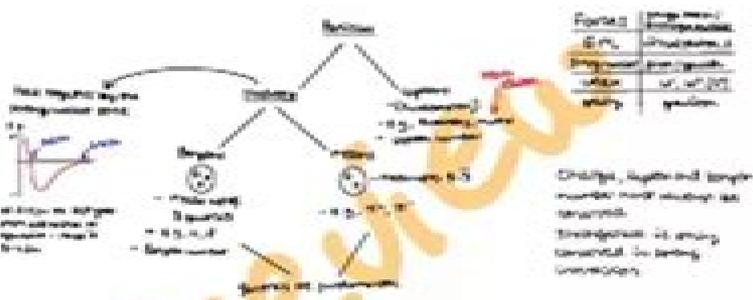


# Particles and Quantum



To absorb must be energy...  $E_{photon} = E_{final} - E_{initial}$

Annihilation - pair of particles and its corresponding antiparticle created and their rest energy is converted into photons

Pair production - when photon turns into a particle and its corresponding antiparticle. The photon must have at least the sum amount of energy which rest energies of particles

**Excitation**

Exciting means they gain energy through energy to climb their atomic

Alpha particles - Helium nucleus,  ${}^4_2\text{He}$

- Highly ionising, so it is dangerous
- Relatively penetrating - stopped by a piece of paper or foil on their

Beta - fast moving electron  $\rightarrow e^-$

- Medium penetrating and relatively quickly - stopped by a few cm of aluminium
- Beta decay -  ${}^A_Z X \rightarrow {}^A_{Z-1} Y + e^- + \bar{\nu}_e$  **antineutrino** to conserve spin/momentum



Gamma - high energy EM ray or photon emitted from a high energy nucleus  $\rightarrow \gamma$

- Highly penetrating - stopped by a few m of concrete

Isotopes - same element - same number of protons

- different relative atomic mass - different number of neutrons

Nuclear charge -  $\frac{Q}{4\pi\epsilon_0} \left( \frac{1}{r^2} \right)$

- charge to mass ratio

Electron rest - charge of an electron when stationary through a bit of wire and

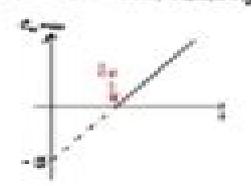
- $1.6 \times 10^{-19} \text{ C}$
- $9.1 \times 10^{-31} \text{ kg}$



## Photoelectric effect

Use photons of sufficient energy on electrons on the surface of the metal, liberating them

- $E_{photon} = hf = \phi + E_{max}$
- $\phi$  - work function - minimum energy to liberate electrons
- $E_{max}$  - kinetic energy of electrons
- $f_0$  - threshold frequency - minimum frequency needed for electrons to be liberated



The photoelectric effect proved the particle nature of light due to the fact that the maximum kinetic energy of electrons  $E_{max}$  is not linearly dependent on the intensity of light. Instead, it is linearly dependent on the frequency of light. Below the threshold frequency  $f_0$ , no electrons are emitted, but above it, the number of electrons that are emitted per second

- Stopping potential - the pd needed to stop any electrons from reaching the other side
- $E_{photon} = hf = \phi + eV_s$
  - $V_s$  - stopping potential

## De Broglie

The de Broglie wavelength is the wavelength that a particle can have. The wave nature of a particle was proven by diffraction of a crystal. This is because the electron is diffracting which is wave nature.

- $\lambda = \frac{h}{p}$
- $\lambda = \frac{h}{mv}$
- $\lambda = \frac{h}{m\gamma v}$
- $\lambda = \frac{h}{m\beta c}$
- $\lambda = \frac{h}{m\beta c}$
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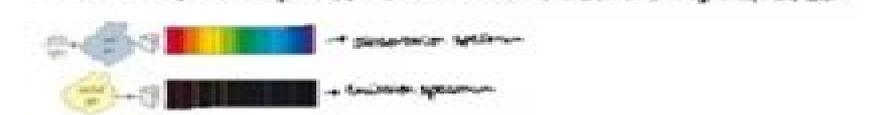
## Fluorescent tubes



This tube contains mercury under a high voltage is applied. This excites the gas atoms to which some of the mercury atoms emit photons when they relax. When the gas relaxes atoms when they return to their ground state, they emit photons in the UV range. A phosphor coating in the tube absorbs the photons and emit visible light.

## Energy levels

Electrons can be excited to higher energy levels. Either by absorbing photons from the light or by the collision. In a gas discharge tube, when an electron collides with a gas atom, it can transfer its energy to the atom.



# A Level Physics Notes

**M Mark**



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