Alkanes

1. Butane, C_4H_{10}, reacts with chlorine to produce a chloroalkane with molecular formula C_4H_9Cl.

The reaction is initiated by the formation of chlorine radicals from chlorine.

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

.....

[1]

(ii) State the conditions necessary to bring about the formation of the chlorine free radicals from Cl_2.

.....

[1]

(iii) State the type of bond fission involved in the formation of the chlorine radicals.

.....

[1]

(iv) The chlorine radicals react with butane in several steps to produce C_4H_9Cl.

Write equations for the two propagation steps.

.....

.....

[2]

[Total 5 marks]

2. Cyclohexane, C_6H_{12}, reacts with chlorine to produce chlorocyclohexane, $C_6H_{11}Cl$.

$$C_6H_{12} + Cl_2 \rightarrow C_6H_{11}Cl + HCl$$

The mechanism for this reaction is a free radical substitution.

(i) Write an equation to show the initiation step.

.....

[1]

(ii) State the conditions necessary for the initiation step.

.....

[1]

(iii) The reaction continues by **two** propagation steps resulting in the formation of chlorocyclohexane, $C_6H_{11}Cl$.

Write equations for these **two** propagation steps.

step 1 .....

step 2 .....

[2]

(iv) State what happens to the free radicals in the termination steps.

.....

[1]

[Total 5 marks]

3. Isomer **L**, C_5H_{10}, reacts with CI_2 in the presence of UV light to produce the organic product $C_5\mathbf{H}_9CI$. The reaction takes place in three stages: initiation, propagation and termination.

(i) The reaction is initiated by the fission of CI_2. State the type of fission involved.

.....

[1]

(ii) Write an equation to illustrate the fission of CI_2 in (i).

.....

[1]

(iii) The fission of CI_2 leads to a chain reaction involving two propagation steps. Complete the equations for the two propagation steps.

C_5H_{10} + ... → $\bullet C_5H_9$ + ...

[1]

$\bullet C_5H_9$ + ... → ..... + ...

[1]

[Total 4 marks]

4. Crude oil is a complex mixture of hydrocarbons. Initial separation is achieved by fractional distillation. The separate fractions are then further refined to produce hydrocarbons such as decane.

(a) (i) State what is meant by the term *hydrocarbon.*

.....

.....

[1]

(ii) A molecule of decane contains ten carbon atoms. State the molecular formula of decane.

.....

[1]

(iii) Deduce the empirical formula of decane. .....

[1]

(b) Dodecane, $C_{12}H_{26}$, is a straight chain alkane that reacts with chlorine to produce a compound with molecular formula $C_{12}H_{25}Cl$.

$$C_{12}H_{26} + Cl_2 \rightarrow C_{12}H_{25}Cl + HCl$$

The reaction is initiated by the formation of chlorine free radicals from chlorine.

(i) What is meant by the term *free radical*?

.....

[1]

(ii) State the conditions necessary to bring about the formation of the chlorine free radicals from Cl_2.

.....

[1]

(iii) State the type of bond fission involved in the formation of the chlorine free radicals.

.....

[1]

(iv) The chlorine free radicals react with dodecane to produce $C_{12}H_{25}Cl$. Write equations for the **two** propagation steps involved.

.....

.....

[2]

(v) How many different structural isomers can be formed when chlorine reacts with dodecane to form $C_{12}H_{25}Cl$?

answer .....

[1]

(c) Dodecane, $C_{12}H_{26}$, can be cracked into ethene and a straight chain alkane such that the molar ratio ethene: straight chain alkane is 2 : 1.

(i) Write a balanced equation for this reaction.

.....

[2]

(ii) Name the straight chain alkane formed.

.....

[1]

[Total 12 marks]

5. Hexane reacts with Br_2 in the presence of ultraviolet light.

$$C_6H_{14} + Br_2 \rightarrow C_6H_{13}Br + HBr$$

(i) State the type of reaction.

.....

[1]

(ii) Identify the three possible structural isomers of the product, $C_6H_{13}Br$, that could be formed from this reaction with hexane.

[3]

[Total 4 marks]

6. Butane, C_4H_{10}, under certain conditions, reacts with Cl_2 to form a mixture of chlorinated products. One possible product is C_4H_9Cl.

$$C_4H_{10} + Cl_2 \rightarrow C_4H_9Cl + HCl$$

(a) (i) State the conditions.

.....

[1]

(ii) Write equations to show the mechanism of this reaction.

initiation .....

propagation .....

.....

[3]

(iii) Write **one** equation for a reaction that would terminate this mechanism.

.....

[1]

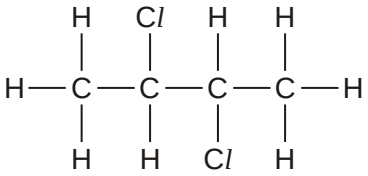
(iv) State the type of bond fission involved in the initiation step.

.....

[1]

(b) One other possible product of the reaction between butane and chlorine is compound **J**, $C_4H_8Cl_2$, shown below.

compound **J**



(i) Name compound **J**.

.....

[1]

(ii) Draw the skeletal formula of compound **J**.

[1]

(iii) In addition to compound **J**, suggest **one** other possible structural isomer of $C_4H_8Cl_2$ that could have been formed in this reaction.

[1]

[Total 9 marks]