

1 The alkenes are a homologous series of unsaturated hydrocarbons.

(a) The table below gives the names, formulae and boiling points of the first members of the series.

| name | for | boiling point / °C |
|---------|-------------|--------------------|
| ethene | C_2H_4 | -1 |
| propene | C_3H_6 | - |
| butene | C_4H_8 | - |
| pentene | C_5H_{10} | 30 |
| hexene | | |

(i) Complete the table by giving the formula of hexene and by predicting its boiling point.

[2]

(ii) Deduce the formula of the alkene which has a relative molecular mass of 168. Show your working.

| | |
|--|-----|
| | [2] |
|--|-----|

(b) Describe a test that will distinguish between the two isomers, but-2-ene and cyclobutane.

| | |
|-------------------------|-----|
| test | |
| | |
| result with but-2-ene | |
| | |
| result with cyclobutane | [3] |

(c) Alkenes undergo addition reactions.

(i) What class of organic compound is formed when an alkene reacts with water?

| | |
|--|-----|
| | [1] |
|--|-----|

(ii) Predict the structural formula of the compound formed when hydrogen chloride reacts with but-2-ene.

| | |
|--|-----|
| | [1] |
|--|-----|

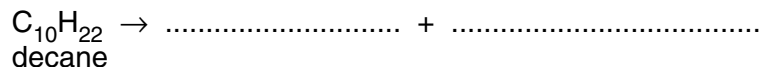
(iii) Draw the structure of the polymer formed from but-2-ene.

| | |
|--|-----|
| | [2] |
|--|-----|

2 Alkenes are unsaturated hydrocarbons. They undergo addition reactions.

(a) Two of the methods of making alkenes are cracking and the thermal decomposition of chloroalkanes.

(i) Complete an equation for the cracking of the alkane, decane.



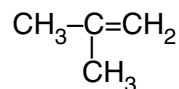
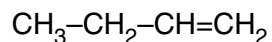
(ii) Propene can be made by the thermal decomposition of chloropropane. Describe how chloropropane can be made from propane.

reagents propane and

conditions

[4]

(b) The following alkenes are isomers.



(i) Explain why they are isomers.

.....
.....

(ii) Give the name and structural formula of another hydrocarbon that is isomeric with the above.

name

structural formula

[4]

(c) Give the name of the product when but-1-ene reacts with each of the following.

steam

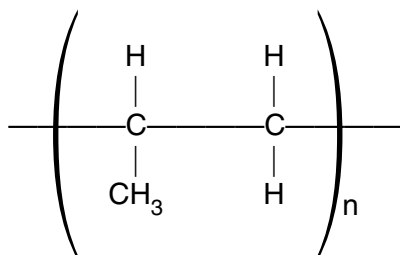
hydrogen

bromine

[3]

(d) Alkenes can polymerise.

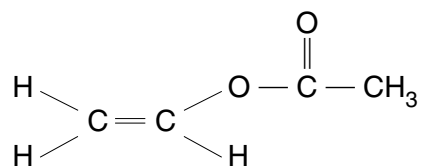
(i) Deduce the name and structural formula of the monomer from the structure of the polymer.



name of monomer

structural formula

(ii) Draw the structure of the polymer formed from the following monomer.



(iii) Describe the pollution problems caused by the disposal of polymers in landfill sites and by burning.

landfill sites

.....[2]

burning

.....[1]

3 Two homologous series of hydrocarbons are the alkanes and the alkenes.

(a) One general characteristic of a homologous series is that the physical properties vary in a predictable way.

State **three** other general characteristics of a homologous series.

.....

.....

..... [3]

(ii) How can the molecular formula of a hydrocarbon show whether it is an alkane or an alkene?

.....

..... [2]

(iii) How do alkanes and alkenes differ in their molecular structures?

.....

..... [2]

(b) Cracking is the thermal decomposition of alkanes into smaller hydrocarbons and possibly hydrogen.

(i) State **two** conditions required for the cracking of an alkane.

..... [2]

(ii) One type of cracking produces an alkane and an alkene.

Complete an equation for the cracking of heptane into an alkane and an alkene.



(iii) Complete an equation for the cracking of heptane into hydrogen and two other products.



(iv) Suggest **one** reason why cracking is important.

..... [1]

(c) Hydrocarbons burn in excess oxygen to form carbon dioxide and water. 20cm^3 of a gaseous hydrocarbon reacts with an excess of oxygen, 200cm^3 . After cooling, the volume of the residual gas at r.t.p. was 150cm^3 , 50cm^3 of oxygen.

(i) Determine the volume of the oxygen used.

..... [1]

(ii) Determine the volume of the carbon dioxide formed.

..... [1]

(iii) The hydrocarbon was an alkane.

Determine the formula of the hydrocarbon.

[1]

[Total: 15]

4 Alcohols can be made by fermentation or from petroleum.

(a) Ethanol can be made by the fermentation of glucose.



Yeast are living single-cell fungi which ferment glucose by anaerobic respiration. This reaction is catalysed by enzymes from the yeast.

(i) What is meant by the term *respiration*?

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

(ii) *Anaerobic* means in the absence of oxygen.

Name the products formed from respiration in the **presence** of oxygen.

..... [1]

(iii) What are enzymes?

..... [1]

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

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

(b) The following observations were noted.

- When a small amount of yeast was added to the aqueous glucose the reaction started and the solution went slightly cloudy.
- The reaction rate increased and the solution became cloudier and warmer.
- After a while, the reaction rate decreased and eventually stopped, leaving a 14% solution of ethanol in water.

(i) Why did the reaction rate increase?

..... [1]

(ii) Suggest an explanation for the increase in cloudiness of the solution.

..... [1]

(iii) Give **two** reasons why the fermentation stopped.

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

(c) One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

..... [2]

(d) Alcohols can be made from petroleum by the following sequence of reactions.

alkanes from petroleum → alkene → alcohol

Describe the manufacture of ethanol from hexane, C_6H_{14} . Include in your description an equation and type of reaction for each step.

.....
.....
.....
..... [5]

[Total: 17]