GCSE C9 – Chemistry of the Atmosphere

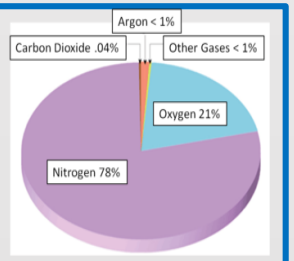
science chemistry

1) Early atmosphere (4.6 billion years ago)

The Earth's early atmosphere mainly contained gases that came from volcanoes.
This early atmosphere is thought to have contained:
no oxygen (or very little)
large amounts of **carbon dioxide**
large amounts of **water vapour**
small amounts of other gases such as **nitrogen** and ammonia

2) Present day atmosphere

78% nitrogen
21% oxygen
0.04% carbon dioxide
<1% argon and other noble gases and water vapour.



Small changes in today's atmosphere are still happening as a result of:

- volcanoes
- human activity (such as burning fossil fuels, deforestation and farming)
- Increases in CO_2 due to burning fossil fuels leads to global warming.

3) The greenhouse effect

Short wavelength radiation passes through atmosphere to Earth's surface. Earth's surface radiates different wavelengths some of which (longer wavelengths) are absorbed by greenhouse gases to produce temperature increases.

- Main greenhouse gases are CO_2, methane (CH_4) & H_2O

4) Consequences of climate change

- Sea level rise, flooding etc
- More storms
- Changes to rainfall
- Changes in temperature
- Changes to food producing capacity
- Changes to distribution of wildlife

5) Why did the atmosphere change?

There are different sources of information about the development of the atmosphere. This makes it very difficult to be precise about how it changed. Some of the evidence from elsewhere in the solar system (such as the planet Venus or the moons of Saturn) is contradictory. Importance of peer review (evidence that is checked by other scientists)

- The early Earth was very hot. When it cooled, much of the water vapour in the atmosphere condensed to form the oceans.
- There is very little carbon dioxide in today's atmosphere so something must have happened to decrease the amount of carbon dioxide:
- Much of the carbon dioxide dissolved in the oceans. This dissolved carbon dioxide was used by sea organisms to make shells (which are mainly calcium carbonate). These shells later sank to the bottom to become part of sedimentary rocks such as limestone ("locked up" carbon refers to carbon that is in sedimentary rocks and fossil fuels).
- Algae first produced oxygen about 2.7 billion years ago.
- Over the next billion years plants evolved.
- The plants and algae used up some of the carbon dioxide in photosynthesis but were also able to produce oxygen so the amounts of oxygen in the atmosphere gradually increased.

Carbon dioxide + water → glucose + oxygen

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

6) Carbon footprint

Carbon footprint is the total amount of CO_2 and other greenhouse gases emitted over the full life cycle of the product / service.

Can be reduced using:

- Alternative energy supplies
- Energy conservation
- Carbon capture and storage
- Carbon taxes and licences
- Carbon off setting (e.g. tree planting)
- Carbon neutrality

7) Atmospheric pollutants

Combustion of fuels (hydrocarbons) is a major source of pollution in the atmosphere.

- Complete combustion occurs when there is a plentiful supply of oxygen and produces water and carbon dioxide.
- Incomplete combustion occurs when there is a limited supply of oxygen and produces water and carbon monoxide or carbon.

- Carbon dioxide is a greenhouse gas
- Carbon monoxide is a toxic gas which is colourless & odourless so not easily detected.
- Carbon particulates (soot) can lead to global dimming and also respiratory problems.

- Coal also contains sulfur which when burnt produces acidic sulfur dioxide gas (SO_2) which causes acid rain.

- At high temperatures (inside an engine) nitrogen reacts with oxygen from the air to produce nitrogen oxides (NO_x)

$N_2 + O_2 \rightarrow 2NO$

- These nitrogen oxides can also cause acid rain.

- Particulates (such as unburnt fuels and soot) can cause respiratory problems.

chaseterrace academy