14. Hydrocarbons

14.1 Alkanes

Paper 2

Question Paper

1 Chlorine is one of the elements in Group 17 of the Periodic Table.

(b) The halogenoalkane CH_3CH_2Cl forms when chlorine reacts with C_2H_6 via a free-radical substitution mechanism.

(i) Define free radical.

.....

..... [1]

(ii) State the essential condition for chlorine to react with C_2H_6 at room temperature.

..... [1]

(iii) Write **two** equations to show the propagation steps in this reaction.

1 .....

2 .....

[2]

2 Chlorine is a very reactive element.

(d) Chlorine reacts with methane in a series of reactions to produce chloroalkanes.

(i) State the conditions required for chlorine to react with methane.

..... [1]

(ii) One of the products of the reaction is CH_2Cl_2 which reacts further to produce $CHCl_3$.

Complete Table 3.2 to show details of the mechanism that forms $CHCl_3$ from CH_2Cl_2.

Table 3.2

name of step	equation
initiation	.....
propagation	CH_2Cl_2 + $Cl\bullet \rightarrow$ .....
termination	..... $\rightarrow CHCl_3$

[3]

3 **(a)** Molecule **M** is present in petrol, a fuel used in cars. **M** is a saturated, non-cyclic hydrocarbon. **M** contains eight carbon atoms.

(i) Construct an equation for the complete combustion of **M**.

..... [2]

(ii) Describe how the composition of products differs when incomplete combustion of **M** occurs.

.....

..... [2]

4 **(a)** Naphtha is a mixture which contains only hydrocarbon molecules.

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

.....

..... [1]

(ii) Name the raw material that is used to produce a sample of naphtha.

..... [1]

(b) Compound **V** is found in naphtha. It has a molecular formula $C_{10}H_{22}$.

When **V** is heated at high pressure in the absence of air, an equal number of moles of ethene, propene and **W** are made. **W** is a compound made of straight chain, saturated molecules.

(i) Name the process that describes this reaction.

..... [1]

(ii) Deduce the structure of **W**. Draw its structure below.

[1]

5 **(a)** Below is a list of species which can react with organic compounds.

CN^- HCl Cl H_2O CO_3^{2-}

(i) From the list, identify a species which can react with ethane.

..... [1]

6 There are many different types of aliphatic and aromatic hydrocarbons.

(a) Name a naturally occurring source of aliphatic and aromatic hydrocarbons and outline how different hydrocarbons are separated from this source.

name of source .....

outline of separation of hydrocarbons .....

.....

[2]

(b) When alkanes are heated to high temperatures, in the absence of air, the molecules can break into smaller molecules.

(i) Identify the type of reaction occurring.

..... [1]

(ii) Write an equation which describes the reaction occurring when heptane, C_7H_{16}, is heated in the absence of air, to form hexane, butane and ethene only.

..... [1]

7 There are many different types of aliphatic and aromatic hydrocarbons.

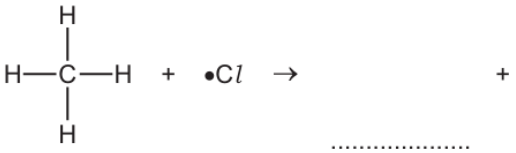
(d) The table compares the reactivity of alkanes and alkenes with chlorine.

	alkanes	alkenes
name of the type of reaction with chlorine	substitution	addition and substitution
name of the type of reacting species	free radical	electrophile and free radical

(iii) Name the stage of the reaction mechanism which occurs when a methane molecule reacts with a chlorine free radical.

..... [1]

(iv) Complete the equation for the reaction which occurs when a methane molecule reacts with a chlorine free radical.



[1]

8 **(e)** Under certain conditions, chlorine undergoes a free-radical substitution reaction with ethane.

(i) State the conditions required to initiate this reaction.

..... [1]

(ii) Write the overall equation for this free-radical substitution reaction.

..... [1]

9 Crude oil is a natural source of hydrocarbons that are used as fuels.

(a) Hydrocarbons with low relative molecular mass, M_r, are used as fuels in industry, in the home and for transport.

There is a high demand for the hydrocarbons with low M_r.

(i) Name the process by which long-chain hydrocarbons are broken down into shorter-chain hydrocarbons.

..... [1]

(ii) Give one reason why hydrocarbons with low M_r are suitable for use as fuels.

..... [1]

10 Crude oil is a complex mixture of hydrocarbon molecules.

The hydrocarbon molecules in crude oil are separated by fractional distillation. Fractional distillation is used because the different hydrocarbon molecules in crude oil have different boiling points.

(b) Some of the hydrocarbon molecules obtained from crude oil are processed further by cracking.

Suggest why some hydrocarbon molecules are processed further by cracking.

.....

.....

..... [1]

(c) Cracking one mole of dodecane, $C_{12}H_{26}$, produces two moles of ethene and one mole of another hydrocarbon molecule.

(i) Write the equation for this cracking reaction.

..... [1]