

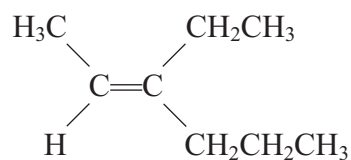
1 (a) Give the general formula for the homologous series of **alkenes**.

(1)

(b) What is meant by the term **unsaturated** as applied to alkenes?

(1)

(c) (i) Name the alkene below using *E-Z* nomenclature.



(2)

(ii) Suggest why this alkene cannot be named using the *cis-trans* naming system.

(1)

(d) Give the structural formula of the organic product of the reaction of ethene, $\text{CH}_2=\text{CH}_2$, with

(i) hydrogen.

(1)

(ii) chlorine.

(1)

(iii) acidified aqueous potassium manganate(VII).

(1)

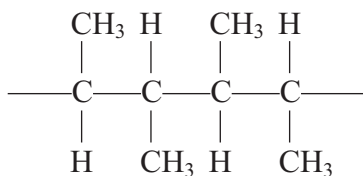
(iv) bromine **water**.

(1)

(e) Draw the mechanism for the reaction of **propene** with hydrogen bromide to give the major product.

(4)

(f) The structure below shows **two** repeat units of a polymer.



(i) Give the displayed formulae of **two** isomeric alkenes, either of which could have given rise to this polymer.

(2)

(ii) State why the empirical formula of a poly(alkene) is the same as that of the monomer from which it is produced.

(1)

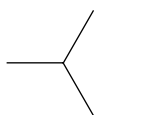
(iii) State, with a reason, the atom economy for the production of a poly(alkene) from an alkene.

(1)

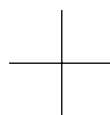
(Total for Question 17 marks)

2 This question is about alkanes.

(a) The skeletal formulae of two alkanes (**A** and **B**) are shown below.



A



B

(i) Write the general formula of the alkanes. (1)

(ii) Compounds **A** and **B** are of each other. (1)

(iii) Draw the displayed formula of compound **A**. (1)

(iv) Give the systematic name of compound **B**. (1)

(b) The largest use for alkanes is as fuels. However, there are problems associated with the combustion of alkanes, whether complete or incomplete.

(i) An incomplete combustion of methane, CH_4 , results in the formation of carbon monoxide and water only.

Write the equation for this reaction. State symbols are **not** required.

(2)

(ii) When does incomplete combustion occur?

(1)

(iii) State **two** problems that result from the incomplete combustion of alkane fuels.

(2)

*(iv) State and explain the main environmental problem arising from the **complete** combustion of alkane fuels.

(3)

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(c) The reactions of organic compounds, including alkanes, may be broken down into a series of steps; this is the mechanism for the reaction. The reaction between methane and chlorine may be represented by a mechanism involving three stages **initiation**, **propagation** and **termination**.

(i) Reaction mechanisms often involve the use of 'curly arrows'. Explain the meaning of the curly arrows shown below.

(2)



Arrow I



Arrow II

Arrow I

.....

Arrow II

.....

(ii) Using the curly arrow notation, show the **initiation** step of the reaction between methane and chlorine.

(2)

(iii) Give the two **propagation** steps of the reaction between methane and chlorine.

Curly arrows are **not** required.

(2)

(iv) Suggest why a small amount of UV light can result in the formation of a large amount of product.

(1)

(v) Ethane is a trace product of this reaction. By means of an equation, show how the ethane is formed.

(1)

(d) Scientists never detect molecular hydrogen, H_2 , amongst the products of the chlorination of methane.

Use the data below to suggest why this is so.

The frequency of UV light used corresponds to an energy of about 400 kJ mol^{-1} .

Bond	Bond enthalpy/ kJ mol^{-1}
C—H	435
Cl—Cl	243

(2)

(Total for Question 22 marks)