



Nuclear & Particle Physics v2024.01.30

Cheatsheet from Deltabotics (<https://deltabotics.net>)

Definitions

- **Nuclide:** Atom characterized by amount of protons and neutrons and the nuclear energy state
- **Stable Nuclide:** Nuclide that does not spontaneously undergo radioactive decay
- **Radionuclide:** Radioactive nuclides
- **Radiogenic Nuclide:** Radionuclide produced by radioactive decay
- **Cosmogenic Nuclide:** Nuclide created by high-energy cosmic-ray nuclear interactions
- **Isotope:** Element varying by neutron number
- **Isotone:** Element differing in proton number, but same neutron count
- **Isodiaphers:** Elements with equal neutron excess (i.e. $N_1 - Z_1 = N_2 - Z_2$)
- **Isomers:** Atoms with the same proton count and neutron count, but differing energy states
- **Mirror Nuclei:** Atoms with proton and neutron counts swapped (e.g. ${}^3\text{H}$, ${}^3\text{He}$)
- **Monoisotopic Element:** Element with one stable isotope
- **Mononuclidic Element:** Element with one nuclide (whether stable or unstable)
- **Decay Product (a.k.a. daughter product/isotope/nuclide):** The remaining nuclide left over from radioactive decay

Nuclear Decay & Reactions

- **Cluster Decay (a.k.a. heavy particle radioactivity):** Rare type of nuclear decay in which the nucleus emits a small cluster of neutrons and protons, more than an alpha particle, but less than a binary fission fragment
- **Induced Gamma Emission:** Only photons are involved in creating and destroying states of nuclear excitation
- **Fission:** Nucleus splits into two or more pieces after absorbing additional particles (usually neutrons)
- **Fusion:** Two nuclei join to form a heavier nucleus with additional particles (usually protons or neutrons) emitted
- **Proton Emission (a.k.a. proton radioactivity):** Rare type of radioactive decay in which a proton is ejected from a nucleus
- **Quaternary Fission:** Comparatively rare (1 per 10 million fissions) type of fission producing four charged products
- **Spallation:** Nucleus is hit by a particle to knock out several small fragments or smash it into many fragments
- **Spontaneous Fission:** Splitting of a nucleus without assistance of additional particles
- **Ternary Fission:** Comparatively rare (0.2-0.4% of fissions) type of fission producing three charged products

Nuclear Reactions Symbols

- **CD:** Cluster decay
- e^+ : Positron emission
- **IC:** Internal conversion
- **IT:** In isomeric transition, a nucleus in a metastable state drops to a lower energy state by emitting a photon or ejecting an electron
- n^0 : Neutron emission
- **SF:** Spontaneous fission
- ϵ : Electron capture
- p : Proton emission
- α : Alpha decay (${}^4\text{He}$)
- **β^+ (a.k.a. positron emission):** Proton inside a nucleus is converted into a neutron while releasing a positron and an electron neutrino
- β : Neutron becomes a proton emitting an electron and an electron antineutrino
- **$\beta\alpha$:** A nucleus decays by β^- emission to an excited state, which then emits an α particle
- β : Beta decay (electron \pm)
- γ : Gamma decay (photon)

Particle Symbols

- \bar{e} : Anti-electron
- $\bar{\nu}$: Anti-neutrino
- d : Down quark
- e^+ : Positron
- e^- : Electron
- g : Gluon
- **H:** Higgs
- n : Neutron (Quarks: udd)
- p^+ : Proton (Quarks: udu)
- q : Quark
- u : Up quark
- μ^- : Muon neutrino
- ν : Neutrino
- ν_e : Electron neutrino
- ν_μ : Muon neutrino
- ν_τ : Tauon neutrino
- τ^+ : Anti-tau
- τ^- : Tau
- l : Lepton

Particle Definitions

- **Boson:** Fundamental subatomic particle whose quantum spin is an integer
- **Fermion:** Fundamental subatomic particle that follows Fermi-Dirac statistics and has half-odd-integer quantum spins

- **Hadron:** Composite subatomic particles made of two or more quarks held together by strong interaction. All hadrons are either bosons or fermions (the two fundamental classes of particle)
- **Baryon:** Fermionic hadron containing an odd number of valence quarks (conventionally 3)
- **Meson:** Bosonic hadron composed of an equal number of quarks and antiquarks
- **Lepton:** Fermionic elementary particles of half-integer spins that do not undergo strong interactions. Two main classes of leptons exist, charged and neutral leptons