Knowledge Organiser Year 9 Earth's Resources and Climate

Earth's Early Atmosphere

Created from volcanic activity 4.5 billion years ago, producing lots of carbon dioxide and water vapour, lots of nitrogen, and traces of methane, CH_4 and ammonia, NH_3. There was no oxygen.

How it Changed – Water vapour, H_2O, condensed and formed the oceans.
Carbon dioxide, CO_2, dissolved in the oceans and carbonate compounds were precipitated producing sediments.

Key Event - Green plants evolved, producing oxygen, O_2, and using up the CO_2 in photosynthesis.

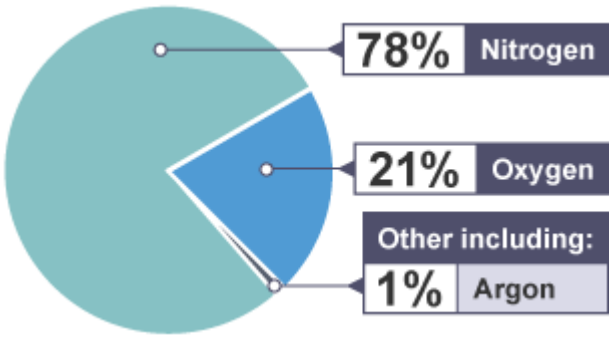
$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

Remember that respiration is the reverse of this equation.

When animals evolved they used CO_2 dissolved in the oceans to form carbonate exoskeletons. Eventually the CO_2 got locked up in sedimentary rocks like limestone and fossil fuels (coal, oil and gas) from plants and animals dying.

The newly formed oxygen reacted with the traces of methane and ammonia in the atmosphere.

Current atmosphere



The atmosphere has not changed much in the last few hundred million years.

The amount of carbon dioxide in our current atmosphere is surprisingly small (about 0.03 %) but has been steadily increasing over the last 200 years or so (as industry increased)

Air pollution from burning fossil fuels

Combustion of fuels will oxidise elements present in the fuel. Many fuels are hydrocarbons (compunds containing carbon and hydrogen only), so **complete combustion will form CO_2 and H_2O**

hydrocarbon + oxygen → carbon dioxide + water

Incomplete combustion (in a poor supply of oxygen) may also produce **carbon monoxide**, CO (toxic), and **carbon particles or soot** (causes breathing difficulties and global dimming or smog)

hydrocarbon + oxygen → carbon monoxide + water

hydrocarbon + oxygen → carbon (soot) + water

Fuels containing traces of sulfur will produce **sulfur dioxide**, SO_2 during combustion (causes breathing difficulties and acid rain)

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sulfur + oxygen → sulfur dioxide

Oxides of nitrogen such as **nitrogen monoxide**, NO, can be formed in car engines as the high temperature causes nitrogen and oxygen from the air to react. Oxides of nitrogen can also cause acid rain.

nitrogen + oxygen → nitrogen oxides

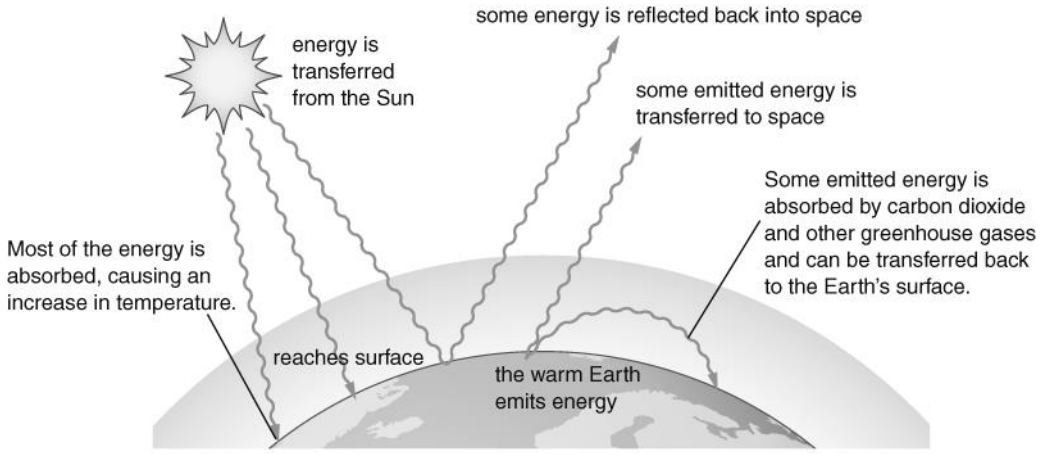
Many products from burning fossil fuels are **pollutants** - they harm habitats and their organisms.

Acid rain

Acid rain is rain water that is made more acidic by dissolved **sulfur dioxide and nitrogen oxides**. (oxides of non-metal atoms are acidic). 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.

Caused by build up of carbon dioxide, CO_2 and methane, CH_4 in the atmosphere.

Radiation changes to a **longer wavelength** as it reflects off the earth's surface, and this then interacts with greenhouse gases in the atmosphere.

CO_2 increased by growing energy demands and combustion of fossil fuels, also deforestation.

CH_4 increased by more animal farming, paddy fields and increased use of landfill sites.

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Main effects of climate change - ice caps melting, rising sea levels and more flooding, possible drought, crop failure and starvation in hot areas, more severe weather and storms, changes to fishing patterns and animal distribution.

Carbon footprint can be reduced by lowering emissions, but actions can be limited by lack of international co-operation and disagreement.

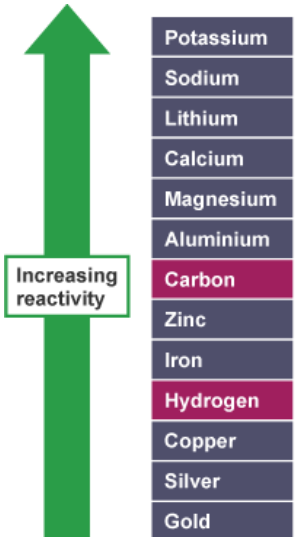
Extracting metals

The reactivity series

The most reactive metals are at the top.

The non-metals hydrogen and carbon are often included in the reactivity series for reference.

A more reactive metal can displace a less reactive metal from a compound.



- Most metals occur as compounds in ores in the Earth's crust. Only a few, such as silver and gold, occur as the metallic element (found native).
- The metals high in the reactivity series are difficult to chemically extract from their ores.
- The metals lower in the reactivity series are easier to extract from their ores.

Extraction of metals 1 – Heating with carbon

This method works when the metal is less reactive than carbon

eg. iron oxide + carbon → iron + carbon dioxide

eg. zinc oxide + carbon →

eg. copper oxide + carbon →

The carbon displaces the metal as the carbon is more reactive. This method would not work for more reactive metals such as magnesium, aluminium or sodium.

- Metals from zinc downwards in the reactivity series can be extracted from their ores by heating with carbon.
- Metals above zinc in the reactivity series need electrolysis to extract them from their ores.

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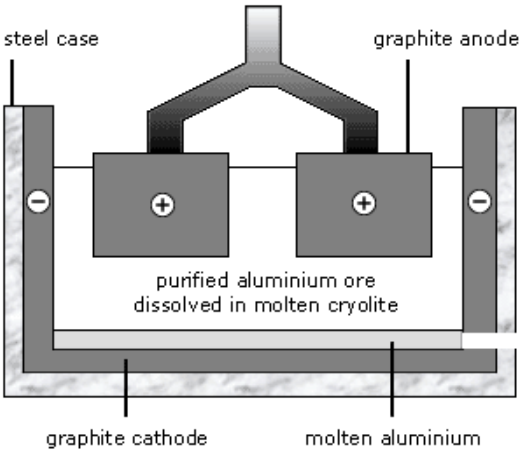
Extraction of metals 2 – Electrolysis



Metals more reactive than carbon must be extracted using electrolysis. eg. aluminium

Electricity involves using electricity to break the compound apart into elements. Aluminium oxide is first dissolved in molten **cryolite** (to lower its melting point). The compound must be **molten** so that it will conduct electricity.

During electrolysis the aluminium attracts to the cathode forming **aluminium** metal, and **oxygen** gas forms at the positive anode.

The hot graphite (carbon) anode reacts with this oxygen to make **carbon dioxide**, so the **anodes gradually burn away** and need replacing.

Electrolysis is expensive due to the high energy costs involved.

Redox Reactions

Where reduction and oxidation happen at the same time. This can be defined in terms of **oxygen**. Oxidation is the gain of oxygen. **Reduction** is the loss of oxygen.

In the displacement reaction here, the iron oxide is reduced, and the aluminium is oxidised

iron oxide + aluminium —> aluminium oxide + iron

Recycling and Sustainability

Sustainability means meeting the needs of the current population without compromising the ability of future generations to meet their own needs.

This means using finite (non-renewable) resources in a responsible way, or using renewable resources where possible.

Main materials recycled are glass, metals and plastics, which are produced from finite resources.

Obtaining raw materials from the earth's crust requires extensive quarrying and mining, and has a significant environmental impact.

Recycling has several main benefits:

- Reduces use of limited resources
- Reduces energy use
- Reduces damage to environment caused by mining
- Reduces waste (amount thrown away in landfill)
- Reduce emissions such as CO_2 and SO_2

Recycling has its own energy costs and still contributes to pollution (transport, separation, re melting and moulding etc.) but the overall environmental impact is reduced.