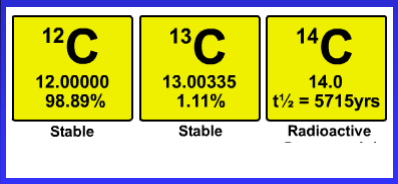
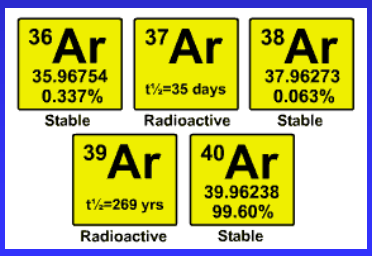
Why are some isotopes more stable than others?

- It has to do with the ratio of neutron to proton in the nucleus of the atom.
- An undesirable ratio of protons to neutrons make an nucleus UNSTABLE.





How does an atom with an unstable nucleus gain stability?

- They lose energy through radioactive decay.

Radioactive decay: spontaneous emission of particles and/or energy from an atom. It changes an atom into a new element.

The goal of radioactive decay is to eventually end up with a stable element. (May need to undergo more then one step)

Forms of radiation

1. Alpha radiation

An **alpha particle** (α) is two protons and two neutrons bound together (identical to the helium nucleus)

Relatively large mass (≈ 4 amu) and can be stopped by a sheet of paper

α (alpha particle) = He_2^4

Plutonium 239 decays by alpha particle emission as follows:

$$Pu_{94}^{239} \xrightarrow[24{,}000\ yrs]{} U_{92}^{235} + He_2^4$$

(alpha particle)

Forms of radiation

2. Beta radiation

A **beta particle** *(β)* is an electron emitted from the nucleus

Decreases the number of neutrons by converting a neutron into a proton and an electron.

Small mass (≈ 0.0055 amu) – Can be stopped by a sheet of aluminum foil

β (beta particle) = e_{-1}^0

The tritium beta-decay process is written as follows:

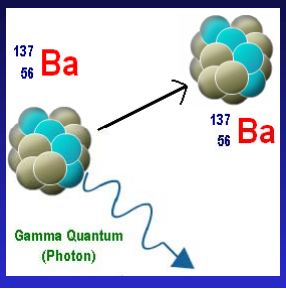
$$H_1^3 \xrightarrow[12.3\ yrs]{} He_2^3 + e_{-1}^0$$

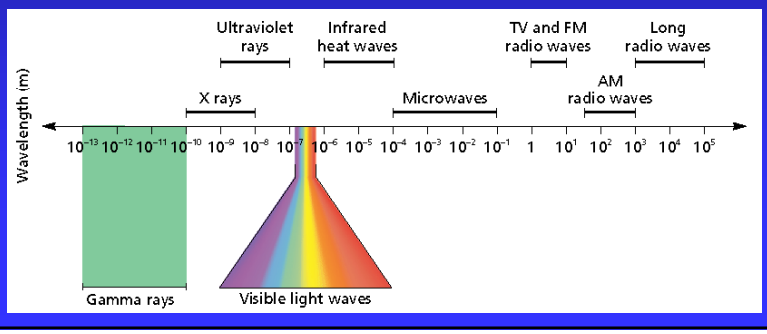
(beta particle)

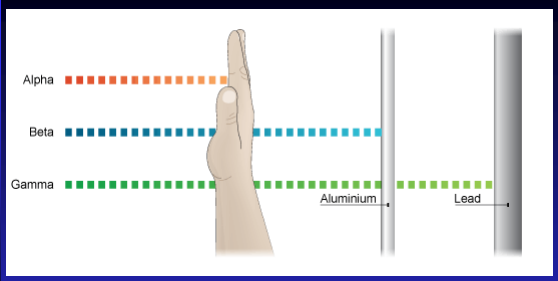
Forms of radiation

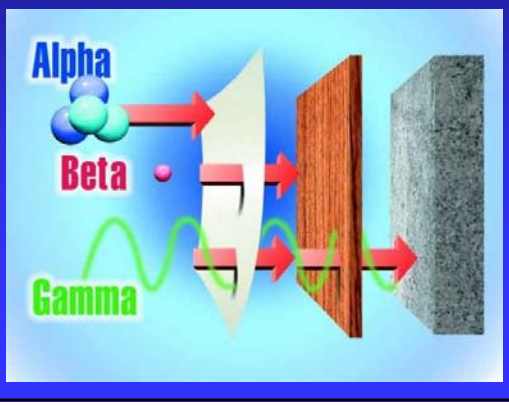
3. Gamma Radiation

Gamma rays (γ) are high-energy electromagnetic waves emitted from a nucleus. They have no mass or charge.










URANIUM 238 (U238)
RADIOACTIVE DECAY
type of radiation
nuclide
half-life
uranium-238
4.47 billion years
α
thorium-234
24.1 days
β
protactinium-234m
1.17 minutes
β
uranium-234
245000 years
α
thorium-230
8000 years
α
radium-226
1600 years
α
radon-222
3.823 days
α
polonium-218
3.05 minutes
α
lead-214
26.8 minutes
β
bismuth-214
19.7 minutes
β
polonium-214
0.000164 seconds
α
lead-210
22.3 years
β
bismuth-210
5.01 days
β
polonium-210
138.4 days
α
lead-206
stable