



Edexcel GCSE Chemistry



Your notes

Earth & Atmospheric Science

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Your notes

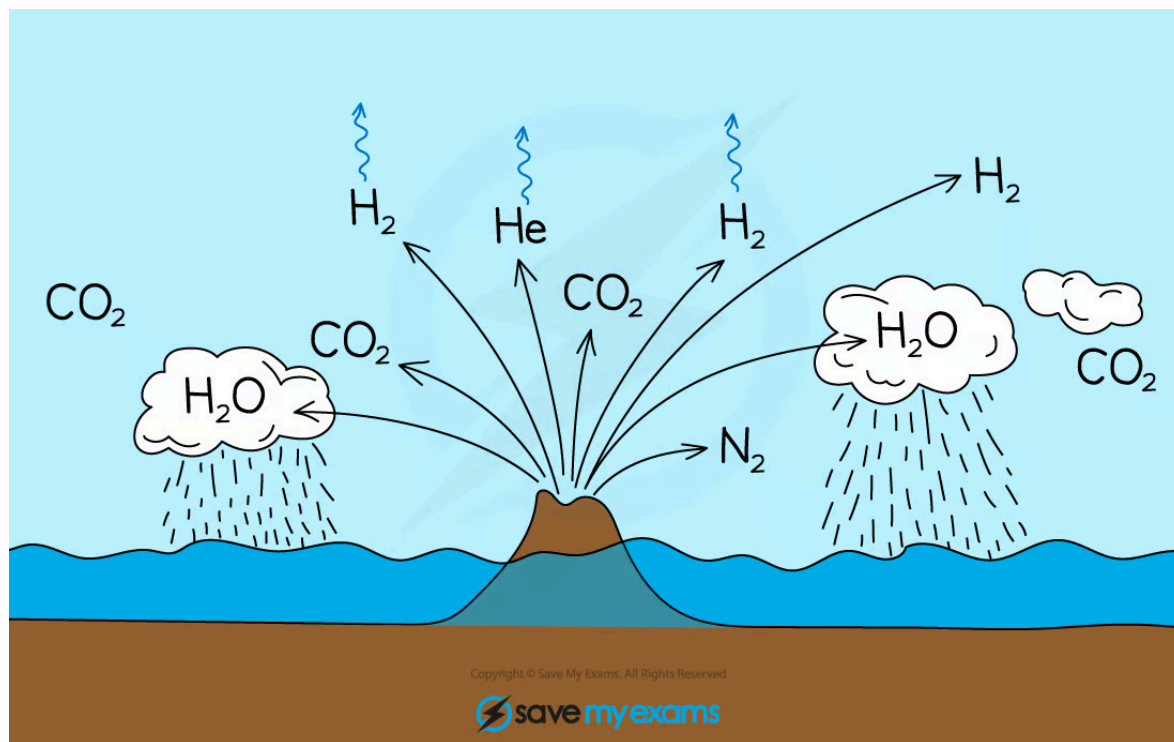
Evolution of the Atmosphere

Earth's Early Atmosphere

- Theories on the development of Earth's atmosphere have developed over time as instrumental analysis has improved
- The surface of the early Earth was **molten** for millions of years during which time there was no atmosphere surrounding the planet
- Eventually cooling began to take effect and allow for molten materials to slowly **solidify** forming land masses
- **Volcanoes** formed on the land masses and released gases from the Earth's interior through violent eruptions
- Earth's gravity prevented the gases from escaping into outer space and they formed the atmosphere
- Analysis of the minerals in the earth's crust enables scientists to deduce the gases present millions of years ago that helped form those minerals
- It is thought that the atmosphere at that moment in Earth's history was similar to that of **Venus** or **Mars** today which consist mainly of CO₂
- During a period of intense volcanic activity, large amounts of **carbon dioxide** and **water vapour** were released, as well as **nitrogen, hydrogen, ammonia, methane** and other gases.
- The early atmosphere therefore contained mainly CO₂ and water vapour
- There was little or no oxygen present



Your notes



Volcanoes spewed out water, carbon dioxide and other gases from the Earth's interior

- While the surface of the Earth was still very hot the large quantities of water vapour remained in the **gaseous** state
- When conditions **cooled sufficiently**, the water vapour later **condensed** and fell to the surface of the Earth, forming the oceans
- Carbon dioxide is a **water soluble** gas (it is the gas used in fizzy drinks) and dissolves readily
- When the water vapour **condensed** large amounts of CO_2 dissolved in the oceans
- Carbonate substances were **precipitated** during this process which later formed sediments



Examiner Tips and Tricks

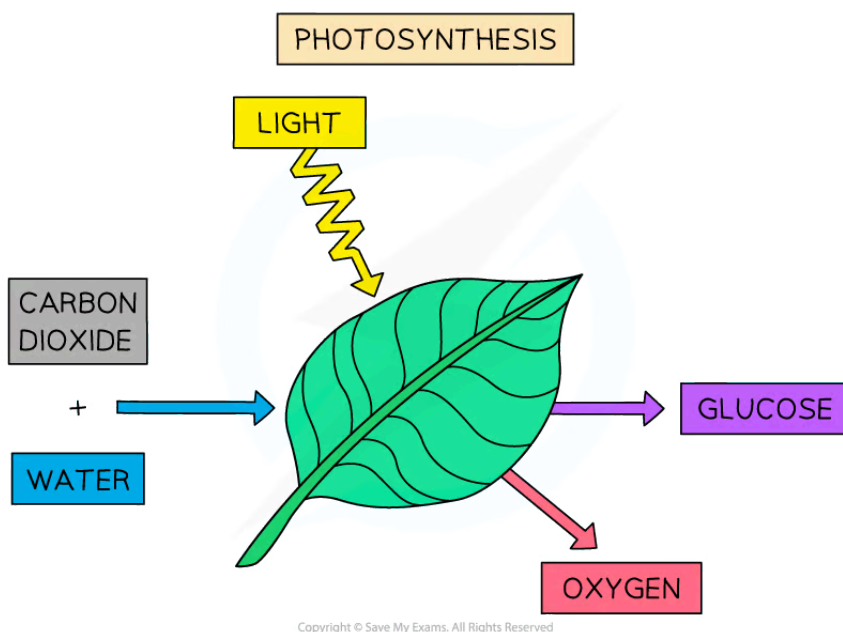
For this topic you should be able to describe how the atmosphere and oceans came about.

How Carbon Dioxide Decreased



Your notes

- Carbon dioxide is a **water soluble** gas (it is the gas used in fizzy drinks) and dissolves readily
- When the water vapour in Earth's early atmosphere **condensed** large amounts of CO_2 dissolved in the oceans
- Carbonates were **precipitated** during this process which later formed sediments on the seabed
- As marine life began to evolve sea creatures began to appear which used up the **carbonates** to form **shells** and **skeletons**
- Green plants** and **algae** began to evolve and absorbed considerable amounts of carbon dioxide during **photosynthesis**



Photosynthesis gradually removed large amounts of carbon dioxide from the atmosphere

- When these organisms died, their remains locked the atmospheric carbon into the rocks
- This is how the large amounts of carbon dioxide in the early atmosphere were reduced

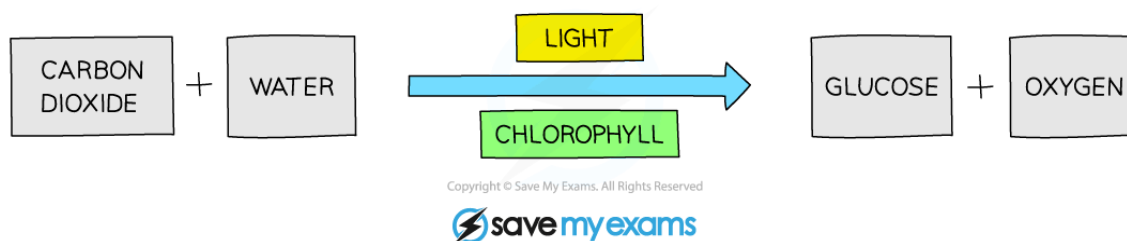


Examiner Tips and Tricks

Exhaled air contains about 4% carbon dioxide and 16% oxygen which is why mouth-to-mouth resuscitation can save someone who has stopped breathing.

How Oxygen Increased

- Primitive plants and algae began **photosynthesizing** which used up carbon dioxide from the atmosphere and released **oxygen**:



Carbon dioxide and water producing glucose and oxygen during photosynthesis

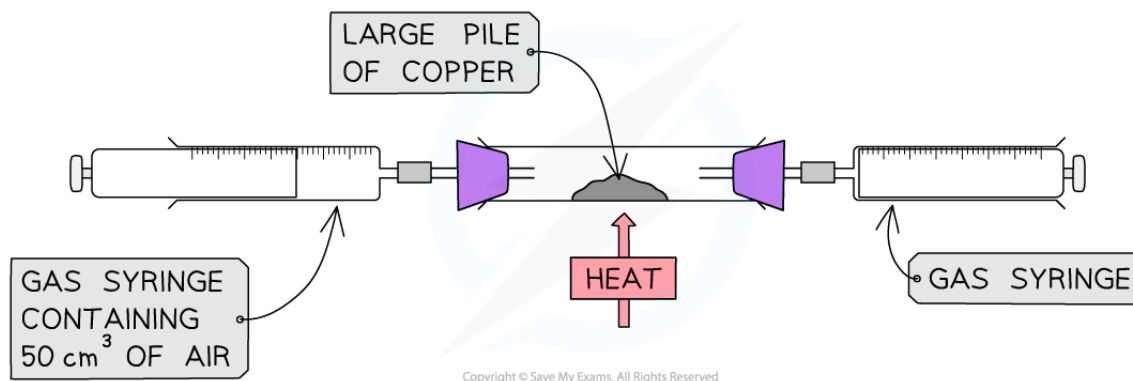
- Through these processes over a long period of time, the amount of O_2 in the atmosphere increased and the amount of CO_2 decreased
- Algae first evolved around 2.7 billion years ago and during the next billion years or so small green plants began to appear
- As more and more plants began to appear the levels of oxygen began to **increase** which allowed for more complex life forms to evolve
- This trend continued until around 200 million years ago the composition of the atmosphere reached similar characteristics as today: around **20% oxygen, 80% nitrogen** and tiny amounts of other gases
- Marine algae are thought to be responsible for about 90% of all the atmospheric oxygen produced

Investigating the percentage of oxygen in air

- The percentage of oxygen in the air can be investigated by passing a known quantity of air over a metal
- The oxygen in the air will react with the metal, forming a metal oxide
- The oxygen will be removed from the air and the volume of the air with the oxygen removed can be measured
- An example of the apparatus that can be used to investigate this is shown below:



Your notes



Method:

- Heat the copper using a Bunsen burner
- Push the plunger of the syringe containing air, forcing the air into the other plunger until all of the air has transferred
- Push the air back from the now filled plunger to the other plunger
- Repeat this several times for about 3 minutes
- The copper will turn black as copper reacts with the oxygen in the air and copper oxide is produced
- Allow the apparatus to cool
- Ensure all the gas is in one syringe and record the volume of gas
- The percentage of oxygen in the air can be calculated from the results



Worked Example

In the experiment above, the starting volume of air was 50.0 cm^3 of air and the final volume of air was 39.5 cm^3

Calculate the percentage of oxygen in the air.

Answer:

- **Step 1** - calculate the volume of oxygen in 50.0 cm^3 of air
 volume of oxygen in air = starting volume - final volume

$$= 50.0 - 39.5 = 10.5 \text{ cm}^3$$



Your notes

- **Step 2** – calculate the percentage of oxygen in air

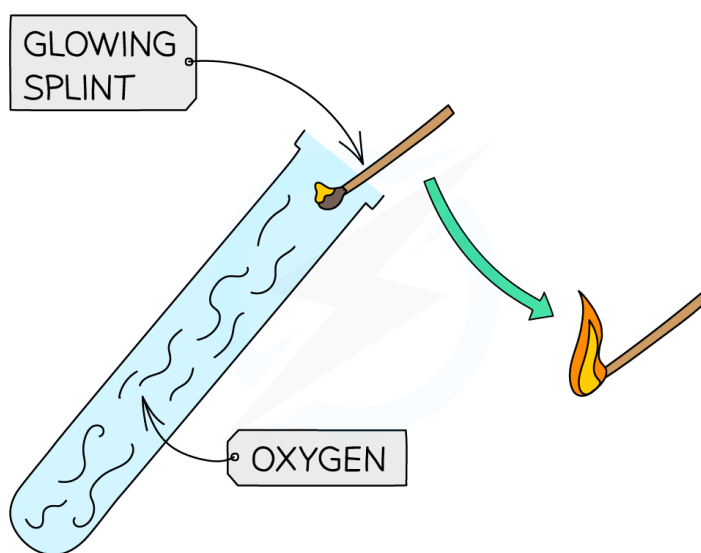
$$\text{Percentage of oxygen in air} = \frac{\text{volume of oxygen in air}}{\text{starting volume of air}} \times 100$$

$$= \frac{10.5}{50.0} \times 100$$

$$= 21.0 \%$$

The Test for Oxygen

- The test for oxygen consists of placing a **glowing splint** inside a test tube of gas
- If the gas is oxygen the splint will **relight**



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Diagram showing the test for oxygen gas



Examiner Tips and Tricks

Sometimes the splint does not relight, but it glows very brightly, which is also a positive result. In an exam, however, it is best to state it relights the glowing splint.

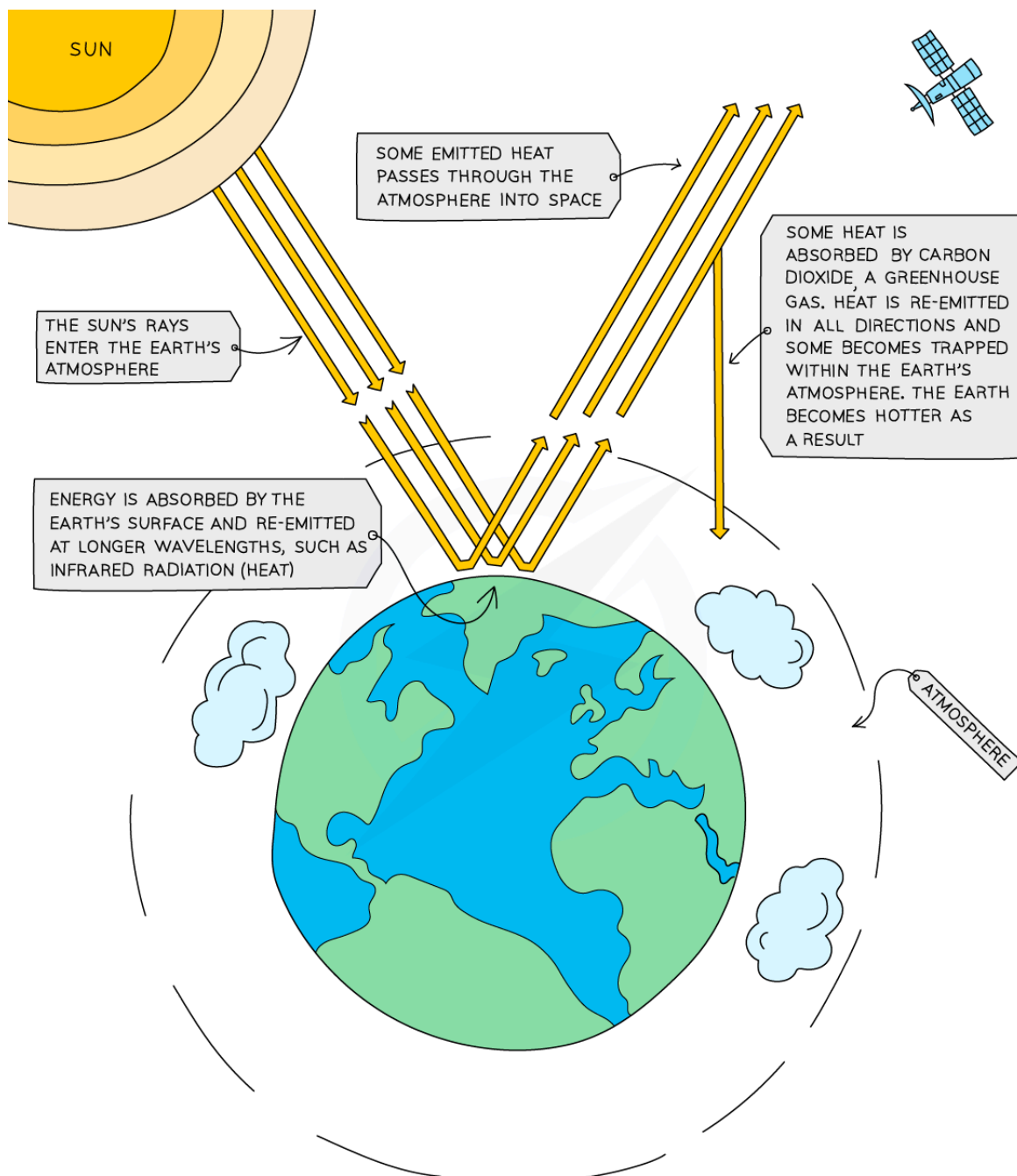
Greenhouse Gases



Your notes

Greenhouse Gases

- When shortwave radiation from the sun strikes the Earth's surface it is absorbed and **re-emitted** from the surface of the Earth as infrared radiation
- Much of the radiation, however, is **trapped** inside the Earth's atmosphere by **greenhouse gases** which can absorb and store the energy
- **Carbon dioxide, methane** and **water vapour** are gases that have this effect
- Increasing levels of carbon dioxide and methane, although present in only small amounts, are causing significant upset to the Earth's natural conditions by trapping extra heat energy
- This process is called the **enhanced greenhouse effect**



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Greenhouse gases trap some of the Sun's radiation causing the Earth to warm up



Your notes

Carbon dioxide

- **Sources:** Combustion of wood and fossil fuels, respiration of plants and animals, thermal decomposition of carbonate rocks and the effect of acids on carbonates

Methane

- **Sources:** Digestive processes of animals, decomposition of vegetation, bacterial action in swamps and in rice paddy fields



Examiner Tips and Tricks

It is important to understand the difference between the greenhouse effect and the enhanced greenhouse effect. The greenhouse effect ensures the mean global temperature is around 15 °C and without greenhouse gases the surface of the Earth would swing between extreme heat and extreme cold. The enhanced greenhouse effect, due an increase in greenhouse gas concentrations, most scientists believe, is leading to global warming.

Human Activity & Climate Change



Your notes

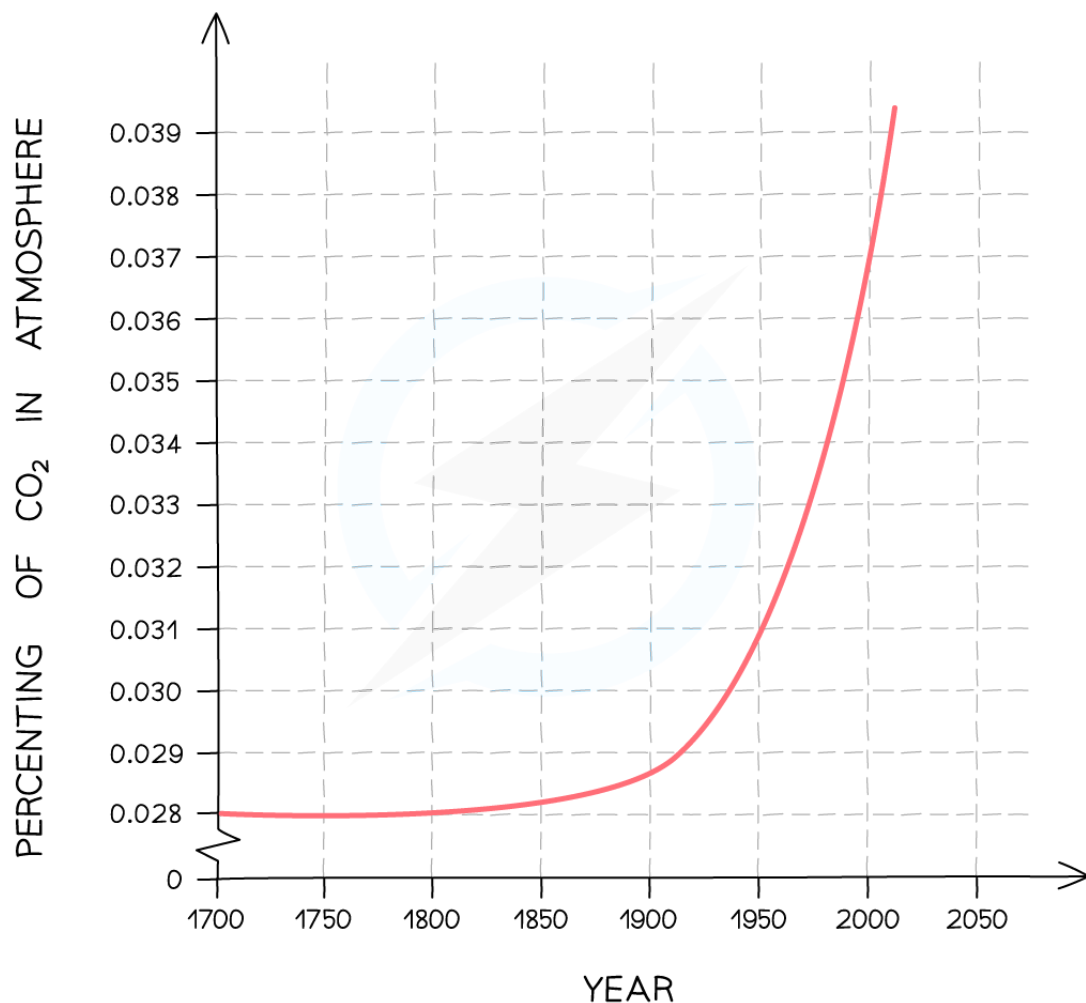
Evaluating the Evidence

- Advances in science and technology mean current levels of CO₂ and global temperatures can be determined with a high degree of **accuracy**
- **Historical data** is much less accurate due to the lack of accurate instrumentation and methods
- **Fewer locations** would also have been measured due to the lack of satellites and transport
- There are some methods to estimate past climate conditions, which include:
 - Analysis of the **fossil record** and **tree rings**
 - Analysis of **gas bubbles** trapped in ice from hundreds of thousands of years ago

Correlating rising CO₂ levels and global temperatures



Your notes



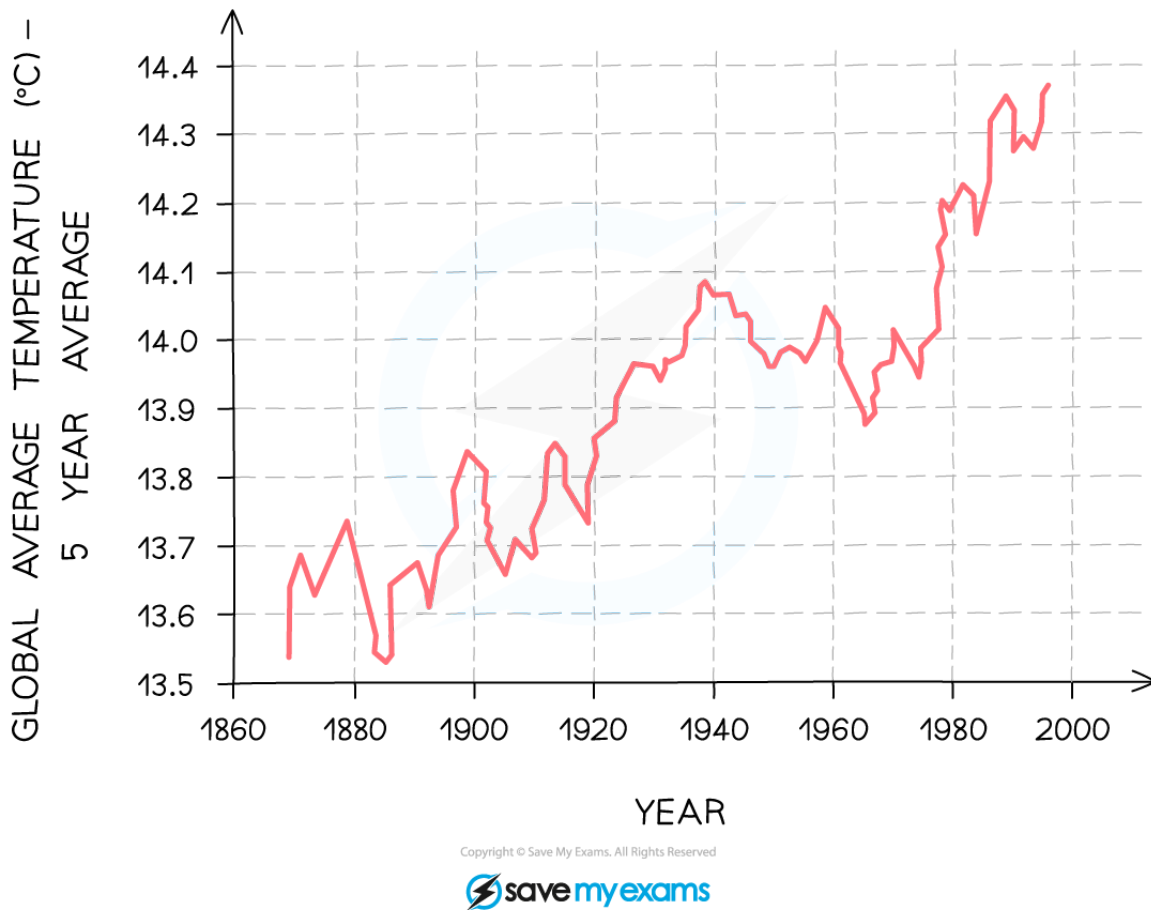
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Graph showing the steady increase in atmospheric CO₂ since 1700



Your notes



Graph showing the steady increase in temperature from when accurate records exist

- Unfortunately, historical methods, while providing at least some data, are not as precise as modern day techniques nor do they provide data which is representative on a **global scale**
- The **complexity** of the Earth's climate and contributing factors make it a difficult task to produce a working model that clearly shows the link between global warming and greenhouse gases
- This and other difficulties have led to hype and speculation in the media in recent times in which some scientists have cast doubts on human activity and climate change
- However, academic surveys have shown that about 97% of climate scientists do believe human activity is causing climate change





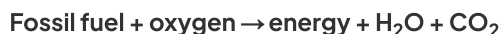
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Examiner Tips and Tricks

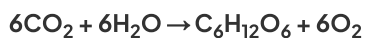
It is important that **peer review** of research results as well as communication to a **wide range of audiences** is carried out to dispell myths and misinformation about climate change

Human Activity & Climate Change

- Human population is **increasing** and with it the global demand for food, water, consumer goods, housing and **energy** which are supplied with greater and more widespread **industrialization**
- This creates more **waste** so more **landfill sites** are needed which increases the amount of methane by decomposition
- The increased energy demands are met in most cases by the burning of **fossil fuels** which produces CO_2 :



- Added to this is the effect of **deforestation** on the amount of CO_2 as large areas of forested land are being destroyed for building and **agricultural** activities
- Plants and trees remove CO_2 during photosynthesis:



- Hence their removal increases the amount of atmospheric CO_2 as there are less plants available to remove it during photosynthesis
- Increasing agricultural activities also cause an increase in methane production
- Methane is produced in the **digestive** processes of animals, by the decomposition of **vegetation**, and by bacterial action in **swamps**
- Scientists agree that greenhouse gases are causing the average temperature of the Earth to increase by the enhanced **greenhouse effect**, which is causing **global warming**
- Climate change** is when there is a shift in worldwide **weather** patterns and **conditions**
- Effects of global warming include difficulties in obtaining **fresh drinking water**, melting of the **polar ice caps**, **flooding** and **flash fires**, and the destruction of **ecosystems**

Dealing with Climate Change

- The production of greenhouse gases needs to be **reduced drastically** to avoid or at least slow climate change
- CO_2 emissions can be reduced by using **renewable** energy supplies such as **solar** or **wind** energy instead of burning fossil fuels



Your notes

- Awareness and being conscientious about reducing energy usage and our carbon footprint is another way to reduce emissions
- Governments and economies in developed nations are slowly switching to greener and sustainable sources of energy and often offer financial incentives to companies in an effort to convince them to “go green”
- Other ways of mitigating the effects of climate change include:
 - Constructing **flood defence** systems in areas of low lying land
 - Developing new farming methods to include switching to crops that are **better adapted** to the new climate
 - Building more **effective irrigation** systems to ensure crops can get water during times of **drought**