2.3 - Electron Arrangement

2.3.1 - Describe the electromagnetic spectrum

Light consists of **electromagnetic waves**. Electromagnetic waves can travel through space or matter. A wavelength is the distance between two successive crests. The velocity of travel, c, is related to its wavelength, λ and its frequency, f. The frequency is the number of waves passing a given point second.

$$c = \lambda \times f$$
$$(\mathrm{m\ s^{-1}}) \quad (\mathrm{m}) \quad (\mathrm{s^{-1}})$$

This radiation is a form of energy. The energy of this radiation is related to its frequency, and Planck's constant

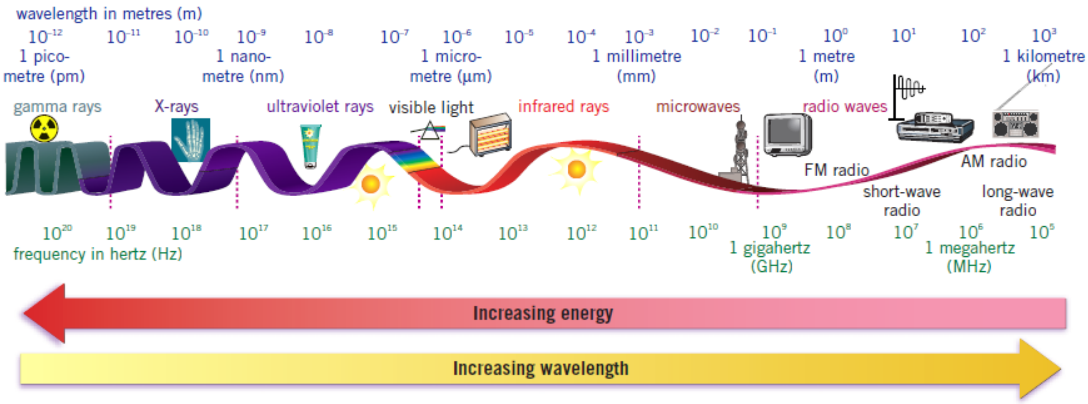
$$E = hf$$

h = Planck's constant

f = frequency

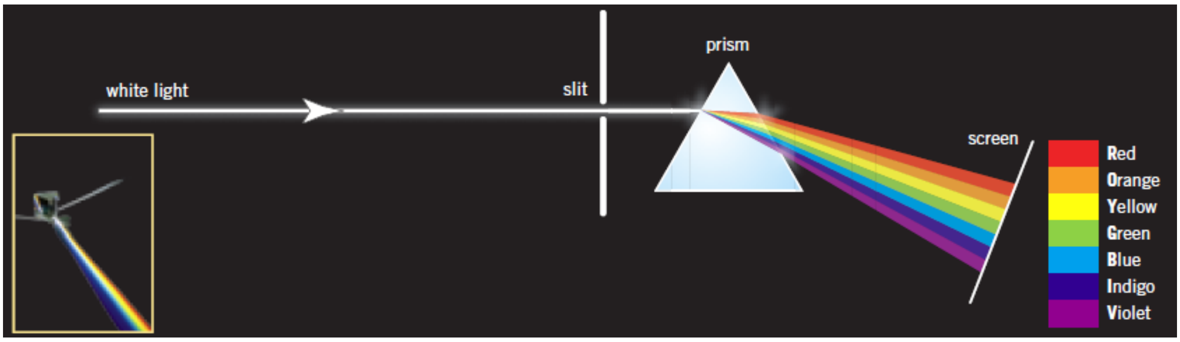
Energy is measured in **joules** and frequency is measured in s^{-1}, so Planck's constant has the unit of J s^{-1}. Its value is 6.63 x 10-34 J s^{-1}

A smaller wavelength has a higher frequency, and possesses more energy. Electromagnetic waves can have a wavelength from low-energy radio waves to very high-energy gamma radiation. Visible light is a narrow part of this spectrum.



As energy increases, so does the **frequency**. So, red light has lower energy than violet light. This is why ultraviolet light is so damaging to our skin, since high energy is more dangerous than low energy. The spectrum includes gamma rays, X-rays, ultraviolet rays, infrared, microwaves and radio waves. The infrared region contains waves with longer wavelengths than visible light.

Sunlight contains all the wavelengths of visible light, so when it passes through a prism, the different wavelengths are bent (or refracted) at different angles, breaking up the light into its components, producing a continuous spectrum of colours.



2.3.2 - Distinguish between a *continuous spectrum* and a *line spectrum*

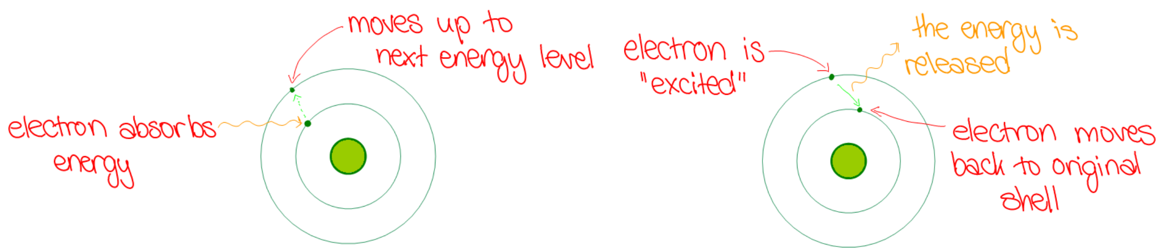
Line spectrum - a representation of light and appears as a series of discrete, coloured lines on a black background.

Continuous spectrum - a spectrum of light in which there are no gaps, so that each region blends directly into the next.

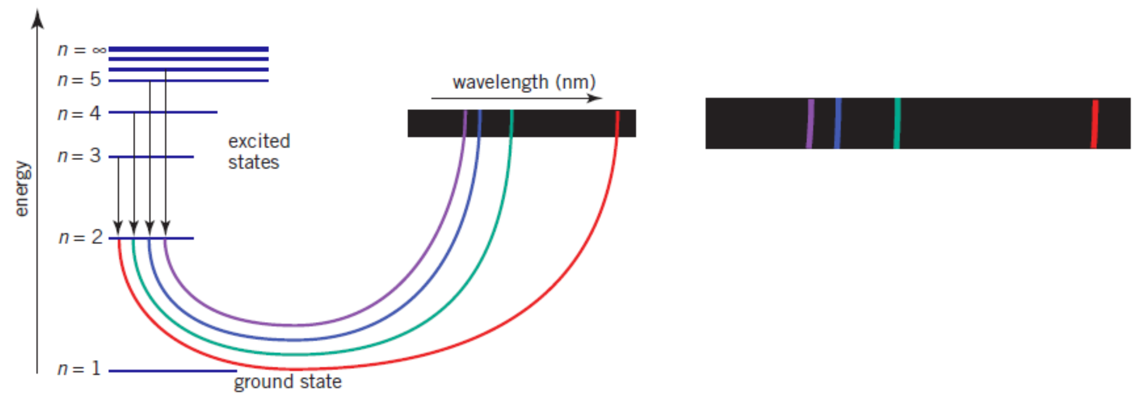
2.3.3 - Explain how the lines on the emission spectrum of hydrogen are related to electron energy levels

Emissions spectra are the emissions of light from atoms that have been provided with energy.

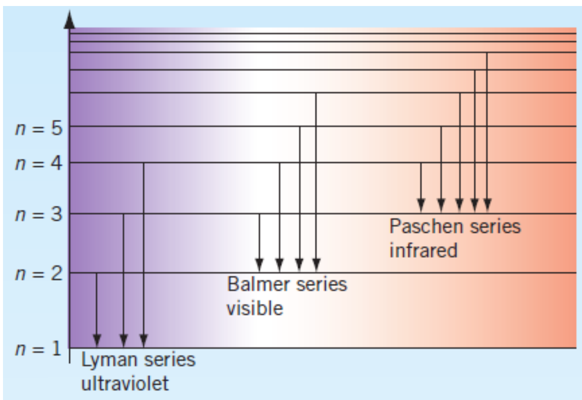
Bohr suggested that when atoms are provided with large amounts of energy, the electrons can **change energy levels**. The electrons jump to levels further from the nucleus than usual, and the atom is said to be excited. When the atom moves to ground state, the energy is released as light. The electrons will make specific jumps, depending on the ground states involved, so the light released has a specific wavelength. The light, a line (or emission) spectrum, looks like coloured lines on a black background. These emissions are not always visible to the naked eye. Studying these emissions is called **emission spectroscopy**



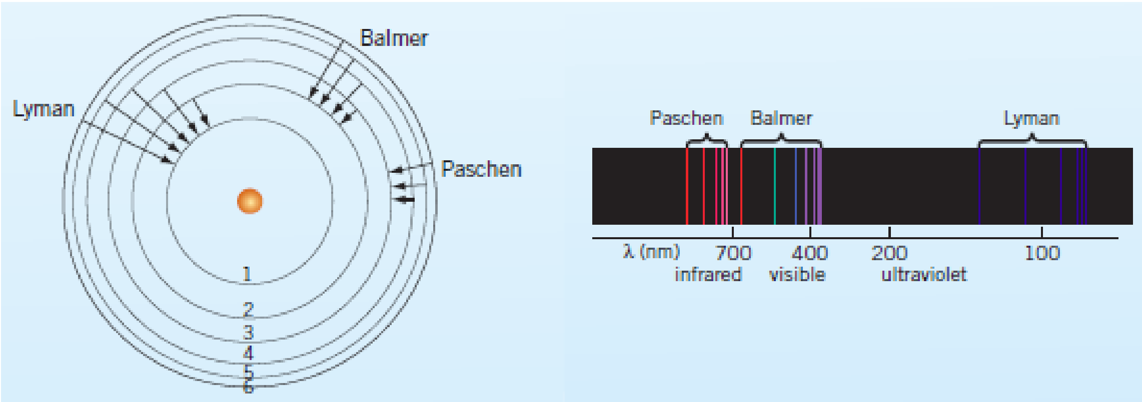
Bohr's model works the best for hydrogen.



It has been discovered that the energy of the lines on the continuous spectrum corresponds to the difference in energies between energy levels.



This all supports Bohr's theory of electron shells of specific energy. With each set of lines, the lines become closer to each other, or converge, as the wavelength decreases.



2.3.4 - Deduce the electron arrangement for atoms and ions up to Z = 20

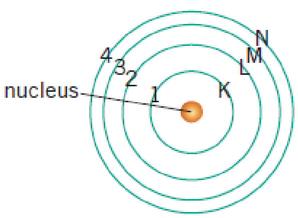
i.e. Z = 17 = 2,8,7

The electron arrangement or configuration for an atom or ion is written showing the electrons in order **from closest to the nucleus, outwards**. Each electron shell can hold a maximum of <u>$2n^2$ electrons</u> (n being the shell number)

The electron shells of an atom are also known as <u>energy levels</u>. The shells nearer the nucleus are of low energy levels, the ones further out being of higher energy levels. The shells are numbered from the nucleus (1, 2, 3...), or are identified by the letters K, L, M... Electrons move around the nucleus in these shells in pathways called orbits

The electron(s) in the outer shell of the atoms are called the **valence electrons**.

The lowest energy state of an atom is when all of the electrons are as close to the nucleus as possible, also known as its **ground state**.



in order from greatest energy (E) to least energy: $E_4 > E_3 > E_2 > E_1$

Atoms may also be represented diagrammatically. In the Bohr model, the atom is drawn showing the protons, neutrons and electrons.

The electron arrangement of an ion will be different from its parent atom.