C7

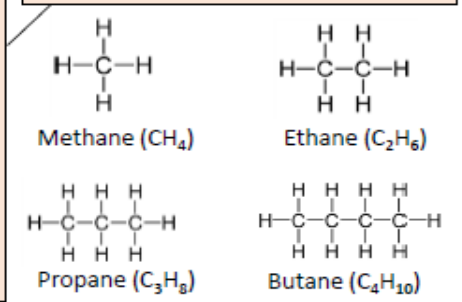
AQA Chemistry
C7: Organic Chemistry

Carbon compounds as fuels and feedstock

Crude oil, hydrocarbons and alkanes

Crude oil	*A finite resource*	Consisting mainly of plankton that was buried in the mud, crude oil is the remains of ancient biomass.
Hydrocarbons	*These make up the majority of the compounds in crude oil*	Most of these hydrocarbons are called alkanes.
General formula for alkanes	C_nH_{2n+2}	For example: C_2H_6 C_6H_{14}

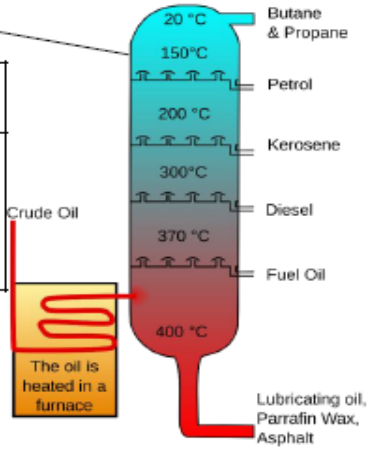
Display formula for first four alkanes



Fractional distillation and petrochemicals

Fractions	*The hydrocarbons in crude oil can be split into fractions*	Each fraction contains molecules with a similar number of carbon atoms in them. The process used to do this is called fractional distillation.
Using fractions	*Fractions can be processed to produce fuels and feedstock for petrochemical industry*	We depend on many of these fuels; petrol, diesel and kerosene. Many useful materials are made by the petrochemical industry; solvents, lubricants and polymers.

Hydrocarbon chains	*In oil*	Hydrocarbon chains in crude oil come in lots of different lengths.
	Boiling points	The boiling point of the chain depends on its length. During fractional distillation, they boil and separate at different temperatures due to this.



Cracking and alkenes

Alkanes to alkenes	*Long chain alkanes are cracked into short chain alkenes.*
Alkenes	*Alkenes are hydrocarbons with a double bond (some are formed during the cracking process).*
Properties of alkenes	*Alkenes are more reactive that alkanes and react with bromine water. Bromine water changes from orange to colourless in the presence of alkenes.*

Cracking	*The breaking down of long chain hydrocarbons into smaller chains*	The smaller chains are more useful. Cracking can be done by various methods including catalytic cracking and steam cracking.
Catalytic cracking	*The heavy fraction is heated until vaporised*	After vaporisation, the vapour is passed over a hot catalyst forming smaller, more useful hydrocarbons.
Steam cracking	*The heavy fraction is heated until vaporised*	After vaporisation, the vapour is mixed with steam and heated to a very high temperature forming smaller, more useful hydrocarbons.

Decane → pentane + propene + ethane

$C_{10}H_{22} \rightarrow C_5H_{12} + C_3H_6 + C_2H_4$

Alkenes and uses as polymers	*Used to produce polymers. They are also used as the starting materials of many other chemicals, such as alcohol, plastics and detergents.*
Why do we crack long chains?	*Without cracking, many of the long hydrocarbons would be wasted as there is not much demand for these as for the shorter chains.*

Properties of hydrocarbons

Combustion	During the complete combustion of hydrocarbons, the carbon and hydrogen in the fuels are oxidised, releasing carbon dioxide, water and energy.

Complete combustion of methane:

Methane + oxygen → carbon dioxide + water + energy

$CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (l)$

Boiling point (temperature at which liquid boils)	*As the hydrocarbon chain length increases, boiling point increases.*
Viscosity (how easily it flows)	*As the hydrocarbon chain length increases, viscosity increases.*
Flammability (how easily it burns)	*As the hydrocarbon chain length increases, flammability decreases.*

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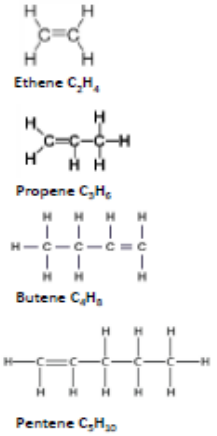
Reactions of alkenes and alcohols

Structure and formula of alkenes

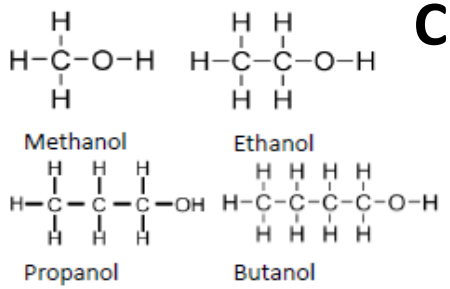
Alkenes	*Hydrocarbons with a double carbon-carbon bond.*
Unsaturated	*Alkenes are unsaturated because they contain two fewer hydrogen atoms than their alkane counterparts.*
General formula for alkenes	C_nH_{2n}



Functional group	*Alkenes are hydrocarbons in the functional group C=C.*	The functional group of an organic compound determined their reactions.
Alkene reactions	*Alkenes react with oxygen in the same way as other hydrocarbons, just with a smoky flame due to incomplete combustion.*	Alkenes also react with hydrogen, water and the halogens. The C=C bond allows for the addition of other atoms.

Alcohols

Functional group	*-OH* *For example: CH_3CH_2OH*	Methanol, ethanol, propanol and butanol are the first four of the homologous series.
Alcohol reactions	*Alcohols react with sodium, air and water.*	Alcohols and sodium: bubbling, hydrogen gas given off and salt formed. Alcohols and air: alcohols burn in air releasing carbon dioxide and water. Alcohols and water: alcohols dissolve in water to form a neutral solution.
Fermentation	*Ethanol is produced from fermentation.*	When sugar solutions are fermented using yeast, aqueous solutions of ethanol are produced. The conditions needed for this process include a moderate temperature (25 – 50°C), water (from sugar solution) and an absence of oxygen.



Carboxylic acids

Functional group	*-COOH* *For example: CH_3COOH*	Methanoic acid, ethanoic acid, propanoic acid and butanoic acid are the first four of the homologous series.
Carboxylic acid reactions	*Carboxylic acids react with carbonates, water and alcohols.*	Carboxylic acids and carbonates: These acids are neutralised by carbonates
		Carboxylic acids and water: These acids dissolve in water.
		Carboxylic acids and alcohols: The acids react with alcohols to form esters.
Strength (HT only)	*Carboxylic acids are weak acids*	Carboxylic acids only partially ionise in water. An aqueous solution of a weak acid with have a high pH (but still below 7).

Synthetic and naturally occurring polymers

Addition polymerisation

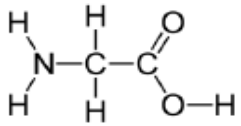
Polymers	*Alkenes are used to make polymers by addition polymerisation.*	Many small molecules join together to form polymers (very large molecules).
Displaying polymers	*In addition polymers, the repeating unit has the same atoms as the monomer.*	It can be displayed like this: ethene → polymerisation → repeating unit of poly(ethene)

Condensation polymerisation (HT only)

Condensation polymerisation	*Condensation polymerisation involves monomers with two functional groups*	When these types of monomers react they join together and usually lose small molecules, such as water. This is why they are called condensation reactions.

Amino acids

Amino acids have two functional groups in a molecule. They react by condensation polymerisation to produce peptides.



DNA and naturally occurring polymers

DNA	*Deoxyribonucleic acid is a large molecule essential for life. DNA gives the genetic instructions to ensure development and functioning of living organisms and viruses.*
DNA structure	*Most DNA molecules are two polymer chains made from four different monomers, called nucleotides. They are in the double helix formation.*
Natural polymers	*Other naturally occurring polymers include proteins, starch and cellulose and are all important for life.*