Combustion and oxidation

Combustion is when a fuel burns. → Stored energy in the fuel is transferred to the surroundings. → This transfer causes the surroundings to get hotter. Some energy may also be transferred by light or sound. → The transfer can be useful for heating, or making engines move.

A **hydrocarbon** is made only of carbon and hydrogen. Many fuels are mainly hydrocarbons.

Hydrocarbon combustion:

hydrocarbon + oxygen → water + carbon dioxide

This is a word equation.

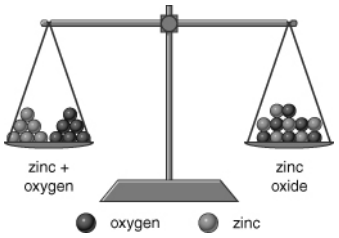
Combustion is also an **oxidation reaction** because the substances react with oxygen.

Carbon and hydrogen are **non-metals** but metals can also be oxidised:

metal + oxygen → metal oxide

Conservation of mass in reactions

In a reaction, the mass of the **reactants** is always the same as the mass of the **products**.



Metals can appear to gain mass when heated in air:

zinc + oxygen → zinc oxide

The difference in mass is the mass of oxygen that reacted.

When a hydrocarbon fuel combusts, it appears to lose mass because the products of the reaction (carbon dioxide, water vapour) are lost into the air.

Phlogiston

Before oxygen was discovered, scientists explained combustion by saying that, as a substance burnt, it gave out a substance called phlogiston to the air. For example:

wood → calx (ash) + phlogiston

However, the phlogiston theory could not explain why metals gained mass when they reacted with air.

The fire triangle and putting fires out

The fire triangle shows the three factors needed for a fire to burn. If any factor is removed, the fire will go out.

We use **fire extinguishers** to put out fires. Water extinguishers remove heat. Powder and carbon dioxide extinguishers exclude oxygen. Foam extinguishers can both remove heat and exclude oxygen.

Oil fires should not be treated with water because the water sinks through the oil, which heats up and causes the water to evaporate. This causes the oil to 'spit' and can spread the fire.

Hazard symbols

Hazard symbols explain why a substance must be handled carefully.

Air pollution from burning fossil fuels

Complete combustion – the fuel reacts completely with oxygen, e.g.:

hydrocarbon + oxygen → carbon dioxide + water

Incomplete combustion – the fuel only partly reacts with oxygen, e.g.:

hydrocarbon + oxygen → carbon dioxide + water + carbon monoxide + carbon (soot)

Impurities in fossil fuels, such as substances that contain sulfur, also react with oxygen when heated:

sulfur + oxygen → sulfur dioxide

At the very high temperatures in vehicle engines, nitrogen gas from the air reacts with oxygen:

nitrogen + oxygen → nitrogen oxides

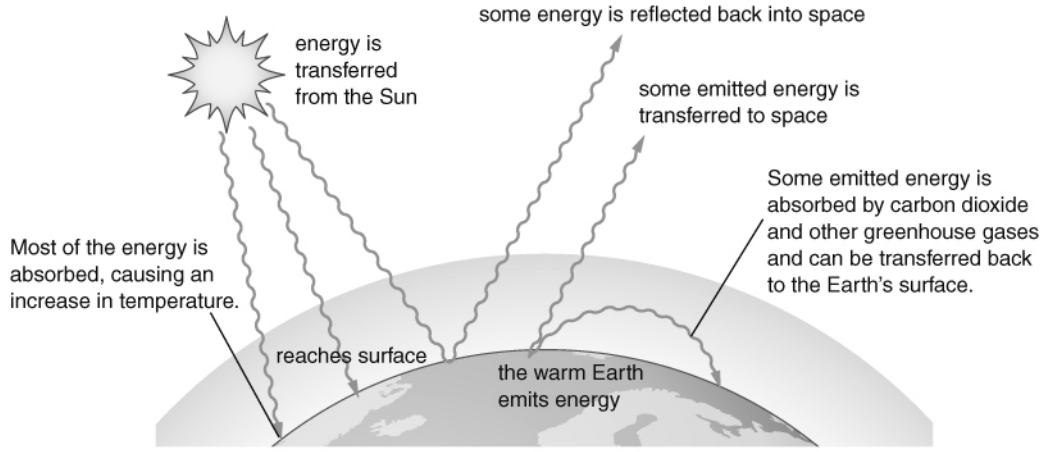
Many products from burning fossil fuels are **pollutants**; they harm the habitats and their organisms.

Acid rain

Acid rain is rain water that is made more acidic by dissolved sulfur dioxide and nitrogen oxides. Some of these gases are removed from power station chimneys by neutralisation, and by using **catalytic converters** on vehicle exhausts. Catalytic converters also remove carbon monoxide (another pollutant).

Greenhouse effect and global warming

Greenhouse gases in the Earth's atmosphere keep the Earth's surface warm. This is the **greenhouse effect**.



Carbon dioxide is a greenhouse gas. Most scientists think that the extra carbon dioxide released from burning fossil fuels has increased the temperature of the Earth's surface (**global warming**).

Scientists predict that global warming will cause **climate change**. The best way to control global warming is probably to reduce the amount of carbon dioxide we release into the air.