dichloroethene) is used to package food. Draw its structure. The structural formula of dichloroethene is shown below.



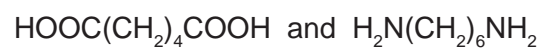
[2]

(c) The polymer known as PVA is used in paints and adhesives. Its structural formula is shown below.



Deduce the structural formula of its monomer.

(d) A condensation polymer can be made from the following monomers.



Draw the structural formula of this polymer.

[3]

[Total: 8]

4 Starch, a complex carbohydrate, is a natural macromolecule or polymer. It can be formed from its monomer by condensation polymerisation.

(a) Explain the terms:


monomer

.....

condensation polymerisation

..... [2]

(ii) Draw the structural formula of starch to include three monomer units.

Glucose, the monomer, can be represented as HO——OH .

[3]

(b) Starch can be hydrolysed to simple sugars by heating with dilute sulfuric acid or by warming with a dilute solution of saliva. The reaction can be catalysed by H⁺ ions from the acid or by the enzymes in saliva.

(i) What is an enzyme?

..... [1]

(ii) Explain why, if the saliva/starch mixture is heated above 70 °C, the hydrolysis stops.

..... [1]

(iii) The complete acid-catalysed hydrolysis of starch forms only glucose. The partial acid-catalysed hydrolysis of starch forms a mixture of sugars which includes glucose. Describe how you could identify the different sugars in this mixture.

.....

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..... [3]

[Total: 10]

5 Monomers polymerise to form polymers or macromolecules.

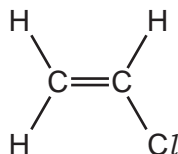
(a) (i) Explain the term *polymerise*.

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

(ii) There are two types of polymerisation - addition and condensation. What is the difference between them?

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

(b) An important monomer is chloroethene which has the structural formula shown below.



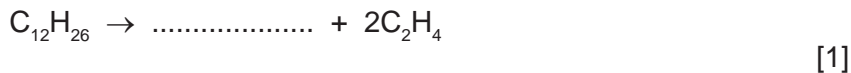
It is made by the following method.



This is heated to make chloroethene.



(i) Ethene is made by cracking alkanes. Complete the equation for cracking dodecane.



Another method of making dichloroethane is from ethane.



(ii) Suggest a reason why the method using ethene is preferred.

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

(iii) Describe an industrial method of making chlorine.

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

(iv) Draw the structural formula of poly(chloroethene).

Include three monomer units.

[2]

[Total: 9]

6 Synthetic polymers are widely used in the modern world.

(a) Their use has brought considerable advantages to modern life as well as some disadvantages.

(i) Suggest **two** advantages of a plastic bucket compared to a steel bucket.

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

(ii) Name **two** uses of man-made fibres, such as nylon and Terylene.

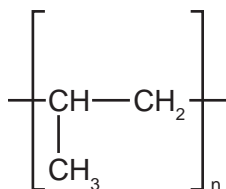
.....
..... [2]

(iii) Describe the pollution caused by synthetic polymers.

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

(b) One type of polymer is formed by addition polymerisation.

(i) The structural formula of an addition polymer is given below.

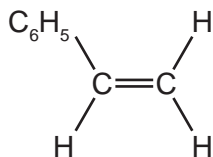


Give the name and structural formula of the monomer.

name of monomer [1]

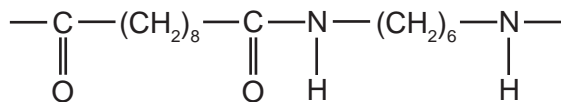
structural formula of monomer

- (ii) Draw the structural formula of the addition polymer formed by the polymerisation of phenylethene. The structural formula of phenylethene is given below.



[2]

- (c) Nylon is made by condensation polymerisation. It has the structural formula shown below.



- (i) Name the linkage in this polymer.

..... [1]

- (ii) Name the natural macromolecules which have the same linkage.

..... [1]

- (iii) Deduce the formulae of the two monomers which reacted to form the nylon and water.

monomer

monomer

[2]