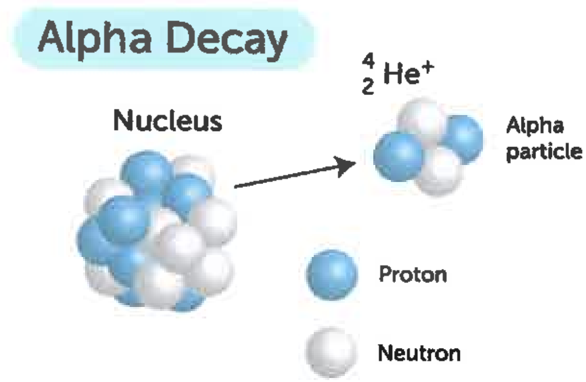
Types of Radioactive Decay

Alpha Decay

Occurs most often in massive nuclei that have too large a proton to neutron ratio.



During alpha decay, an alpha particle (2 protons and 2 neutrons) (similar to helium 4) is ejected from the nucleus.

The atom left behind has its atomic number reduced by 2 and its mass reduced by 4.

Alpha particles have the largest ionizing ability of all radioactive decay types.

- … meaning they are capable of removing electrons from atoms and/or breaking chemical bonds.
- All forms of ionizing radiation can destroy or cause damage to DNA in cells.

Alpha particles are large, meaning they collide with a lot of other atoms as they travel and therefore quickly run out of energy.

- This means alpha particles travel only a few cm from their source and are easy to shield – a piece of paper or the outer layer of human skin stops them.

Alpha particles are most harmful when are inhaled and/or ingested, causing them to come in direct contact with internal organs.

Typical alpha decay equation:

aka = alpha particle

① find these first
② identify element

mass →
atomic # →

$$^{222}_{88}Ra \longrightarrow {}^{4}_{2}He + {}^{218}_{86}Rn$$

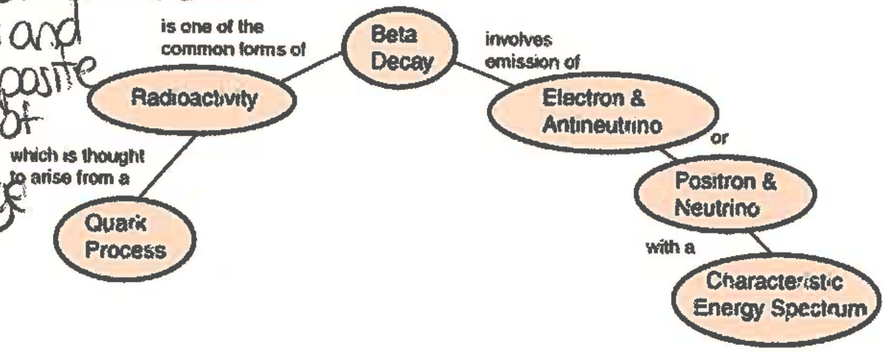
Example:
Use a periodic table to write the equation for the alpha decay of polonium – 208.

Solution:

$$^{208}_{84}Po \rightarrow {}^{4}_{2}He + {}^{204}_{82}Pb$$

antimatter = any particle of matter that has same mass and electric charge but opposite sign of

Beta Decay

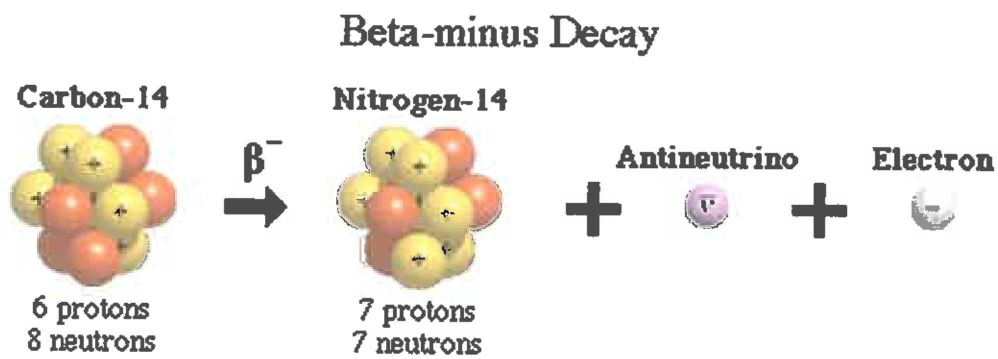


Beta particles come in two types: electrons and their charge antimatter partners, positrons.

Unlike alpha particles, which pre-exist in the nucleus, the electrons and positrons have to be created in the process of decaying.

For example, a nucleus with an excess of neutrons will undergo **Beta Minus Decay**, in which a neutron changes into a proton plus an electron. The electron, known as the beta particle, is then ejected from the nucleus.

$({}^{0}_{-1}e$



$({}^{0}_{0}\bar{\nu}$

At the same time, a very small particle with no charge, called an antineutrino is also ejected. The antineutrino is ejected to balance the conservation of energy.

The atomic number goes up by one and the mass number remains unchanged.

Beta particles are small, meaning:

- they travel fast, have few collisions, and can therefore travel farther (meters rather than cm)
- more difficult to shield, but safety glasses, work gloves, and coveralls will stop them.

Typical beta minus decay equation: ☆ Classic Decay ☆

$$ {}^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e + {}^{0}_{0}\bar{\nu} $$

Example:

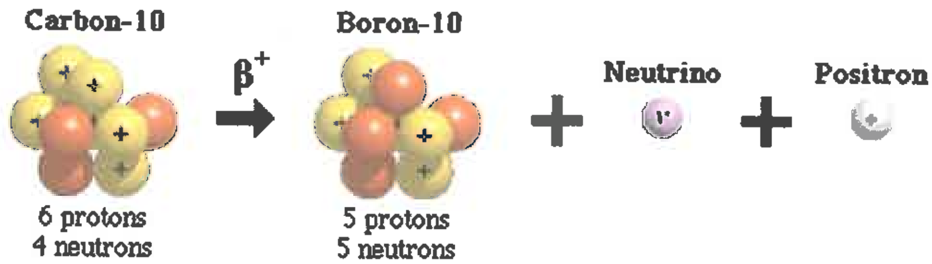
Use a periodic table to write the equation for the beta minus decay of iodine – 131.

Solution:

$$ {}^{131}_{53}I \rightarrow {}^{0}_{-1}e + {}^{0}_{0}\bar{\nu} + {}^{131}_{54}Xe $$

Beta-Plus Decay occurs when an excess of protons prompts one of them to convert into a neutron plus a ___positron___. The positron is ejected from the nucleus and carries off the proton's charge. $^{0}_{+1}e$

Beta-plus Decay

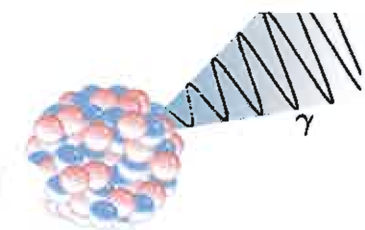


$^{0}_{0}\nu$

At the same time, a very small particle with no charge, called a ___neutrino___ is also ejected. The neutrino is ejected to balance the conservation of energy.

eg. $^{50}_{25}Mn \rightarrow ^{50}_{24}Cr + ^{0}_{+1}e + ^{0}_{0}\nu$

Gamma Decay

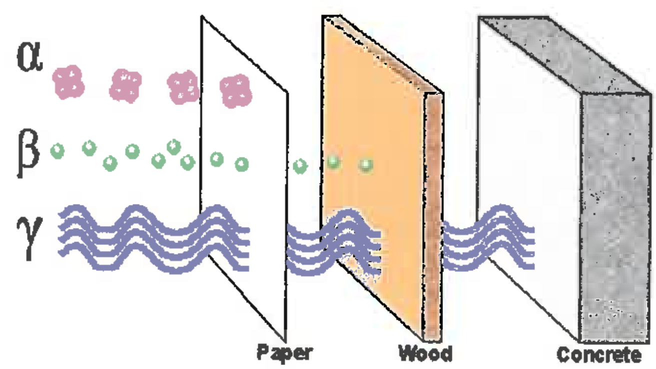


Unlike alpha and beta decay, gamma decay emits an electromagnetic ___wave___, not a particle.

Gamma decay often happens alongside alpha or beta decay and is the nucleus's way of releasing ___energy___.

Gamma rays travel as waves meaning:

- they travel at the speed of light
- they do not lose energy very quickly - can travel up to 100s of m from their source and penetrate skin and human organs.
- can only be shield by lead or concrete or reduced by large distances.



They produce damage similar to that caused by X-rays such as burns, cancer, and genetic mutations.

Typical gamma decay equation:

$$^{238}_{92}U \rightarrow ^{238}_{92}U + ^{0}_{0}\gamma$$