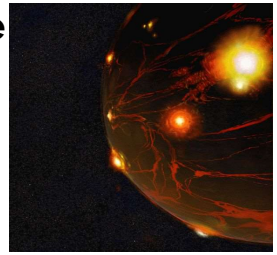
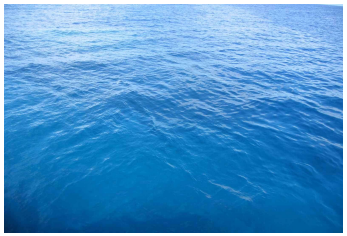
Synergy Science Knowledge Organiser
10 Earth's Atmosphere

Development of the Earth's Atmosphere



- Evidence for the early atmosphere is limited because of the time scale of 4.6 billion years.
- One theory suggests that during the first billion years of the Earth's existence there was intense volcanic activity, which released gases that formed the early atmosphere and water vapour that condensed to form the oceans. At the start of this period the Earth's atmosphere may have been like the atmospheres of Mars and Venus today, consisting mainly of carbon dioxide with little or no oxygen gas.

- Volcanoes also produced nitrogen, which gradually built up in the atmosphere, and there may have been small proportions of methane and ammonia.



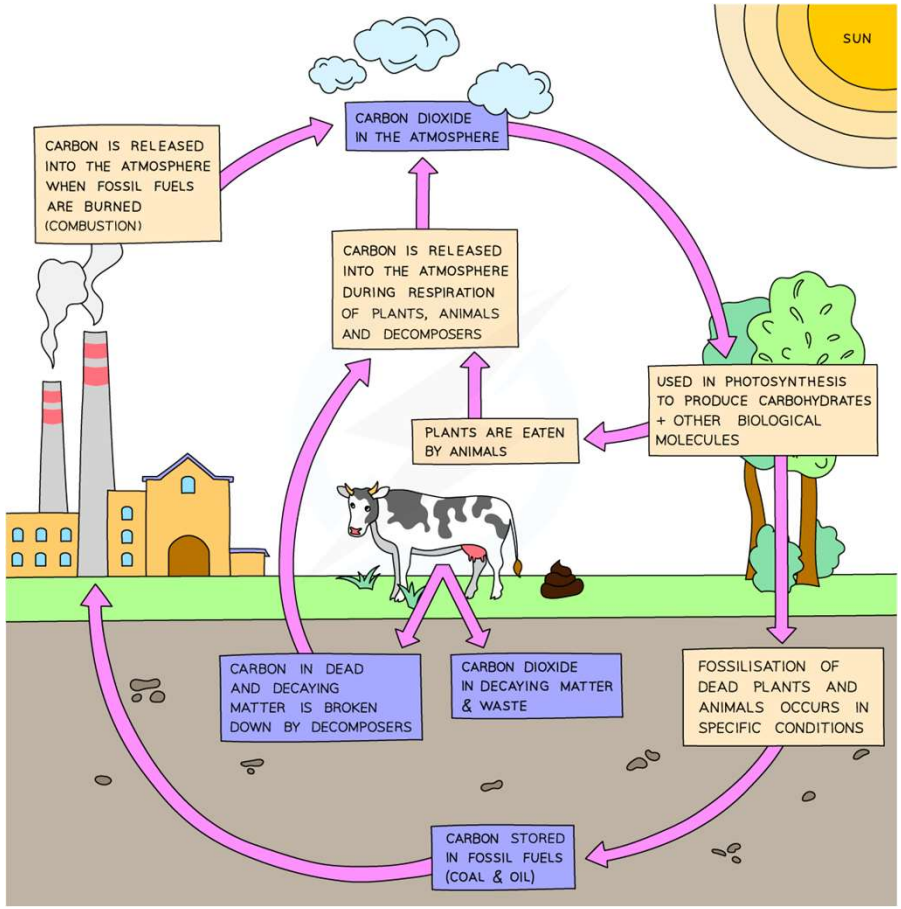
- When the oceans formed, carbon dioxide dissolved in the water and carbonates were precipitated producing sediments, reducing the amount of carbon dioxide in the atmosphere.

- Algae and plants produced the oxygen that is now in the atmosphere by photosynthesis.
- Algae first produced oxygen about 2.7 billion years ago and soon after this oxygen appeared in the atmosphere. Over the next billion years plants evolved and the percentage of oxygen gradually increased to a level that enabled animals to evolve.

- Photosynthesis by algae and plants also decreased the percentage of carbon dioxide in the atmosphere. Carbon dioxide was also used up in the formation of sedimentary rocks, such as limestone, and fossil fuels such as coal, natural gas and oil.

Carbon Cycle

- The element carbon is found as carbon dioxide in the atmosphere, dissolved in the water of the oceans, as calcium carbonate in sea shells, in fossil fuels and in limestone rocks, and as carbohydrates and other large molecules in all living organisms. Carbon cycles through the environment by processes that include photosynthesis, respiration, combustion of fuels and the industrial uses of limestone.
- Life depends on photosynthesis in producers such as green plants, which make carbohydrates from carbon dioxide in the air. Animals feed on plants, passing the carbon compounds along food chains. Animals and plants respire and release carbon dioxide back into the air.



- Decay of dead plants and animals by microorganisms returns carbon to the atmosphere as carbon dioxide and mineral ions to the soil

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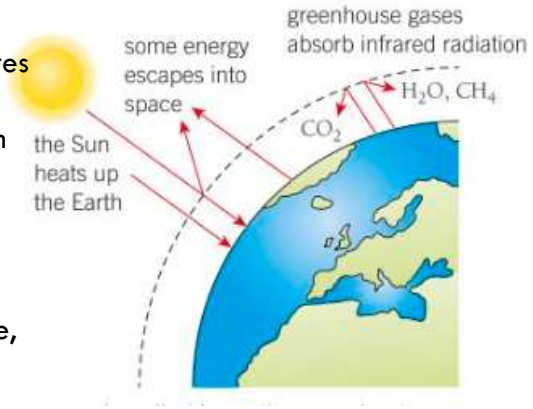
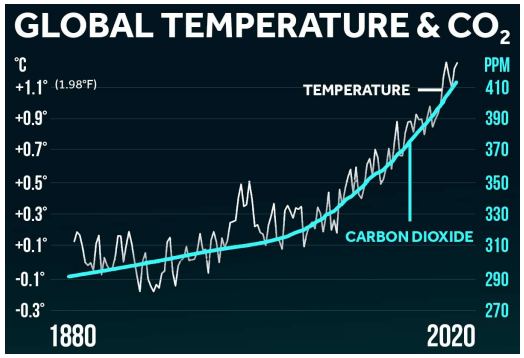
Greenhouse Effect

- Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life. They allow short-wavelength radiation from the Sun to pass through the atmosphere to the Earth's surface but absorb the outgoing long wavelength radiation from the Earth's surface, causing an increase in temperature.



- Water vapour, carbon dioxide and methane are greenhouse gases that increase the absorption of outgoing, long-wavelength radiation.

Gas	Short wavelength radiation	Long wavelength radiation
Nitrogen	Transmit	Transmit
Oxygen	Transmit	Transmit
Carbon dioxide	Transmit	Absorb
Methane	Transmit	Absorb



- The average temperature of the surface of the Earth has risen. The scientific consensus is that this is more than correlation and that the rise in greenhouse gas concentrations has caused the rise in temperature.

Human Impacts on the Climate

- Human activities that involve burning fossil fuels (coal, oil and gas) for generating electricity, transport and industry all add carbon dioxide to the atmosphere. These activities have led to a large rise in the concentration of carbon dioxide in the air over the last 150 years.

Propane + oxygen ⟶ carbon dioxide + water

- Methane gets into the atmosphere from swamps and rice fields. Another source of methane is emissions from the growing number of grazing cattle, and from their decomposing waste. The increasing human population produces more waste to dispose of in landfill sites, which are another source of methane gas.

- Climate describes the long-term patterns of weather in different parts of the world. Climate change is shown by changes to patterns in measures of such things as air temperature, rainfall, sunshine and wind speed.

- Scientists analyse data on climate change using computer models based on the physics that describes the movements of mass and energy in the climate system. Many complex changes on Earth affect the climate, and detailed data about the scale of the changes is not available from all over the world. Also, when predicting climate change, scientists have to make assumptions about future greenhouse gas emissions. This means that there are uncertainties in the predictions.

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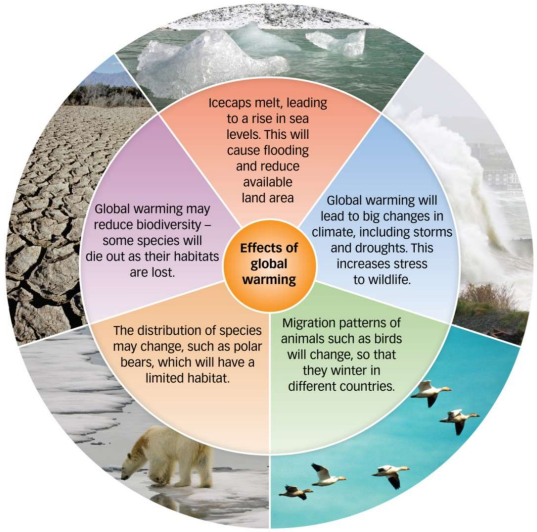
Climate change: Impacts and Mitigation

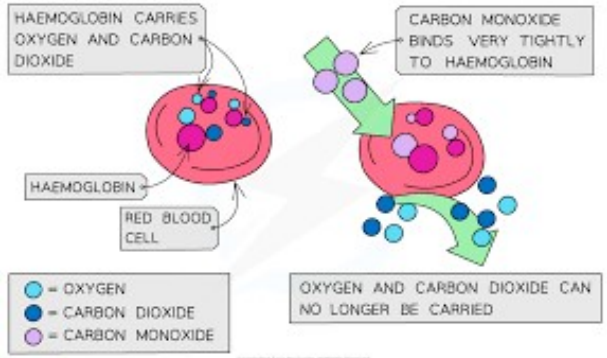
- Consequences of global warming and climate change include:
  - sea-level rise
  - loss of habitats
  - changes to weather extremes
  - changes in the amount, timing and distribution of rainfall
  - temperature and water stress for humans and wildlife
  - changes in the distribution of species
  - changes in the food-producing capacity of some regions.



- Steps can be taken to mitigate the effects of climate change by reducing the overall rate at which greenhouse gases are added to the atmosphere. Examples of mitigation include:
  - using energy resources more efficiently
  - using renewable sources of energy in place of fossil fuels
  - reducing waste by recycling
  - stopping the destruction of forests
  - regenerating forests
  - developing techniques to capture and store carbon dioxide from power stations.

Pollutants that Affect Air Quality

- The combustion of fuels is a major source of atmospheric pollutants that can be harmful to health and the environment.
- Carbon monoxide is formed by the incomplete combustion of hydrocarbon fuels when there is not enough air. Carbon monoxide is a toxic gas that combines very strongly with haemoglobin in the blood. At low doses it puts a strain on the heart by reducing the capacity of the blood to carry oxygen. At high doses it kills.



- Sulfur dioxide is produced by burning fuels that contain some sulfur. These include coal in power stations and some diesel fuel burnt in ships and heavy vehicles. Sulfur dioxide turns to sulfuric acid in moist air.
- Oxides of nitrogen are produced by the reaction of nitrogen and oxygen from the air at the high temperatures involved when fuels are burned.

- Sulfur dioxide and oxides of nitrogen cause respiratory problems in humans and cause acid rain. Acid rain damages plants and buildings. It also harms living organisms in ponds, rivers and lakes.
- Particulates in the air include soot (carbon) from diesel engines and dust from roads and industry. The smaller particulates can go deep into people's lungs and cause damage that can lead to heart disease and lung cancer.

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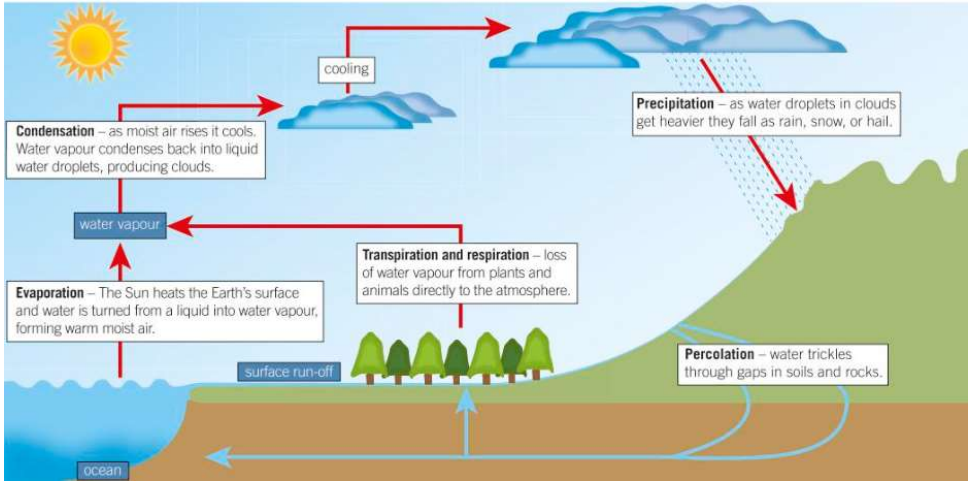
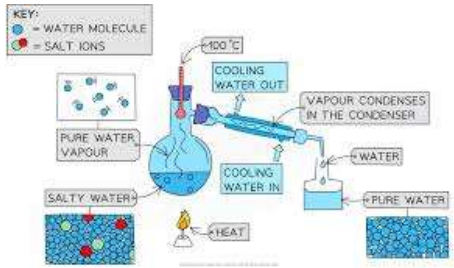
Water Cycle

- Water is found in the solid state in glaciers and ice sheets, in the liquid state in the oceans, rivers, lakes and aquifers and in the gas state in the atmosphere.
- Water cycles through the environment by processes that include melting, freezing, evaporation and condensation. Precipitation of water from the atmosphere can take the form of rain, sleet or snow.

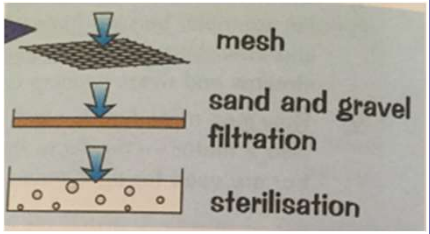


- Life on Earth depends on water, on land and in the seas. Water acts as the solvent for chemical reactions in cells. It also helps transport dissolved compounds into and out of cells. Water is either a reactant or a product of biochemical changes such as respiration, photosynthesis and digestion. Rivers, lakes and seas provide habitats for many living organisms.
- Simple distillation is used to collect a solvent from a solution, e.g. pure water from an aqueous solution of solutes.
- During distillation, water id boiled and then water vapour is cooled and condensed as it passes through a condenser.

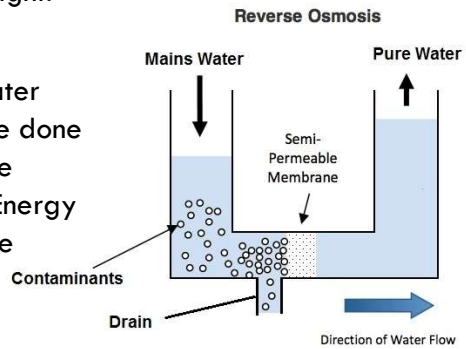


Sources of Potable Water

- Water that is safe to drink is called potable water. Potable water is not pure water in the chemical sense because it contains dissolved substances.
- The methods used to produce potable water depend on available supplies of water and local conditions. In the UK, rain provides water with low levels of dissolved substances (fresh water) that collects in the ground and in lakes and rivers and most potable water is produced by:
  - choosing an appropriate source of fresh water
  - passing the water through filters
  - sterilising.



- Sterilising agents used for potable water include chlorine, ozone or ultraviolet light.
- If supplies of fresh water are limited, desalination of salty water or sea water may be required. Desalination can be done by distillation or by processes that use membranes such as reverse osmosis. Energy resources have to be used to run these processes.



- Urban lifestyles and industrial processes produce large amounts of waste water that require treatment before being released into the environment. Sewage and agricultural waste water require removal of organic matter and harmful microbes. Industrial waste water may require removal of organic matter and harmful chemicals.
- Sewage treatment includes:
  - screening and grit removal
  - sedimentation to produce sewage sludge and effluent
  - anaerobic digestion of sewage sludge
  - aerobic biological treatment of effluent.

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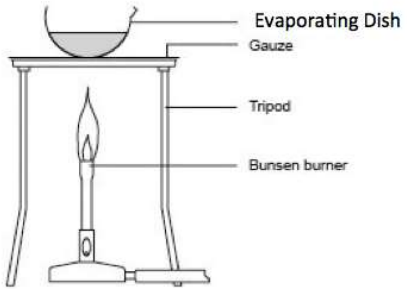
Required Practical 11 Analysing Water

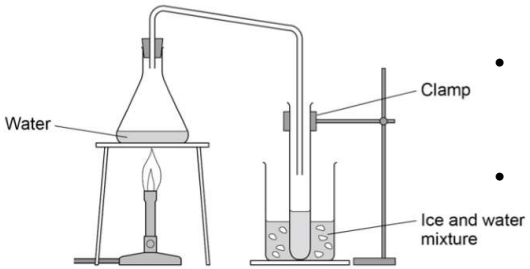
- analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.

- Use the universal indicator solution to measure the pH of the water samples.

- Accurately weigh an empty evaporating basin
- Pour 10 cm^3 of water sample 1 into the evaporating basin.
- Heat the evaporating basin on a tripod and gauze using a Bunsen burner until the solids start to form and the majority of water has evaporated.

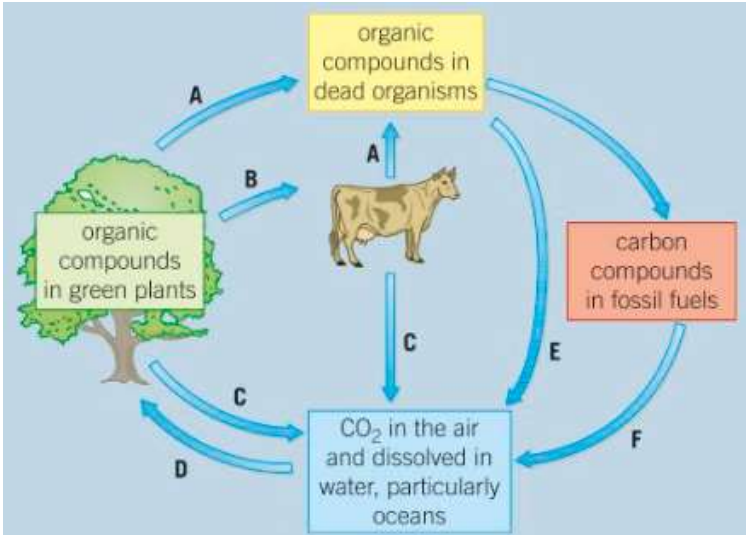


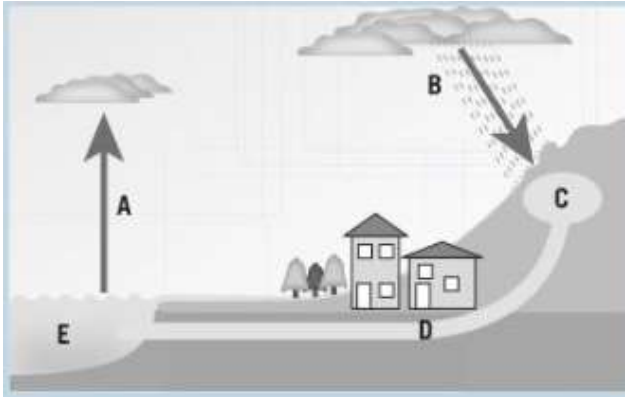
- Weigh the cooled evaporating basin
- Calculate the mass of the solids that were dissolved in the water.



- Place the water sample in the conical flask.
- Heat the water using the Bunsen burner until it boils. Then reduce the heat so that the water boils gently.
- 3. The distilled water will collect in the cooled test tube. Collect about 1 cm depth of water in this way, then stop heating.
- Test the water you have distilled by comparing its pH with the samples from your first experiment

- Task: name the processes A – F that are involved in the different stages of the carbon cycle.





- Task: name the different stages of the water cycle labelled A – E.

Highlight the keywords: photosynthesis, volcano, microorganisms, carbon cycle, combustion, respiration, global warming, wavelength, radiated, climate change, carbon dioxide, methane, atmospheric pollutants, carbon monoxide, sulfur dioxide, oxides of nitrogen, particulates, condensation, precipitation, evaporation, transpiration, potable water, chlorine, pure water, desalination, filtration, distillation, reverse osmosis, aerobic digestion, pure