4.7 Organic Chemistry

Crude oil

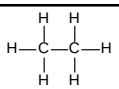
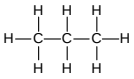
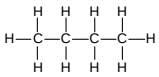
Crude oil is a finite resource found in rocks. Crude oil is the remains of an ancient biomass consisting mainly of plankton that was buried in mud.

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**.

Alkanes

Most of the hydrocarbons in crude oil are hydrocarbons called alkanes. Alkanes **only** contain **single** covalent bonds and are classed as **saturated** hydrocarbons

The general formula for the homologous series of alkanes is C_nH_{2n+2}

Name of Alkane	n (number of carbons)	Molecular formula	Displayed Formula
Methane	1	CH_4	
Ethane	2	C_2H_6	
Propane	3	C_3H_8	
butane	4	C_4H_{10}	

Physical properties of hydrocarbons

Some properties of hydrocarbons depend on the size of their molecules. These properties influence how hydrocarbons are used as fuels.

- **Boiling points** and **viscosity** of hydrocarbons **increase** as the molecules get bigger (as the intermolecular forces become bigger)
- **Volatility** (how easily a liquid vaporises) and **Flammability** of the fuels **decrease** as the molecules get bigger

Combustion of Hydrocarbons

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. (needs a plentiful supply of air)

Hydrocarbon + Oxygen → Carbon dioxide + Water

e.g. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Fractional Distillation of crude oil - how it works

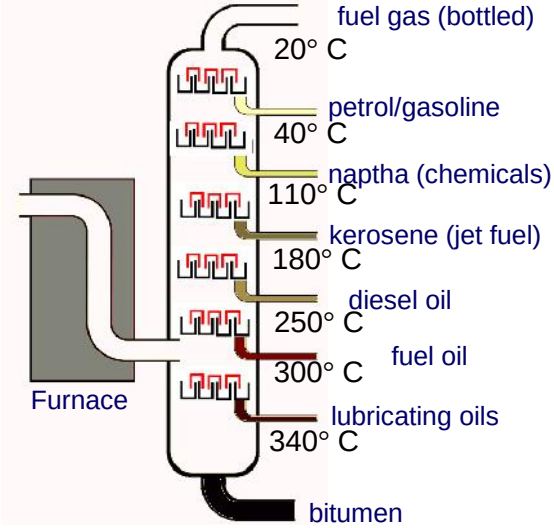
The many hydrocarbons in crude oil may be separated into fractions, each of which contains molecules with a similar number of carbon atoms, by **fractional distillation**.

- Oil is pre-heated then passed into column.
- Some of the oil **evaporates**
- **Vapours rise** up the column and **cool**
- Some vapours **condense** , separate and flow out the column in a pipe
- Some vapours stay as gases and rise out the top of the column
- Each fraction has a **different boiling point** and condenses at **different levels** in the fractionating column
- The temperature of column decreases upwards
- Boiling point depends on size of molecules.
- Small molecules condense at the top at lower temperatures
- and big molecules condense at the bottom at higher temperatures

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.



Cracking

Larger Hydrocarbons can be broken down (cracked) to produce **smaller**, more useful molecules.

Cracking reactions are **thermal decomposition** reactions.

The cracking process involves **heating the hydrocarbons** to **vaporise** them.
The vapours are either
- passed over a **hot catalyst**
- or **mixed with steam** and heated to a **very high temperature**

The products of cracking include alkanes and unsaturated hydrocarbons called alkenes

Be able to complete balanced equations for cracking reactions.
Example
Decane → pentane + pentene
$C_{10}H_{22} \rightarrow C_5H_{12} + C_5H_{10}$

Uses of Cracking products
- 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.

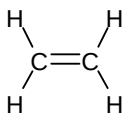
Alkenes

Alkenes are hydrocarbons with **a double carbon-carbon bond**. Alkene molecules are **unsaturated** because they contain two fewer hydrogen atoms than the alkane with the same number of carbon atoms.

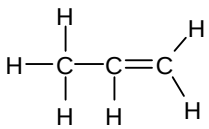
The general formula for the homologous series of alkenes is C_nH_{2n}

Alkenes are **more reactive** than alkanes and react with **bromine wate**r, turning it from **orange to colourless**

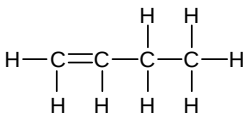
The first four members of the **homologous series** of alkenes are ethene, propene, butene and pentene.



Ethene is C_2H_4



Propene is C_3H_6



butene is C_4H_8