Fuels

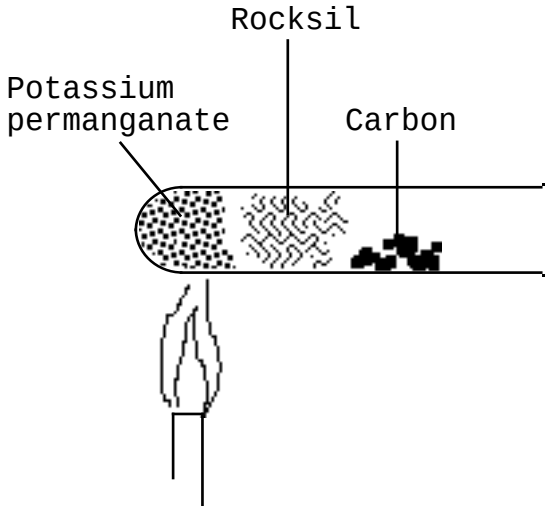
A **fuel** is a chemical (e.g. coal and oil) which is burned to produce energy.

When a substance burns it reacts with the Oxygen in the air. We call this reaction **combustion**.

e.g. the combustion of Carbon to form Carbon dioxide:

Carbon + Oxygen -> Carbon dioxide

Burn some Carbon in the apparatus below:



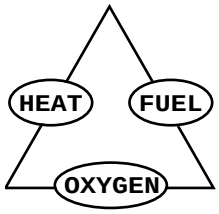
Potassium permanganate gives off Oxygen gas when heated.
The Oxygen passes across the hot Carbon.
The Carbon burns (orange to white-hot). Red hot sparks of burning Carbon are thrown out of the test-tube. Heat and light energy are produced.

Burning Fuels

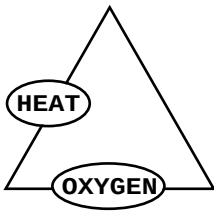
For a fire we need:

* Something to burn (the **fuel**)
* **Oxygen**, usually from the air
* A source of **heat** to start the fire and keep it going

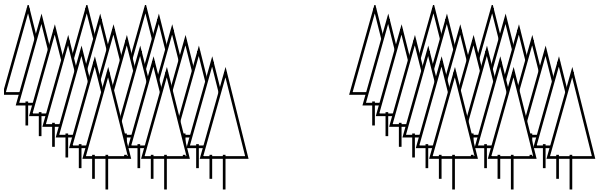
This can be summarised in the Fire Triangle:

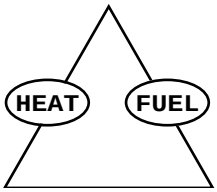


If we take away any one of these three, the fire goes out.



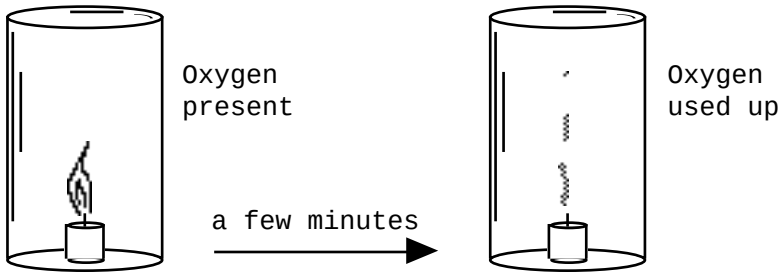
Remove the fuel and the fire cannot spread e.g. gaps are left between blocks of trees to prevent a forest fire from spreading.





When a substance burns it reacts with Oxygen. Remove the Oxygen and the fuel cannot burn.

Your teacher will show you what happens when a candle burns inside a closed jar:



The burning candle reacts with the Oxygen inside the jar. When all the Oxygen is used up the flame goes out.

Water is commonly used to 'smother' the flames and keep out Oxygen but we must never use Water to put out:

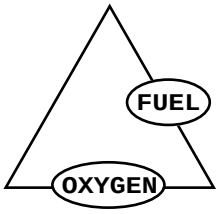
* **Electrical fires**

  Water conducts electricity!

* **Burning petrol or fat**

  Water, heavier than petrol or fat, sinks under the burning liquid, turns into lots of steam and explodes the burning petrol or fat everywhere.

  Alternative extinguishers are: fire blankets, sand, Carbon dioxide and foam.



Remove the heat and the fire cannot keep going. Most house fires are put out with water which cools the fire and removes the heat.

Conservation and Pollution

We must take care when using fossil fuels:

* Fossil fuels (coal, oil, natural gas and peat) will not last forever. Since they were formed from the remains of plants and animals over hundreds of millions of years, they cannot be replaced very easily! We say that they are a 'finite' energy source.

  Since the over-use of fossil fuels may lead to a shortage of fuels in the future alternative fuels are being investigated.

  * **Methane** is found in biogas which is made from the decomposition of waste plant material.

  * **Ethanol** is obtained from sugar cane and can be mixed with petrol to make a fuel for cars.

  * **Hydrogen** can be obtained from Water.

  All these fuels can be replaced so they are called **RENEWABLE** fuels.

* Burning fossil fuels produces Carbon dioxide which causes the 'Greenhouse Effect'.

* Oil spillages can cause great damage to marine life and the environment.

Hydrocarbons

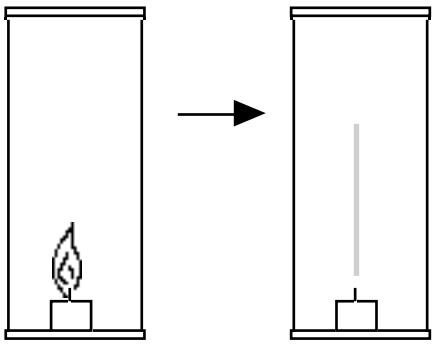
The compounds which are found in fossil fuels are mainly hydrocarbons - they consist of Hydrogen and Carbon only.

Hydrocarbons burn in a plentiful supply of air to produce Carbon dioxide and Water

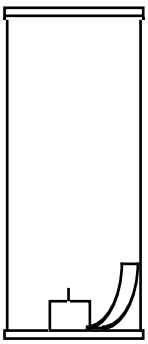
e.g. the burning of natural gas (mainly Methane):

Methane + Oxygen -> Carbon dioxide + Water

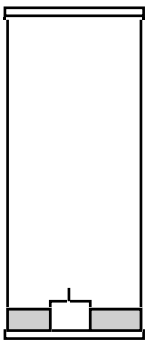
We can show that Carbon dioxide and Water are formed by burning a candle. Candle wax is a mixture of large hydrocarbon molecules.



Burn the candle in a sealed gas jar so that the products are trapped. Wait until the flame goes out.



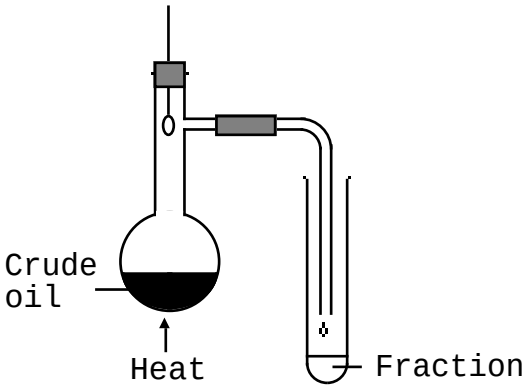
Cobalt chloride paper turns from blue to pink showing that Water has been formed



Limewater turns milky showing that Carbon dioxide has been formed

Crude Oil

Crude oil is a mixture of hydrocarbons which can be separated by fractional distillation:



The oil is gradually heated. Fractions, groups of hydrocarbons with boiling points within a given range, are collected.

The larger the molecule the higher the boiling point.

The small gas molecules therefore boil off first, at low temperatures. We call this the '**gas** fraction'. The gas fraction is used to make Calor Gas.

As the oil is heated further, slightly larger molecules with higher boiling points begin to distil over - **petrol**.

Further heating produces larger molecules with even higher boiling points - **paraffin**, followed by **diesel** then **lubricating oil**.

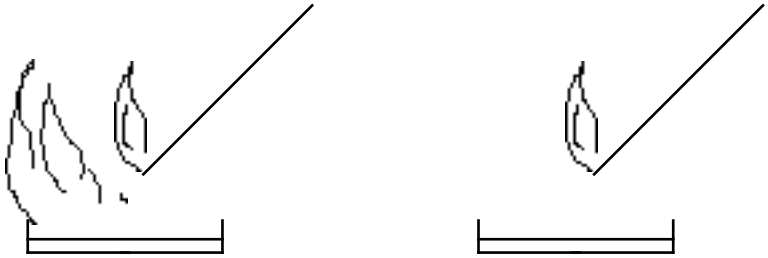
A black solid called **bitumen** is left in the flask. This is used as a road covering.

The uses of these fractions depend on their properties:

* Gases, Petrol, Paraffin and Diesel are flammable and so are used as fuels.

* Diesel is more viscous and less flammable than petrol and requires a different type of engine.

Apply a lit taper to trays containing petrol and diesel:



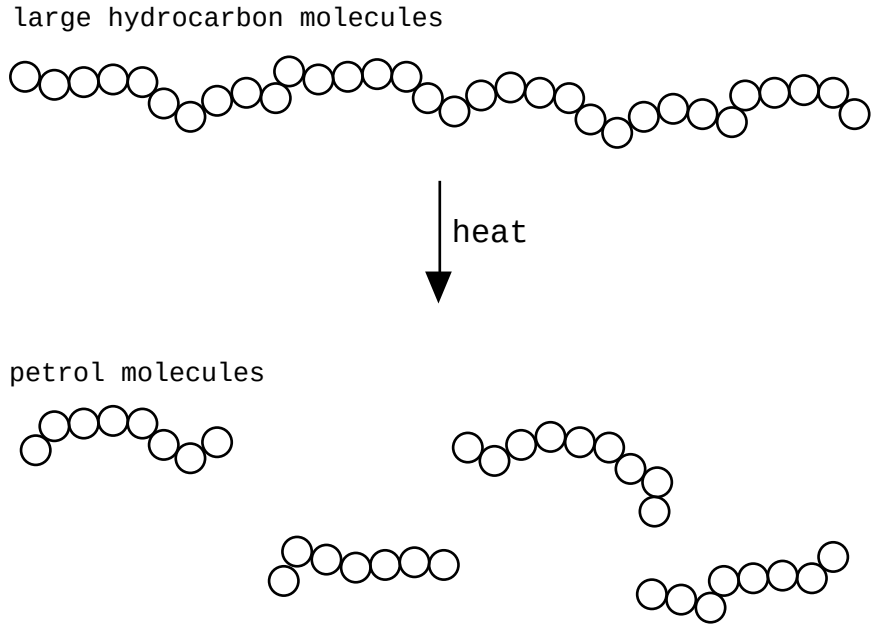
The petrol ignites easily; the diesel only ignites once it has been heated.

* Diesel freezes more easily than petrol and so petrol must be used in cold climates instead of diesel.

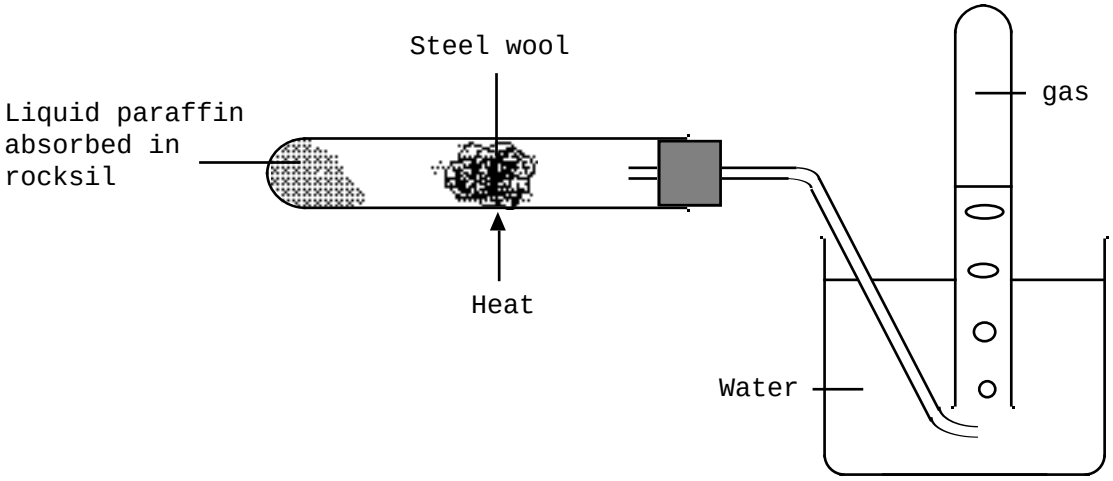
* Lubricating oil evaporates only very slowly and so can be used to lubricate machinery without fear of it 'drying up'!

Cracking

Unfortunately crude oil contains very few of the smaller molecules suitable for use as petrol. There are, however, plenty larger molecules so these are broken down, by heating, into the smaller molecules required for petrol by a process known as **cracking**:



We can crack the molecules in liquid paraffin in the laboratory. Liquid paraffin is a mixture of hydrocarbon molecules similar to diesel. Heating liquid paraffin vapour in the apparatus below produces small gas molecules:



Pollution caused by the motor car

In the car engine, the supply of Oxygen is insufficient for complete combustion. Carbon, Carbon monoxide and unburned hydrocarbons are produced under these conditions.

Carbon monoxide is a poisonous gas.

Soot particles (Carbon) produced by the incomplete combustion of diesel are harmful.

Most fuels contain trace amounts of Sulphur compounds. When the fuels burn, Sulphur dioxide is released into the atmosphere. Sulphur dioxide is a poisonous gas. It also causes acid rain.

Nitrogen and Oxygen from the air react inside a petrol engine to form Nitrogen oxides which are poisonous gases. Nitrogen dioxide causes acid rain.

Lead compounds, once added to petrol to make the engine more efficient, caused pollution. Lead compounds are poisonous.

Unleaded petrol is now being used instead but this fuel contains Benzene, a substance which causes cancer of the blood (leukaemia).

The catalytic converter speeds up the conversion of pollutant gases into harmless gases e.g.

Nitrogen monoxide	+	Carbon monoxide	->	Nitrogen	+	Carbon dioxide