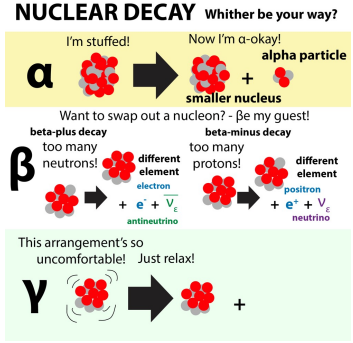
Nuclear Decay Processes



Nuclear Decay

Unstable Isotopes are isotopes that have a z-ratio outside the stable range for the element.

Most common nuclear decay processes include:

Alpha Decay – Atom too large
Beta Decay (+) – Too many n^o
Beta Decay (-) – Too many p$^+$

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Nuclear Decay Processes

Type	Nuclear equation	Representation	Change in mass/atomic numbers
Alpha decay	${}^{A}_{Z}X \rightarrow {}^{4}_{2}He + {}^{A-4}_{Z-2}Y$		A: decrease by 4 Z: decrease by 2
Beta decay	${}^{A}_{Z}X \rightarrow {}^{0}_{-1}e + {}^{A}_{Z+1}Y$		A: unchanged Z: increase by 1
Gamma decay	${}^{A}_{Z}X \rightarrow {}^{0}_{0}\gamma + {}^{A}_{Z}X$	Excited nuclear state → γ	A: unchanged Z: unchanged
Positron emission	${}^{A}_{Z}X \rightarrow {}^{0}_{+1}e + {}^{A}_{Y-1}Y$		A: unchanged Z: decrease by 1
Electron capture	${}^{A}_{Z}X \rightarrow {}^{0}_{-1}e + {}^{A}_{Y-1}Y$	X-ray	A: unchanged Z: decrease by 1

Additional Decay Processes

In addition to Alpha and Beta decay additional decay processes can occur including **gamma radiation**, **positron emission**, and **electron capture**

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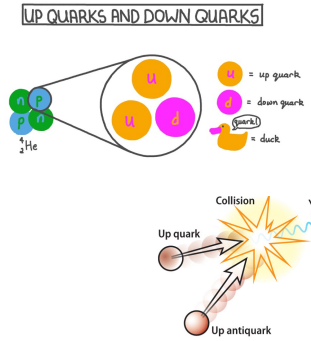
Energy of Subatomic Particles



Subatomic Particles Contain Energy

All particles are made of individual particles called quarks and antiquarks.

Neutrons (p$^+$ + e$^-$) break down to produce energy, electrons, and protons

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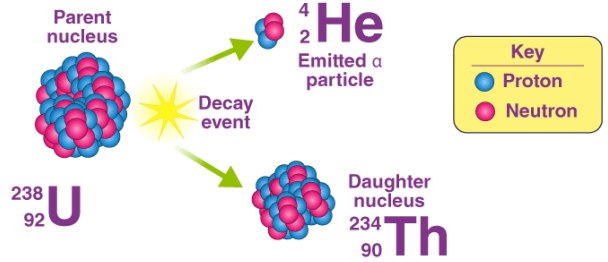
Alpha Nuclear Decay

Breakdown of a large unstable atomic isotope by removing 2 protons and 2 neutrons (2p$^+$ + 2n^o) producing an alpha particle and a smaller isotope



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Writing Alpha Nuclear Decay

Alpha nuclear decay can be written in equation form

$$ {}^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}\alpha $$

Alpha decay removed 2 p^+ which reduces atomic number (Z) by 2.

$$ {}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}\alpha $$

Ra (88) → Rn (86)

$$ {}^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha $$

U (92) → Th (90)

The smaller atom is more stable due to reducing the z-ratio (p^+:n^o ratio)

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