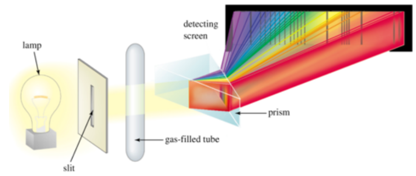
Atomic spectra & Rydberg

1. Relate the lines and series in the emission and absorption spectra of hydrogen to energy transitions and use the Rydberg equation to calculate the wavelengths
2. Describe the uses and application of atomic spectra in modern science and technology e.g. fireworks, AAS

Atomic spectrum

- Photon absorption and emission processes is observed in atomic spectra
  - A spectrum (light) that has been shined through or originates from a material (usually a gas) and contains patterns that are characteristic of elements present in material
  - When white light is shined through a prism, it splits into every colour we see (visible light)
  - As energy levels are discrete and different atoms have different energy levels, each of the possible electron transitions in an atom will produce a photon with different frequency (emission) --> line spectra + colour
  - Increase in wavelength = decrease in frequency = decrease in energy
  - Transition of hydrogen electron correspond to a different amount of energy and color that is being released

Absorption spectrum

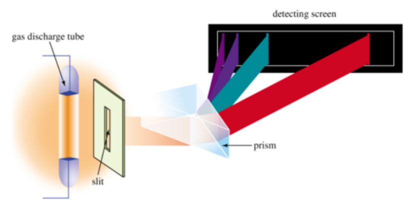


Experiment:

1. White light is polychromatic (have photons of every wavelength)
2. Light passes through a silt to make sure all wavelengths are orientated in all directions
3. Photons of light (lamp) passes through gaseous atoms (tube) e.g. hydrogen
4. Some photon's energies with specific frequencies that match the difference between energy levels are absorbed --> electron is excited
5. Spectra is observed - black lines (absorption lines) correspond to wavelength of light that was absorbed by hydrogen (certain wavelengths are depleted) as energy is taken in
6. Remaining photons are diffracted to different directions from prism by energy and colour and shown as rainbow

Emission spectrum

- Colour of light that is emitted by each element is different → can find out identity of gas
- When photon is absorbed, black line is seen. If photon is emitted again, it emits in same wavelength but since light is diffracted to every direction in sphere, the chance of energy in and out is 0

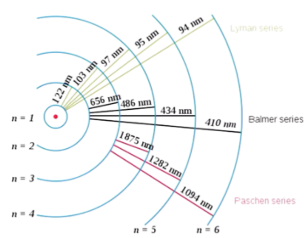


Experiment:

1. Gases are heated by electrical discharge (a current is passed through tube) --> emit photon at specific frequencies (n=1,2,3)
2. Atoms absorb the energy diffracted and lines are produced - correspond to energy levels in sample
3. When light is split into its individual wavelengths by prism --> cast on black background and shows colours and wavelengths
4. These objects diffract different wavelengths of light through different angles, so the light that passes through spreads out in space, with each wave- length appearing at its own characteristic angle
5. Since energy levels are same, lines in emission spectra of an element are in same position as lines in absorption spectra of same element

Hydrogen spectra

- Hydrogen atom has regular progression of quantised energy levels
- Energy levels are closer as you approach ionisation (further away from nucleus)



Named series

- Certain sets of transitions that are in emission spectrum
- Lyman (n= above 1 - n=1) high energy (low wavelength) --> low energy (high wavelength)
- Balmer (n= above 2 - n=2) - visible spectrum
- Paschen (n= above 3 - n=3)

Rydberg Equation

- Relates wavelength of a photon absorbed / emitted to the transition between two energy levels of a hydrogen atom