

Alkenes

Question Paper 1

Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Organic Chemistry
Sub-Topic	Alkenes
Paper	(Extended) Theory
Booklet	Question Paper 1

TimeAllowed: 86 minutes

Score: /71

Percentage: /100

1 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum.

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

(b) Ethene, $\text{CH}_2=\text{CH}_2$, and propene, $\text{CH}_2=\text{CHCH}_3$, can both be converted into polymers.

(i) What type of polymerisation takes place when ethene forms a polymer?

..... [1]

(ii) What is the empirical formula of the polymer formed from ethene?

..... [1]

(iii) Propene has the structural formula $\text{CH}_2=\text{CHCH}_3$.

Draw **two** repeat units of the polymer made from propene.

[2]

(c) Ethene will react with steam to form ethanol.

Propene will react with steam to form two isomers, both of which are alcohols.

Suggest the structures of these alcohols.

(d) Esters are organic chemicals noted for their characteristic smells. Ethanoic acid and methanol will react to form an ester.

(i) Name the catalyst needed to form an ester from ethanoic acid and methanol.

..... [1]

(ii) Name the ester formed when ethanoic acid reacts with methanol.

..... [1]

(iii) Draw the structure of the ester formed when ethanoic acid reacts with methanol. Show all bonds.

[2]

(iv) Give the name of a polyester.

..... [1]

[Total: 13]

2 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?

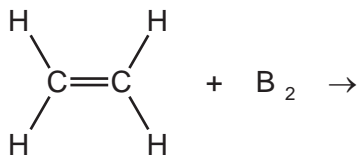
.....
..... [2]

(b) Alkenes and simpler alkanes are made from long-chain alkanes by cracking.
Complete the following equation for the cracking of the alkane C₂₀H₄₂.



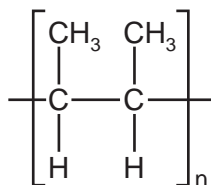
(c) Alkenes such as butene and ethene are more reactive than alkanes. Alkenes are used in the petrochemical industry to make a range of products, which includes polymers and alcohols.

(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, $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2$? 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 cm³ of a hydrocarbon was burnt in 175 cm³ of oxygen. After cooling, the volume of the remaining gases was 125 cm³. The addition of aqueous sodium hydroxide removed carbon dioxide leaving 25 cm³ of unreacted oxygen.

(i) volume of oxygen used = cm³ [1]

(ii) volume of carbon dioxide formed = cm³ [1]

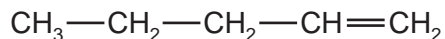
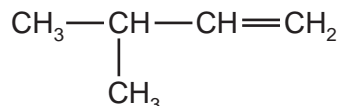
(iii) Deduce the formula of the hydrocarbon and the balanced equation for the reaction.

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

[Total: 15]

- 3 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, $\text{CH}_3-\text{CH}=\text{CH}_2$, would produce ethanoic acid, CH_3-COOH , and methanoic acid, $\text{H}-\text{COOH}$. Deduce the formulae of the alkenes which would form the following carboxylic acids when oxidised.

ethanoic acid and propanoic acid

only ethanoic acid

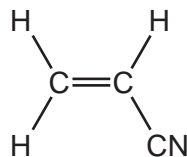
[2]

(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]

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, $\text{CH}_3\text{-CH}_2\text{-CH=CH-CH}_3$, oxidises to $\text{CH}_3\text{-CH}_2\text{-COOH}$ and CH_3COOH . Name these two acids.

$\text{CH}_3\text{-CH}_2\text{-COOH}$

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) $\text{CH}_3\text{-CH=CH}_2 + \text{Br}_2 \rightarrow$ [1]

(ii) $\text{CH}_3\text{-CH=CH}_2 + \text{H}_2\text{O} \rightarrow$ [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 O₂ : moles of CO₂

From this ratio determine the formula of the alkene.

..... [3]

Write an equation for the complete combustion of this alkene.

..... [1]

[Total: 13]

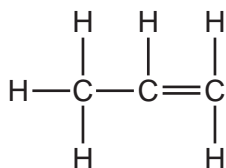
5 The alkenes are a series of unsaturated hydrocarbons. They have the general molecular formula C_nH_{2n} .

(a) Deduce the molecular formula of an alkene which has a relative molecular mass of 126. Show your working.

.....

..... [2]

(b) The structural formula of propene is drawn below.



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

Use x to represent an electron from an atom of carbon.

Use o to represent an electron from an atom of hydrogen.

[3]

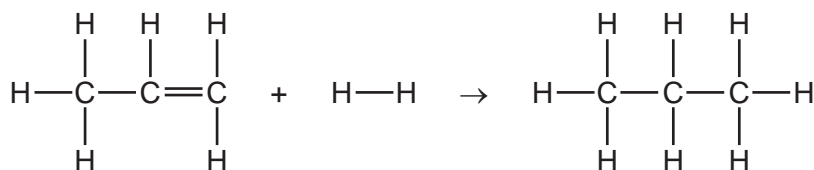
(ii) Draw the structure of the polymer formed from propene

[2]

- (iii) Bond energy is the amount of energy, in kJ, which must be supplied to break one mole of the bond.

bond	bond energy in kJ/mol
H—H	+436
C=C	+610
C—C	+346
C—H	+415

Use the data in the table to show that the following reaction is exothermic.



.....

 [3]

- (c) This question is concerned with some of the addition reactions of but-1-ene.

- (i) Name the product formed when but-1-ene reacts with water.

..... [1]

- (ii) Complete the equation.



- (iii) Deduce the formula of the compound which reacts with but-1-ene to form 1-iodobutane.

..... [1]

[Total: 14]