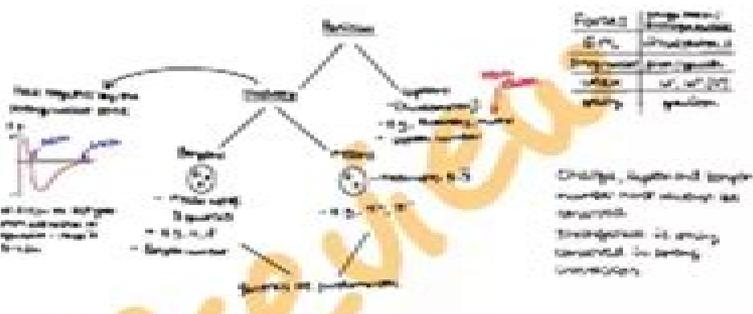


Particles and Quantum



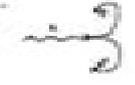
Force	Direction
EM	Electromagnetic
Gravitational	Gravitational
Weak	Weak
Strong	Strong

Charge, spin and baryon number must always be conserved. Conservation is only conserved in every interaction.

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 give electrons enough energy to climb their atomic shells.

- 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 way.
- ${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^4_2\text{He}$

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

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



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

- Highly ionising
- Highly penetrating - stopped by a few m of concrete.

Isotopes - same element - same number of protons

- different relative atomic mass - different number of neutrons

${}^A_Z\text{X} = {}^A_Z\text{C} + {}^N_Z\text{C}$

Nucleic charge - $\frac{Q}{m} [C/kg]$

- charge to mass ratio

Electron volt - charge of an electron when accelerated through a pot of one volt

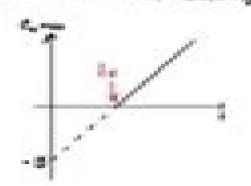
- $1.6 \times 10^{-19} \text{ J}$
- 1 eV



Photoelectric effect

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

- $E_{\text{photon}} = hf = \phi + E_{\text{max}}$
- ϕ - 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 only dependent on the frequency of light. E_{max} is zero for frequencies below f_0 and increases linearly for frequencies above f_0 .

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

- $E_{\text{photon}} = hf = \phi + eV_s$
- ϕ - work function
- 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-like.



- $\lambda = \frac{h}{p} = \frac{h}{mv}$
- λ - de Broglie wavelength
- p - momentum / mass x velocity

Fluorescent tubes



This tube works because under a high voltage is applied. This accelerates free electrons to which some of the moving electrons collide with phosphor ions, free electrons.

When the free electrons collide with phosphor ions, moving electrons, they are excited to higher energy levels. When the electrons descend, they emit photons in the visible range. A phosphor coating is on the inner surface of the tube 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 example below it is a free electron colliding with an electron in the ground state.

Ionisation energy - is enough energy to pull an electron out of an atom, so will completely change the atom.



A Level Physics Notes

L Reisser



A Level Physics Notes:

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