

Definitions and Concepts for WJEC (Eduqas) Physics A-level

Component 3: Light and Nuclei

Activity: The rate of decay of the radioactive nuclei in a given isotope. It is proportional to the total number of nuclei in the sample.

Alpha Radiation: The radiation of a particle containing two protons and two neutrons. It is strongly ionising, slow moving and positively charged so therefore deflected by a magnetic field.

Amplitude: A wave's maximum displacement from its equilibrium position.

Annihilation: The process of a particle and its antiparticle colliding and being converted into energy. The energy is released in two photons to conserve momentum.

Antinode: A position of maximum displacement in a stationary wave.

Antiparticles: All particles have a corresponding antiparticle with the same mass but opposite charge and conservation numbers.

Antiphase: If two waves are in antiphase, they have a phase difference of $\pi/2$ radians (180°).

Atomic Mass Unit: $1/12$ the mass of a Carbon-12 nuclei.

Avogadro Constant: The number of particles that make up one mole of any gas.

Background Radiation: Radiation that is found in small quantities all around us. It originates from natural sources such as rocks and cosmic rays as well as man-made sources such as nuclear accidents and medical sources.

Baryon Number: A quantum number that is conserved in all particle interactions. Baryons have a baryon number of +1 and non-baryons have a baryon number of 0.

Baryons: A class of hadron, that is made up of three quarks. The proton is the only stable baryon.

Becquerel: The unit of radioactive activity.

Beta-Minus Radiation: Radiation consisting of a high energy electron that is mildly ionising, fast moving and negatively charged so therefore deflected by a magnetic field.

Beta-Plus Radiation: Radiation consisting of a high energy positron that is mildly ionising, fast moving and positively charged and so therefore deflected by a magnetic field in the opposite direction to beta-minus radiation.

This work by [PMT Education](https://www.pmt.education) is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)



Binding Energy: The amount of energy required to split a nucleus into all its separate constituent nucleons. It is equivalent to the mass defect.

Binding Energy per Nucleon: The amount of energy required to split a nucleus into all its separate constituent nucleons, divided by the number of nucleons involved. This division allows the value to be compared for different nuclei.

Bright Fringe: When coherent waves constructively interfere, creating a wave of the sum of their amplitudes that is a 'bright' spot in the interference pattern.

Coherent Source: Sources are coherent if they have the same wavelength and frequency, as well as there being a fixed phase difference between them.

Critical Angle: The angle of incidence beyond which a wave will be totally internally reflected.

Cyclotron: A particle accelerator made up of two D shaped electrodes positioned opposite each other. The electric field changes direction each time a particle moves from one electrode to the other, causing the particle to accelerate.

Dark Fringe: When coherent waves destructively interfere, cancelling each other's amplitude

Decay Constant: The probability of a decay occurring per unit time.

Diffraction: The spreading of a wave as it passes through a gap, or around an obstacle, of a similar magnitude to its wavelength.

Diffraction Grating: A grating with hundreds of slits per millimetre, that results in sharper interference patterns when a wave passes through it. They are used to calculate atomic spacing and to analyse elements.

Electromagnetic Interaction: An interaction between charged particles with infinite range. It follows the inverse square law.

Electron Diffraction: The spreading of electrons as they pass through a gap similar to the magnitude of their de Broglie wavelength. It is evidence of the wave-like properties of particles.

Energy Levels: Defined and distinct energies at which electrons can exist in an atom. An electron cannot exist between energy levels.

Energy of a Photon: The energy of a single photon, given by $E = hf$ where h is Planck's constant and f is the frequency of the light.

Exponential Law of Decay: Radioactive decay follows a decreasing exponential relationship. This means that the activity of a sample, or the number of unstable nuclei in a sample should always decrease exponentially.

Faraday's Law: The magnitude of an induced emf is equal to the rate of change of flux



linkage through the circuit.

Fringe Spacing: The distance between two adjacent bright fringes or two adjacent dark fringes.

Gamma Radiation: High energy photons that are weakly ionising, travel at the speed of light and have no charge. This means they are not deflected by magnetic or electric fields.

Hadrons: A class of subatomic particles that experience the strong nuclear interaction.

Half-Life: The time it takes for half of the unstable nuclei in a sample to decay or for the activity of the sample to halve or for the count rate to halve.

Hall Probe: A device used to measure a magnetic field, making use of the hall effect.

Higgs Boson: A boson in the standard model of particle physics, giving particles mass.

In Phase: If two waves are in phase, they have a phase difference of zero or π radians (360°).

Intensity: The power transferred per unit area. It is proportional to the square of a wave's amplitude.

Internodal Distance: The distance between two nodes in stationary waves. Equal to the wavelength divided by two.

Ionisation Energies: The amount of energy required to remove an electron from an atom thereby ionising it.

Ions: An atom that is positively or negatively charged.

Laser: A light source that produces a collimated and coherent beam.

Lenz's Law: An induced current is always in a direction so as to oppose the change that caused it.

Lepton Number: A quantum number that is conserved in all particle interactions. Both electron lepton numbers and muon lepton numbers must be conserved.

Leptons: A group of elementary subatomic particles, consisting of electrons, muons and neutrinos.

Linear Accelerator: Particle accelerator where ions are accelerated using an alternating p.d. The acceleration occurs between the drift tubes.

Longitudinal Wave: A wave with oscillations that are parallel to the direction of energy propagation. Sound waves are an example of a longitudinal wave.

Magnetic Field: A region surrounding a magnet or current-carrying wire that will exert a



force on any other magnet, magnetic material or current-carrying wire placed within it.

Magnetic Field Lines: Lines that represent the direction and strength of a magnetic field. The density of the lines indicates the strength of the field and their direction points from North to South.

Magnetic Flux: A value which describes the magnetic field or field lines passing through an area. It is the product of magnetic flux density and the perpendicular area it passes through.

Magnetic Flux Density: The force per unit current per unit length on a current-carrying wire placed at 90° to the field lines. Sometimes also referred to as the magnetic field strength.

Mass-Energy Equivalence: All matter has an associated energy. This means that mass can be converted into energy in the form of radiation.

Modal Dispersion: Waves enter an optical fibre at slightly different angles, meaning the distance each beam has to travel is slightly different. This leads to the beams reaching the end at different times and so causes pulse broadening.

Monomode Optical Fibre: Optical fibres which have only a single mode which is parallel to the wire (through the centre).

Multimode Dispersion: When the different paths of light in multimode fibres reach the end at different times and create distortion.

Multimode Optical Fibre: Fibres that have multiple paths of light travelling through it.

Neutron: A neutrally charged nucleon, found in the nucleus of an atom. Neutrons are a form of hadron. Composed of udd quarks.

Node: A position of minimum displacement in a stationary wave.

Nuclear Fission: The splitting of a large nucleus to produce smaller nuclei, fast moving neutrons and energy.

Nuclear Fusion: The fusing of two smaller nuclei to form a single nuclei producing a large quantity of energy. Very high temperatures and pressures are needed as well as high magnetic fields to contain the fusing plasma.

Path Difference: A measure of how far ahead a wave is compared to another wave, usually expressed in terms of the wavelength.

Penetration Ability: A particle's ability to pass through different mediums.

Period: The time it takes for one complete wave to pass a given point. It is the inverse of frequency.

Phase: A measure of how far through the wave's cycle a given point on the wave is.



Phase Difference: The difference in phase between two points on a wave. It is usually expressed in radians.

Photoelectric Effect: The emission of electrons from a metal surface when light above a certain frequency is shone on it.

Photon: A packet of energy.

Pions: A type of meson and the exchange particle for the strong nuclear force.

Planck's Constant: A constant relating the energy of a photon to its frequency.

Polarisation: The restriction of a wave so that it can only oscillate in a single plane. This can only occur for transverse waves.

Population Inversion: When there are more electrons in the upper level than the lower level.

Positron: A positively charged particle that is the antiparticle of an electron.

Progressive Waves: A wave that transfers energy from one point to another, without the transfer of matter.

Proton: A positively charged nucleon, found in the nucleus of an atom. Protons are a form of hadron. Composed of uud quarks.

Quark Confinement: The principle that states that quarks cannot exist alone - they must be either in quark, antiquark pairs or in threes.

Quarks: Fundamental particle that interacts with other quarks via the strong interaction, it will change flavour via the weak interaction and annihilate with antiquarks to form photons via the electromagnetic interaction. They come in 6 flavours: up, down, charm, strange, top, bottom.

Refraction: The changing of speed of a wave when it enters a different medium. The frequency of a wave remains constant during refraction.

Refractive Index: A material property that is equal to the ratio between the speed of light in a vacuum, and the speed of light in a given material.

Relative Molecular Mass: The ratio of the mass of a given molecule over the mass of one twelfth of a carbon-12 atom.

Semiconductor Laser: A laser where the amplifying medium is a semiconductor.

Snell's Law: A law linking a wave's angle of incidence to its angle of refraction, with the use of the refractive indexes of the mediums involved.

Solenoid: A wire wrapped into the shape of a coil, that has a strong and uniform magnetic field inside of it. The solenoid's magnetic field strength can be increased by adding an iron



core.

Speed of Light in a Vacuum: $c = 299\,792\,458\text{ ms}^{-1}$ often quoted as $c = 3 \times 10^8\text{ ms}^{-1}$

Spontaneous Nature of Nuclear Decay: Radioactive decay is random - you cannot predict when a nucleus will decay or which nucleus will decay next.

Stationary Wave: A wave that stores, but does not transfer, energy.

Stimulated Emission: This is the process by which lasers produce light. It occurs when an electron is already in an excited state. If a photon has an energy equal to the energy difference between the electrons excited level and the level below, it can stimulate the electron to drop down to that lower level releasing a photon of equal energy to the incoming photon.

Strong Interaction: An interaction between all quarks, it has short range and binds quarks and nucleons together.

Superposition of Waves: When two waves meet at the same point in space their displacements combine and the total displacement at that point becomes the sum of the individual displacements at that point.

Synchrotron: A particle accelerator that accelerates ions by passing them through alternating electric fields situated at intervals in the beam pipe. The ions are kept in place by magnetic fields that must alter as the ion's velocity increases.

Total Internal Reflection: An effect that occurs in optical fibres, where full reflection occurs at the inside boundary of the fibre, meaning no radiation passes out.

Transverse Waves: A wave with oscillations that are perpendicular to the direction of energy propagation. Electromagnetic waves are examples of transverse waves.

Two Source Interference: Interference caused by the interference of two sources of waves.

Vacuum Photocell: A device which can be used to measure the maximum kinetic energy of electrons.

Velocity of a Wave: The velocity at which energy is transferred through a medium. It is equal to the product of the wave's wavelength and frequency.

Visible Spectrum: The portion of the electromagnetic spectrum that is visible to the human eye

Wavefront: An imaginary surface representing points of a wave that oscillate in phase. The direction of propagation is perpendicular to the wavefronts.

Wavelength: The distance between two identical positions on two adjacent waves. It is commonly measured from peak to peak or trough to trough.



Weak Interaction: The force that causes flavour change in quarks and leptons, it is responsible for beta decay.

Young's Double Slit: An experiment that demonstrates the diffraction of light by passing monochromatic light across two narrow slits and observing the resulting pattern of bright and dark fringes.

