

Definitions and Concepts for CAIE Physics IGCSE

Topic 5: Nuclear Physics

*Definitions in **bold** are for extended students only*

5.1 The Nuclear Model of the Atom

5.1.1 The atom

Alpha particle: A positively charged particle consisting of two protons and two neutrons. They are highly ionising but can be stopped by a few centimetres of air.

Atom: The smallest component of an element having the chemical properties of the element, consisting of a nucleus containing combinations of neutrons and protons and one or more electrons bound to the nucleus by electrical attraction.

Electrons: A negatively charged constituent of the atom, that are found in different energy levels, around the nucleus.

Ion: An atom which has lost or gained electrons to obtain an overall charge.

Neutrons: A neutral particle in the nucleus of an atom. Their quantity varies between isotopes of the same element and can be found by subtracting the proton number from the nucleon number.

Nuclear model: The model developed from Rutherford's alpha particle experiment, with the central nucleus as a small, positively charged area harbouring all the atom's mass, and electrons orbiting around this.

Proton: A positively charged particle in the nucleus of an atom. There are the same number of protons as electrons in a neutral atom, balancing their charges.

5.1.2 The nucleus

Isotopes: Atoms with the same number of protons but different numbers of neutrons. The atomic number is the same, but the mass number is different.

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Nuclear fission: The splitting of a large and unstable nucleus into two smaller and more stable nuclei to produce energy. This is the method currently used in nuclear power stations.

Nuclear fusion: The joining of two small, light nuclei to form a larger, heavier one and release energy. It cannot happen at low pressures and temperatures since in these conditions the electrostatic repulsion of protons in the nucleus cannot be overcome.

Nucleon number: The number of protons and neutrons in an atom.

Nucleus: A collection of particles called protons, which are positively charged, and neutrons, which are neutral.

Nuclide: Refers to an atom with a distinct number of protons and neutrons in its nucleus.

Nuclide notation: A shorthand method of showing information about atoms.

Proton number: The number of protons found in an atom of a specific element. Each element has a different proton number.

5.2 Radioactivity

5.2.1 Detection of Radioactivity

Background radiation: Radiation that is found in small quantities all around us.

Corrected count rate: The background radiation count produced solely from the source being investigated. Found by subtracting the count when the source is not present from the count when it is.

Count rate: The number of counts of radiation per second (units = Bq) or per minute.

Ionising radiation: Radiation capable of removing electrons from atoms, to form ions.

Radioactivity: When unstable atoms give radiation that can be harmful to humans.

Radiation: The energy emitted as electromagnetic waves or as moving subatomic particles (alpha, gamma, or beta).



5.2.2 The three types of nuclear emission

Beta particle: A high-speed electron that a nucleus emits when a neutron converts into a proton. **They are ionising but can be stopped by a thin sheet of aluminium.**

Gamma ray: Electromagnetic radiation emitted from a nucleus. They have a very high penetrating power and can penetrate up to several centimetres of lead.

Random nature of radioactive decay: You cannot predict which nuclei in a radioactive sample will decay next, or when the next decay will occur - it is a random process.

5.2.3 Radioactive Decay

Radioactive decay: The random process of unstable nuclei emitting radiation to become more stable. During α - or β -decay the nucleus changes to that of a different element.

5.2.4 Half-Life

Half-life: The time it takes for the initial count rate of a sample of an isotope to halve (different for different isotopes).

5.2.5 Safety Precautions

Mutations: Changes in DNA, which can be caused by radiation and lead to disease.

Shielding: A barrier placed between a source of radiation and the living tissues that need to be protected.

