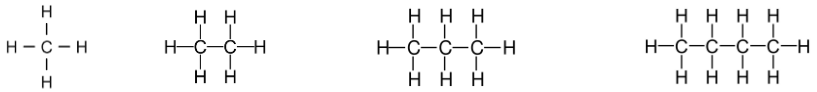
AQA Chemistry Organic Chemistry Journey of Knowledge

Context and introduction to the unit: The chemistry of carbon compounds is so important that it forms a separate branch of chemistry. A great variety of carbon compounds is possible because carbon atoms can form chains and rings linked by C-C bonds. This branch of chemistry gets its name from the fact that the main sources of organic compounds are living, or once-living materials from plants and animals. These sources include fossil fuels which are a major source of feedstock for the petrochemical industry. Chemists are able to take organic molecules and modify them in many ways to make new and useful materials such as polymers, pharmaceuticals, perfumes and flavourings, dyes and detergents
KS3: ***Chemical reactions in Year 8. Atoms, Elements & Compounds in Year 7.***

CORE KNOWLEDGE

5.7.1.1 Crude oil, hydrocarbons and alkanes -Crude oil is a finite resource found in rocks. Crude oil is the remains of an ancient biomass consisting mainly of plankton that was buried in mud. Crude oil is a mixture of a very large number of compounds. Most of the compounds in crude oil are hydrocarbons, which are molecules made up of hydrogen and carbon atoms only. Most of the hydrocarbons in crude oil are hydrocarbons called alkanes. The general formula for the homologous series of alkanes is C_nH_{2n+2} The first four members of the alkanes are methane, ethane, propane and butane.



5.7.1.2 Fractional distillation and petrochemicals - The many hydrocarbons in crude oil may be separated into fractions, each of which contains molecules with a similar number of carbon atoms, by fractional distillation. The fractions can be processed to produce fuels and feedstock for the petrochemical industry. Many of the fuels on which we depend for our modern lifestyle, such as petrol, diesel oil, kerosene, heavy fuel oil and liquefied petroleum gases, are produced from crude oil. Many useful materials on which modern life depends are produced by the petrochemical industry, such as solvents, lubricants, polymers, detergents. The vast array of natural and synthetic carbon compounds occur due to the ability of carbon atoms to form families of similar compounds

5.7.1.3 Properties of hydrocarbon - Some properties of hydrocarbons depend on the size of their molecules, including boiling point, viscosity and flammability. These properties influence how hydrocarbons are used as fuels Boiling point, viscosity and flammability change with increasing molecular size. The combustion of hydrocarbon fuels releases energy. During combustion, the carbon and hydrogen in the fuels are oxidised. The complete combustion of a hydrocarbon produces carbon dioxide and water.

5.7.1.4 Cracking and alkenes - Hydrocarbons can be broken down (cracked) to produce smaller, more useful molecules. Cracking can be done by various methods including catalytic cracking and steam cracking. The products of cracking include alkanes and another type of hydrocarbon called alkenes. Alkenes are more reactive than alkanes and react with bromine water, which is used as a test for alkenes. Bromine water is used to test for alkenes with the positive test being a colour change from brown to colourless. There is a high demand for fuels with small molecules and so some of the products of cracking are useful as fuels. Alkenes are used to produce polymers and as starting materials for the production of many other chemicals.

Disciplinary knowledge
WS1.2,4.1

Vocabulary
Alkane, alkene, saturated, unsaturated, hydrocarbon, molecule, viscosity, flammability, fractional distillation, cracking, incomplete combustion, complete combustion, carbon dioxide, carbon monoxide, exothermic.

Reading is Power
"Sweet oil fragrance of the gods"

Where next?
Earth's atmosphere
Using Earth's resources

AQA Chemistry Organic Chemistry Journey of Knowledge – SEPS ONLY

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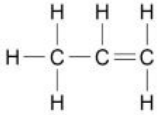
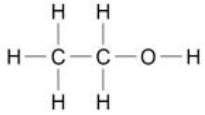
CORE KNOWLEDGE

4.7.2.1 Structure and formulae of alkenes - Alkenes are hydrocarbons with a double carbon-carbon bond. The general formula for the homologous series of alkenes is C_nH_{2n} Alkene molecules are unsaturated because they contain two fewer hydrogen atoms than the alkane with the same number of carbon atoms. The first four members of the homologous series of alkenes are ethene, propene, butene and pentene. Alkene molecules can be represented in the following forms: C_3H_6 or



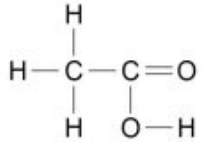
4.7.2.2 Reactions of alkenes - Alkenes are hydrocarbons with the functional group C=C. It is the generality of reactions of functional groups that determine the reactions of organic compounds. Alkenes react with oxygen in combustion reactions in the same way as other hydrocarbons, but they tend to burn in air with smoky flames because of incomplete combustion. Alkenes react with hydrogen, water and the halogens, by the addition of atoms across the carbon-carbon double bond so that the double bond becomes a single carbon-carbon bond.

4.7.2.3 Alcohols - Alcohols contain the functional group –OH. Methanol, ethanol, propanol and butanol are the first four members of a homologous series of alcohols. Alcohols can be represented in the following forms: CH_3CH_2OH or



Aqueous solutions of ethanol are produced when sugar solutions are fermented using yeast.

4.7.2.4 Carboxylic acid - Carboxylic acids have the functional group –COOH. The first four members of a homologous series of carboxylic acids are methanoic acid, ethanoic acid, propanoic acid and butanoic acid. The structures of carboxylic acids can be represented in the following forms: CH_3COOH or



Disciplinary knowledge

AT 2, 5, 6 Opportunities within investigation of the reactions of carboxylic acids.

WS 1.2

Vocabulary

Hydration, hydrogenation, halogenation, fermentation, alcohol, carboxylic acid, ester, condensation, addition, polymer.

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Where next?

Earth's atmosphere

Using Earth's resources

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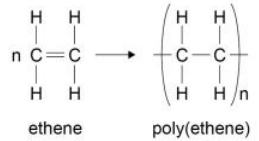
CORE KNOWLEDGE

4.7.3.1 Addition polymerisation - Alkenes can be used to make polymers such as poly(ethene) and poly(propene) by addition polymerisation. In addition polymerisation reactions, many small molecules (monomers) join together to form very large molecules (polymers). For example:

In addition polymers the repeating unit has the same atoms as the monomer because no other molecule is formed in the reaction.



4.7.3.2 Condensation polymerisation (HT only) - **Condensation polymerisation involves monomers with two functional groups. When these types of monomers react they join together, usually losing small molecules such as water, and so the reactions are called condensation reactions. The simplest polymers are produced from two different monomers with two of the same functional groups on each monomer. For example:**

ethanediol

$HO-CH_2-CH_2-OH$ **or** $HO-\square-OH$

and

hexanedioic acid

$HOOC-CH_2-CH_2-CH_2-CH_2-COOH$ **or**
$HOOC-\square-COOH$

polymerise to produce a polyester:

$n\,HO-\square-OH + n\,HOOC-\square-COOH \longrightarrow$

$\left(O-\square-O-CO-\square-CO\right)_n + 2n\,H_2O$

4.7.3.3 Amino acids (HT only) - **Amino acids have two different functional groups in a molecule. Amino acids react by condensation polymerisation to produce polypeptides. For example: glycine is H_2NCH_2COOH and polymerises to produce the polypeptide Different amino acids can be combined in the same chain to produce proteins.**

$$\left(HNCH_2CO\right)_n \text{ and } n\,H_2O$$

4.7.3.4 DNA (deoxyribonucleic acid) and other naturally occurring polymers - DNA (deoxyribonucleic acid) is a large molecule essential for life. DNA encodes genetic instructions for the development and functioning of living organisms and viruses. Most DNA molecules are two polymer chains, made from four different monomers called nucleotides, in the form of a double helix. Other naturally occurring polymers important for life include proteins, starch and cellulose.

Disciplinary knowledge

AT 2, 5, 6 Opportunities when investigating reactions of alcohols.

WS 1.2 Use models to represent addition polymerisation.

Vocabulary

Hydration, hydrogenation, halogenation, fermentation, alcohol, carboxylic acid, ester, condensation, addition, polymer.

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Where next?

Later in chemistry pupils will study atmospheric pollutants which links the combustion of hydrocarbons. Also pupils learn about finite and renewable resources which links to crude oil.