Earth's Atmosphere Notes

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The Earth formed approximately 4.5 billion years ago. Scientists believe, based on the evidence that we have, that Earth's early atmosphere was produced by volcanic activity. Volcanic eruptions released lots of different gases in to the atmosphere.

Earth's early atmosphere versus the modern atmosphere	
The earths early atmosphere more than likely had:	The modern atmosphere has:
1. A large amount of carbon dioxide gas.	1. A lot less carbon dioxide gas.
2. A small amount of oxygen gas.	2. A lot more oxygen gas.
3. Lots of water vapour.	3. Much less water vapour.
4. Small amounts of other gases, like ammonia and methane.	4. Much less ammonia and methane.
Exam Note: A popular exam question that can be asked is: *"Why are people unsure about the composition of the earths early atmosphere?"* **Ideal answer**: There were no scientists around when the early atmosphere formed/no eye witnesses. Scientists can analyse evidence that is trapped in rocks and other sources.	

How was the modern atmosphere formed? What happened to each gas?

Gas	Change	Reason
Carbon dioxide	Decrease	CO_2 is very soluble in water. As the oceans formed, carbon dioxide dissolved into the water and the amount in the atmosphere decreased. Photosynthesis – plants evolved and used CO_2 to make glucose. Over time this reduced the amount of CO_2 in the atmosphere.
Oxygen	Increase	Photosynthesis – plants evolved and use photosynthesis to make glucose. Oxygen is given out as a waste product. Over time this increased the amount of oxygen in the atmosphere. Carbon dioxide + water → glucose + oxygen $6CO_2\ (g) + 6H_2O\ (l) \rightarrow C_6H_{12}O_6\ (aq) + 6O_2\ (g)$
Water vapour	Decrease	The Earth cooled after it formed. When it became cool enough, water vapour in the atmosphere condensed to liquid. It fell as rain, creating the oceans.

Common atmospheric pollutants and their sources

Pollutant	Source
Carbon dioxide, CO_2	Is the product of combustion of any fuel containing carbon atoms, for example pentane. $C_5H_{12}\ (l) + 8O_2\ (g) \rightarrow 5CO_2\ (g) + 6H_2O\ (g)$
Carbon monoxide, CO	Is the product of incomplete combustion of any fuel containing carbon atoms. It is a toxic gas. It is colourless and odourless, so it is not easily detected.
Particulate carbon, C solid (soot)	Is the product of incomplete combustion of any fuel containing carbon atoms. Cause global dimming and respiratory problems in humans.
Unburned hydrocarbons	Hydrocarbon fuel molecules which have not been oxidised at all this could be due to a fault in the engine.
Sulfur dioxide, SO_2	Is the product of combustion of a fossil fuel which contains sulfur. This can lead to acid rain and it can also cause respiratory problems.
Nitrogen oxides, NO_x	The oxidation of atmospheric nitrogen inside the engine of a car, lorry or bus etc. This can also lead to the formation of acid rain.

The Greenhouse Effect

The greenhouse effect: is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without this atmosphere.

A greenhouse gas: a gas that contributes to the greenhouse effect by absorbing infrared radiation. Without greenhouse gases in its atmosphere, the Earth would be about 32°C colder on average than it is.

Examples: carbon dioxide, methane and water vapour.

How do greenhouse gases cause global warming?
There's a bit of explaining in this so it has been condensed to the key information that we need.

- The Sun emits energy in the form of electromagnetic radiation, mostly as visible and ultraviolet light.
- This high-energy, shortwave radiation passes through Earth's atmosphere because most of it is <u>not</u> absorbed by the gases in the atmosphere.
- When this radiation reaches Earth's surface, it is absorbed by land, water, and vegetation, warming the planet.
- The warmed surface then re-emits this energy as <u>infrared radiation</u>, which has <u>longer wavelengths and lower energy compared to the incoming solar radiation</u>.
- Greenhouse gases such as CO_2 and CH_4 absorb this infrared radiation as it tries to return to space.
- After absorbing infrared radiation, greenhouse gas molecules release it again in all directions. Some of this re-emitted radiation goes back down to Earth's surface, while the rest escapes to space.
- The infrared radiation that is sent back toward Earth's surface contributes to additional warming

Human Activities

Sadly, human activities are causing an increase in the amounts of greenhouse gases in the atmosphere. Carbon dioxide gas is mainly coming from the burning of fossil fuels and methane is mostly coming from decay in landfill sites and farming.

Climate Change

The climate describes the average weather over a long time and over a large area. The enhanced greenhouse effect is leading to climate change. The effects of this include:

- Melting polar ice caps and melting glaciers.
- Rising sea levels
- Increasing floods or droughts occurring.
- Reducing the amount of land that can be farmed.