Chapter 8

Hydrocarbons

Topic 8 introduces some more ideas about the reactions of alkanes and their uses. You should by now be able to define empirical formula, molecular formula, structural formula and displayed formula. Illustrate these with reference to ethane.

By the end of the topic you will be able to recognise different types of isomerism: structural isomerism, geometric isomerism and optical isomerism. Show and name the geometric isomers of but-2-ene.

8.1 Alkanes

The alkanes are useful because they are relatively unreactive. They can be stored easily and burn with clean flames to release a large amount of energy. This unreactivity comes from the high values of the bond energies E(C-C) and E(C-H), and they will not react with oxidising agents, *aqueous* halogen solutions, concentrated sulphuric acid or alkalis. You should be able to write a balanced equation for the complete combustion of an alkane (it is acceptable to use fractional stoichiometric coefficients). Incomplete combustion produces carbon monoxide which is toxic. Alkane combustion involves free radical intermediates.

Mixtures of long chain alkanes can be cracked to produce shorter chain alkanes

and alkenes. You should be able to draw the apparatus used in the lab to crack alkanes.

8.1.1 Free radical substitution reactions

Free radicals are very reactive species - they contain an unpaired electron. In the presence of UV light or sunlight halogens in an alcoholic solvent can be split into two atoms - this is called **homolytic fission**.

$$Cl_2 \longrightarrow 2\ Cl^{\bullet} \tag{8.1}$$

Write an equation for the heterolytic fission of chlorine, and explain why it does not happen in these circumstances.

This first process is called **chain initiation**. After this come the **chain propagation** and **chain termination** reactions. You should be able to write 5 equations for these processes, and write an overall equation for the reaction.

8.2 Alkenes

The functional group in an alkene is a carbon - carbon double bond. This means that they are **unsaturated** molecules. There are two definitive tests for this unsaturation. Describe what you would see and what would be produced in these two tests.

8.2.1 Oxidation

8.2.2 Reaction with bromine

The alkenes are more reactive than alkanes because the π-bond is slightly weaker than the σ-bond. Explain how the presence of the π-bond leads to the possibility of geometric isomerism.

Concentrated sulphuric acid reacts with alkenes in a similar way to bromine - by **electrophilic addition**. An electrophile is an electron-deficient species which usually has a full or partial positive charge which can form a new covalent bond using a pair of electrons from the carbon compound. The product of this addition can be hydrolysed to produce an alcohol.

8.2.3 Polymerisation

Small molecules (monomers) can be joined together to form giant chains called polymers. Ethene and its derivatives undergo **addition polymerisation** reactions which are started by free radicals.