2.5 Crude oil and fuels

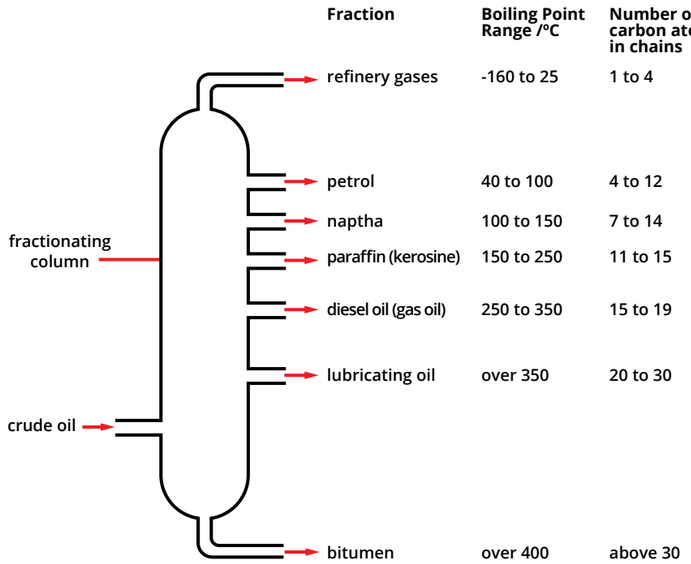
Hydrocarbons:

Hydrocarbons are compounds that contain carbon and hydrogen atoms **only**. Carbon atoms have the ability to form bonds with other carbon atoms resulting in the formation of hydrocarbon chains. These chains can vary in length and as a result, hydrocarbons have different boiling points. The longer the chain, the higher the boiling point.

Crude oil:

Crude oil is a complex mixture of hydrocarbons, which can be separated by fractional distillation. It is produced from the remains of dead marine animals and plants that lived around 300 million years ago. When the remains sank to the bottom of the sea, they were covered by sand and other sediments. Layer upon layer of sediments built up over time and pressure and heat caused the remains to break down, forming crude oil.

Fractional distillation:



Fraction	Boiling Point Range /°C	Number of carbon atoms in chains
refinery gases	-160 to 25	1 to 4
petrol	40 to 100	4 to 12
naptha	100 to 150	7 to 14
paraffin (kerosine)	150 to 250	11 to 15
diesel oil (gas oil)	250 to 350	15 to 19
lubricating oil	over 350	20 to 30
bitumen	over 400	above 30

Crude oil is boiled/vaporised before it enters the fractionating column and the hydrocarbons condense at different heights in the column. The lower the boiling point, the higher in the column a compound is collected. Fractions are mixtures containing hydrocarbon compounds that have similar chain lengths and, therefore, similar boiling points.

The molecules of hydrocarbons are held together by intermolecular forces. Larger molecules have more intermolecular forces, and so more energy is needed to overcome them in order for melting or boiling to occur. These forces also explain why longer chain hydrocarbons are more viscous (i.e. thicker liquids, less easy to pour).

Combustion of hydrocarbons:

The combustion of any fuel requires oxygen (from the air). Burning hydrocarbons produces carbon dioxide and water;

e.g.

methane + oxygen → carbon dioxide + water

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

All combustion reactions are exothermic, i.e. they release heat.

Hydrogen as a fuel:

Hydrogen is used as a rocket fuel and in hydrogen fuel cells that are now being utilised to power cars. There are some advantages and disadvantages of its use as a fuel.

Advantages	Disadvantages
Produced from water; therefore, it is renewable.	Requires large amounts of electricity to produce hydrogen from water by electrolysis.
Water is the only product of its combustion so burning hydrogen does not contribute towards global warming or acid rain.	Storage requires bulky and heavy pressurised containers.
It ignites easily.	Forms an explosive mixture with air.

Ethanol as a fuel (SS only):

Ethanol is an example of a biofuel made from crops such as corn, sugar cane and rapeseed. Ethanol can be mixed with petrol and used as a fuel in cars.

Advantages	Disadvantages
Renewable.	Dependent on climate for sugar growth.
Carbon-neutral, i.e. the amount of carbon dioxide absorbed by plants during photosynthesis balances the amount of carbon dioxide released on burning the fuel made from them.	Decreases the amount of land available to grow food crops - could result in higher food prices.

Fire triangle:

The fire triangle shows the factors required for combustion to occur. Firefighting and fire prevention are based on removing one or more factors.

Carbon dioxide and fire blankets can be used to remove oxygen. Water can be used to remove heat. Trees can be felled to remove fuel in a forest fire.