1 Alkanes and alkenes are both series of hydrocarbons.

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

.....

..... [1]

(ii) What is the difference between these two series of hydrocarbons?

.....

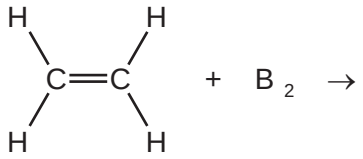
..... [2]

(b) Alkenes and simpler alkanes are made from long-chain alkanes by cracking.
Complete the following equation for the cracking of the alkane $C_{20}H_{42}$.

$$C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + \text{.....} \quad [1]$$

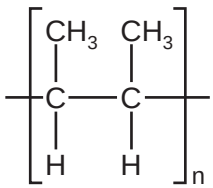
(c) Alkenes such as butene and ethene are more reactive than alkanes.
Alkenes are used in the petrochemical industry to make a range of products, which includes polymers and alcohols.

(i) Dibromoethane is used as a pesticide. Complete the equation for its preparation from ethene.



[1]

(ii) The structural formula of a poly(alkene) is given below.



Deduce the structural formula of its monomer.

[2]

(iii) How is butanol made from butene, $CH_3-CH_2-CH=CH_2$? Include an equation in your answer.

.....

..... [2]

(iv) Cracking changes alkanes into alkenes. How could an alkene be converted into an alkane? Include an equation in your answer.

.....

..... [2]

(d) 20 cm^3 of a hydrocarbon was burnt in 175 cm^3 of oxygen. After cooling, the volume of the remaining gases was 125 cm^3. The addition of aqueous sodium hydroxide removed carbon dioxide leaving 25 cm^3 of unreacted oxygen.

(i) volume of oxygen used = ... cm^3 [1]

(ii) volume of carbon dioxide formed = ... cm^3 [1]

(iii) Deduce the formula of the hydrocarbon and the balanced equation for the reaction.

.....

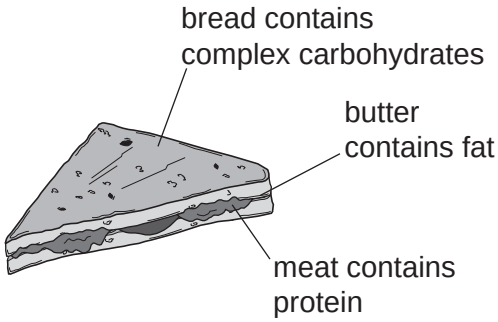
.....

.....

..... [2]

[Total: 15]

2 A sandwich contains three of the main constituents of food.



(a) These constituents of food can be hydrolysed by boiling with acid or alkali.
Complete the table.

constituent of food	product of hydrolysis
protein	
fat	
complex carbohydrate	

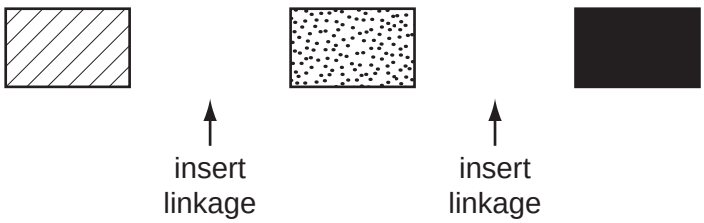
[3]

(ii) What type of synthetic polymer contains the same linkage as

fats, ...

proteins? ..... [2]

(b) An incomplete structural formula of a protein is given below.
Complete this diagram by inserting the linkages.



[2]

(c) Butter contains mainly saturated fats. Fats based on vegetable oils, such as olive oil, contain mainly unsaturated fats.

A small amount of fat was dissolved in an organic solvent.
Describe how you could determine if the fat was saturated or unsaturated.

.....

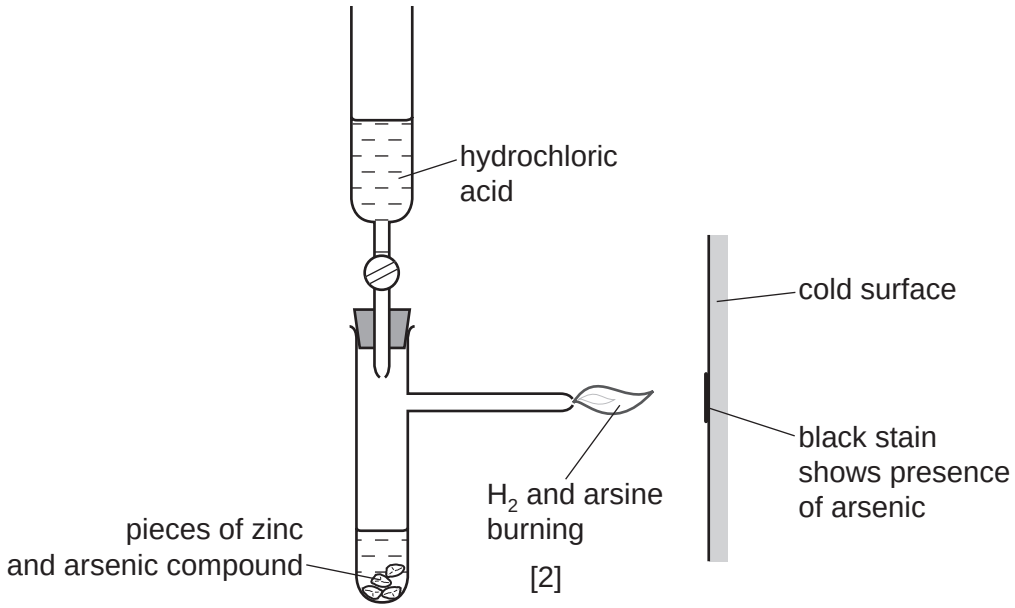
.....

..... [3]

[Total: 10]

3 Until recently, arsenic poisoning, either deliberate or accidental, has been a frequent cause of death. The symptoms of arsenic poisoning are identical with those of a common illness, cholera. A reliable test was needed to prove the presence of arsenic in a body.

(a) In 1840, Marsh devised a reliable test for arsenic.



[2]

Hydrogen is formed in this reaction. Any arsenic compound reacts with this hydrogen to form arsine which is arsenic hydride, AsH_3.
The mixture of hydrogen and arsine is burnt at the jet and arsenic forms as a black stain on the glass.

(i) Write an equation for the reaction which forms hydrogen.

..... [2]

(ii) Draw a diagram which shows the arrangement of the outer (valency) electrons in one molecule of the covalent compound arsine.
The electron distribution of arsenic is 2 + 8 + 18 + 5.

Use x to represent an electron from an arsenic atom.
Use o to represent an electron from a hydrogen atom.

[2]

(b) Another hydride of arsenic has the composition below.

arsenic 97.4% hydrogen 2.6%

(i) Calculate the empirical formula of this hydride **from the above data**.
Show your working.

.....

.....[2]

(ii) The mass of one mole of this hydride is 154 g. What is its molecular formula?

..... [1]

(iii) Deduce the structural formula of this hydride.

[1]

(c) Hair is a natural protein. Hair absorbs arsenic from the body. Analysis of the hair provides a measurement of a person's exposure to arsenic. To release the absorbed arsenic for analysis, the protein has to be hydrolysed.

(i) What is the name of the linkage in proteins?

..... [1]

(ii) Name a reagent which can be used to hydrolyse proteins.

..... [1]

(iii) What type of compound is formed by the hydrolysis of proteins?

..... [1]

(d) In the 19th Century, a bright green pigment, copper(II) arsenate(V) was used to kill rats and insects. In damp conditions, micro-organisms can act on this compound to produce the very poisonous gas, arsine.

(i) Suggest a reason why it is necessary to include the oxidation states in the name of the compound.

.....

..... [1]

(ii) The formula for the arsenate(V) ion is AsO_4^{3-}. Complete the ionic equation for the formation of copper(II) arsenate(V).

.....Cu^{2+} + ...AsO_4^{3-} $\rightarrow$ .....

[2]

[Total: 14]

4 Structural formulae are an essential part of Organic Chemistry.

(a) Draw the structural formula of each of the following. Show all the bonds in the structure.

(i) ethanoic acid

[1]

(ii) ethanol

[1]

(b) Ethanoic acid and ethanol react to form an ester.
What is the name of this ester?

..... [1]

(ii) The same linkage is found in polyesters. Draw the structure of the polyester which can be formed from the monomers shown below.

$HOOC—C_6H_4—COOH$ and $HO—CH_2—CH_2—OH$

[3]

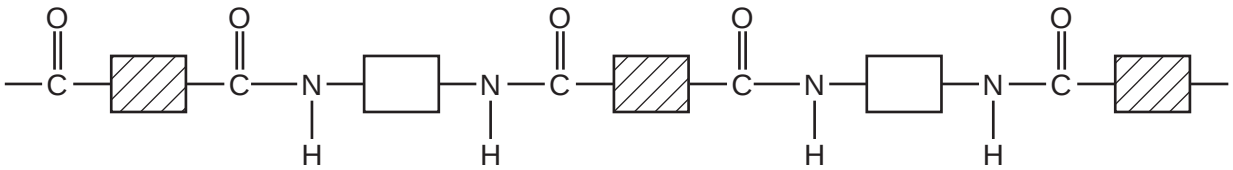
(iii) Describe the pollution problems caused by non-biodegradable polymers.

.....

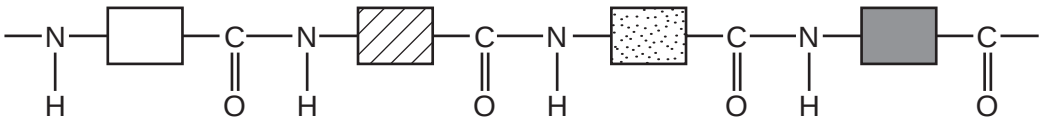
.....

..... [2]

(c) Two macromolecules have the same amide linkage.
Nylon, a synthetic polymer, has the following structure.



Protein, a natural macromolecule, has the following structure.



How are they different?

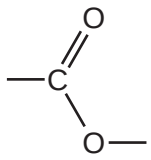
.....

.....

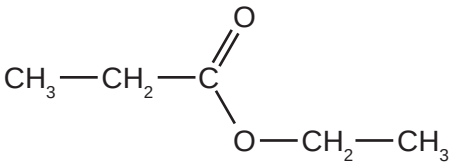
..... [2]

[Total: 10]

5 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.

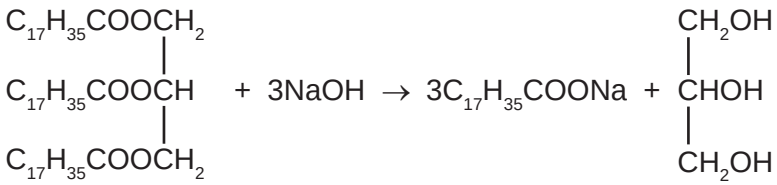


name ..... name .....

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?

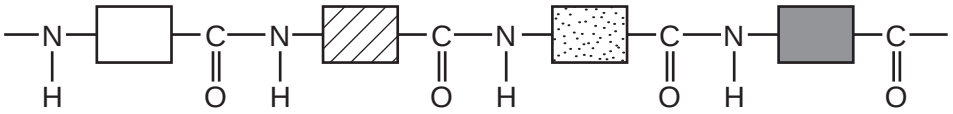
type of compound ..... [1]

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]