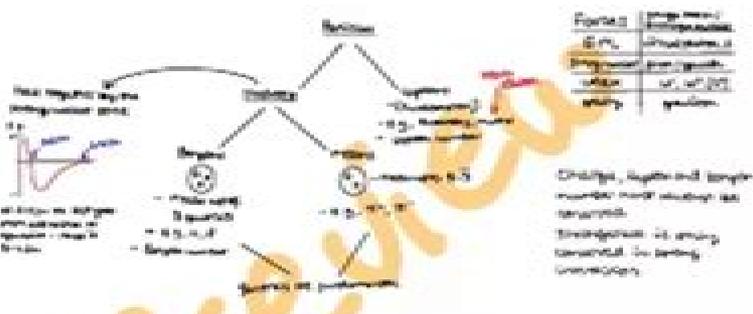


Particles and Quantum



Force	Direction
EM	Electromagnetic
Gravitational	Gravitational
Weak	Weak
Strong	Strong

To convert mass to energy, use $E=mc^2$
 Annihilation - pair of particles and its corresponding antiparticle collide and their rest energy is converted into photons



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



Excitation

Exciting means they gain energy through energy to climb their atomic energy levels - ΔE
 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 own
 ${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^4_2\text{He}$

Beta - fast moving electron $\rightarrow e^-$
 - Medium penetrating and relatively ionising - stopped by a few cm of aluminium
 - Beta decay - ${}^A_Z\text{X} \rightarrow {}^A_{Z+1}\text{Y} + e^- + \bar{\nu}_e$ **neutrino** 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
 ${}^A_Z\text{X} \rightarrow {}^A_Z\text{X} + \gamma$

Nuclear charge - $\frac{Q}{m} [C/kg]$
 - charge to mass ratio

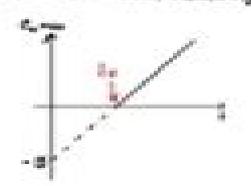
Electron volt - charge of an electron when accelerated through a pot of one volt
 - $1.6 \times 10^{-19} \text{ J}$
 - 1 eV



Photoelectric effect

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

- $E_{\text{photon}} = hf = \phi + E_{\text{kin}}$
- ϕ - work function - minimum energy to liberate electrons
- E_{kin} - kinetic energy of electron after it is liberated
- 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 is 0 if the frequency is less than f_0 and increases linearly with frequency above f_0 . This is because the electrons are liberated but do not have all the energy of the photon that is incident per photon

Stopping potential - the pot. needed to stop any electrons from reaching the other side

- $E_{\text{photon}} = hf$
- ϕ - work function
- E_{stop} - stopping potential

De Broglie

The de Broglie wavelength is the wavelength that a particle can have. The wave nature of a particle will occur by being described as a packet of waves which interferes under certain conditions. This is because the electron is diffracting which is wave-like



$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

λ - de Broglie wavelength
 p - momentum / mass x velocity

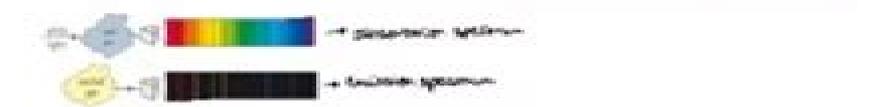
Fluorescent tubes



These tubes contain mercury under a high voltage is applied. This excites the gas resulting in which some of the mercury atoms emit photons when they relax. When the gas relaxes it emits UV light which is higher energy than what the electrons have, 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 or in a gas discharge cell when ionizing the electron energy is transferred to the gas atoms in the tube, so that completely ionize the atoms



A Level Physics Notes

David J. Lucas



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