WJEC England GCSE Chemistry

Topic 12: The earth and its atmosphere

Notes

(Content in bold is for Higher Tier only)

The proportions of different gases in the atmosphere

- For 200 million years, the proportions of different gases in the atmosphere have been much the same as they are today:
    - ~4/5 (80%) nitrogen
    - ~1/5 (20%) oxygen
    - Small proportions of various other gases, i.e. CO_2, $H_2O(g)$ and noble gases

~ means approximately

The Earth's early atmosphere

- Evidence 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 that released gases that formed the early atmosphere
        - At the start of this period, the atmosphere may have been like the atmospheres of Mars and Venus today, mainly CO_2 with little or no $O_2(g)$
        - Volcanoes also produced nitrogen which gradually built up in the atmosphere & there may have been small proportions of methane and NH_3
    - Water vapour condensed to form the oceans
        - CO_2 dissolved in the water and carbonates were precipitated producing sediments, reducing the amount of CO_2 in the atmosphere

How oxygen increased

- Algae & plants produced the O_2 that is now in the atmosphere by photosynthesis

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

carbon dioxide + water –(light)-> glucose + oxygen

- 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 % oxygen gradually increased to a level that enabled animals to evolve

How carbon dioxide decreased

- Algae and plants decreased the % CO_2 in the atmosphere by photosynthesis
- CO_2 was also decreased by the formation of sedimentary rocks and fossil fuels that contain carbon

Greenhouse gases

- Maintain temperatures on Earth high enough to support life

- Include: water vapour, CO_2 & CH_4
- Explanation of the greenhouse gas effect:
    - Electromagnetic radiation at most wavelengths from the sun passes through the Earth's atmosphere
    - The Earth absorbs some radiation and thus warms up (essential for life on Earth). But some heat is radiated from the Earth as infrared radiation.
    - Some of this IR radiation is absorbed by greenhouse gases in the atmosphere
    - Atmosphere warms up leading to the greenhouse effect and global warming
- Global warming is an 'enhanced greenhouse effect'

Human activities, which contribute to an increase in greenhouse gases in the atmosphere

- Examples include
    - Driving (CO_2)
    - Consuming electricity (CO_2)
    - Raising livestock (cows – CH_4)
    - Decay of organic waste in landfill sites (CH_4)
- Based on peer-reviewed evidence, many scientists believe that human activities will cause the temperature of the Earth's atmosphere to increase at the surface and that this will result in global climate change
    - But, it is difficult to model such complex systems as global climate change.
    - This leads to simplified models, speculation and opinions presented in the media that may be based on only parts of the evidence and which may be biased.

Global climate change

- An increase in average global temperature is a major cause of climate change
- There are several potential effects of global climate change
    - Extinction of species
    - Raising sea levels due to the melting of polar ice caps
    - Increased risk of skin cancer due to more dangerous UV rays hitting the surface of the Earth

The carbon footprint and its reduction

- The carbon footprint is the total amount of CO_2 and other greenhouse gases emitted over the full life cycle of a product, service or event.
- It can be reduced by reducing emissions of carbon dioxide and methane.

Atmospheric pollutants from fuels

carbon monoxide:

- If there's not enough oxygen, some of the fuel doesn't burn – this is partial combustion. Here, solid particles of soot (carbons) and unburnt fuel are released.
- Carbon monoxide (CO) is also released when there isn't enough oxygen to produce CO_2 instead
- Carbon monoxide causes health problems
- Soot causes global dimming

oxides of nitrogen:

- Nitrogen and oxygen from the air combine to produce nitrogen monoxide
- When this nitrogen monoxide is released from vehicle exhaust systems, it combines with oxygen in the air to form nitrogen dioxide
- nitrogen monoxide and nitrogen dioxide are pollutants

sulfur dioxide

- Most fuels, including coal, contain carbon and/or hydrogen and may also contain some sulfur
- when the fuels are burnt in oxygen, this sulfur can react to form sulfur dioxide
- when sulfur dioxide dissolves in rainwater, acid rain forms:
  - Damages buildings and statues (made of limestone)
  - Reduce the growth of or kill trees and crops
  - Lower pH of water in lakes, killing fish

obtaining potable water

- potable water: it is suitable for drinking so must have:
  - low levels of microbes
  - low levels of contaminating substances
  - it is not the same as pure water but is still safe
- making waste and ground water potable:
  1. sedimentation: large insoluble particles will sink to the bottom of the water
  2. filtration: water is filtered through beds of sand which removes small insoluble particles
  3. chlorination: chlorine gas is put through water to kill microbes
- making sea water potable using distillation:
  1. filter the seawater
  2. boil it
  3. water vapour is cooled and condensed
- water used in analysis:
  - must be pure because any dissolved salts could react with the substances you are analysing, leaving you with a false result