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.

How does an atom with an unstable nucleus gain stability?

- They lose energy through radioactive decay.

Radioactive decay: spontaneous emission of particles and/or electromagnetic radiation (energy) from an atom; changes an atom into a new element

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) – stopped by a sheet of paper

2. Beta radiation

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

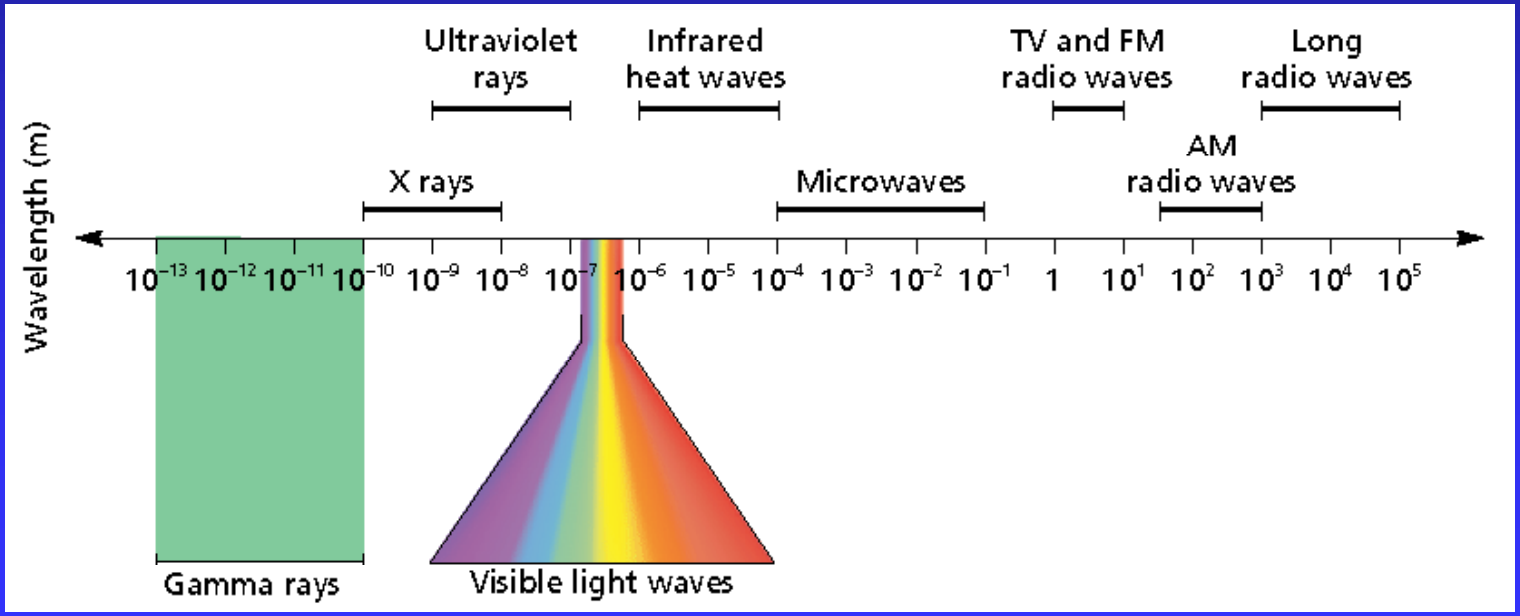
Decreases the number of neutrons by converting a neutron into a proton and an electron.

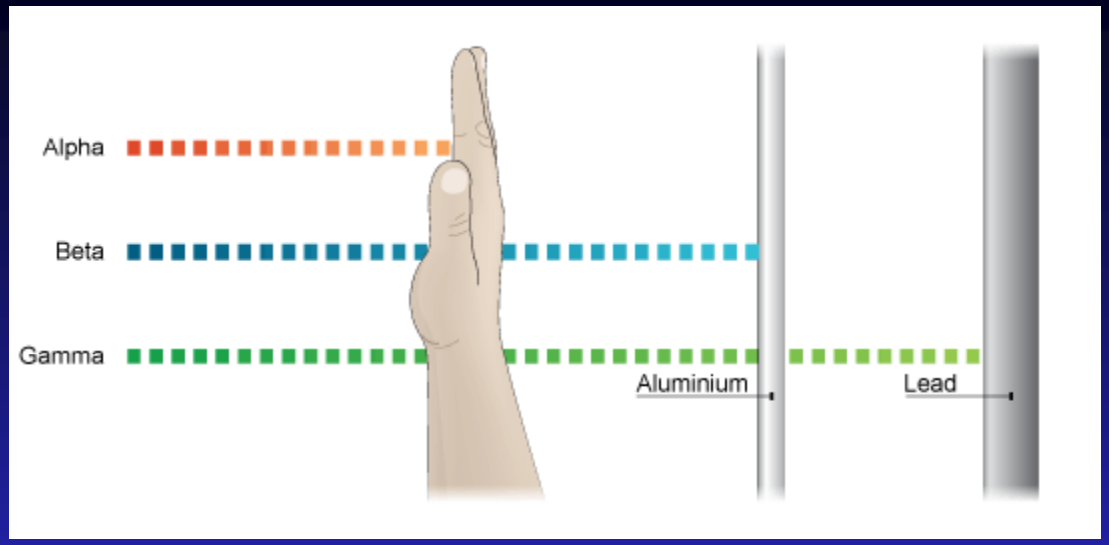
Small mass (≈ 0.0055 amu) – stopped by a sheet of aluminum foil

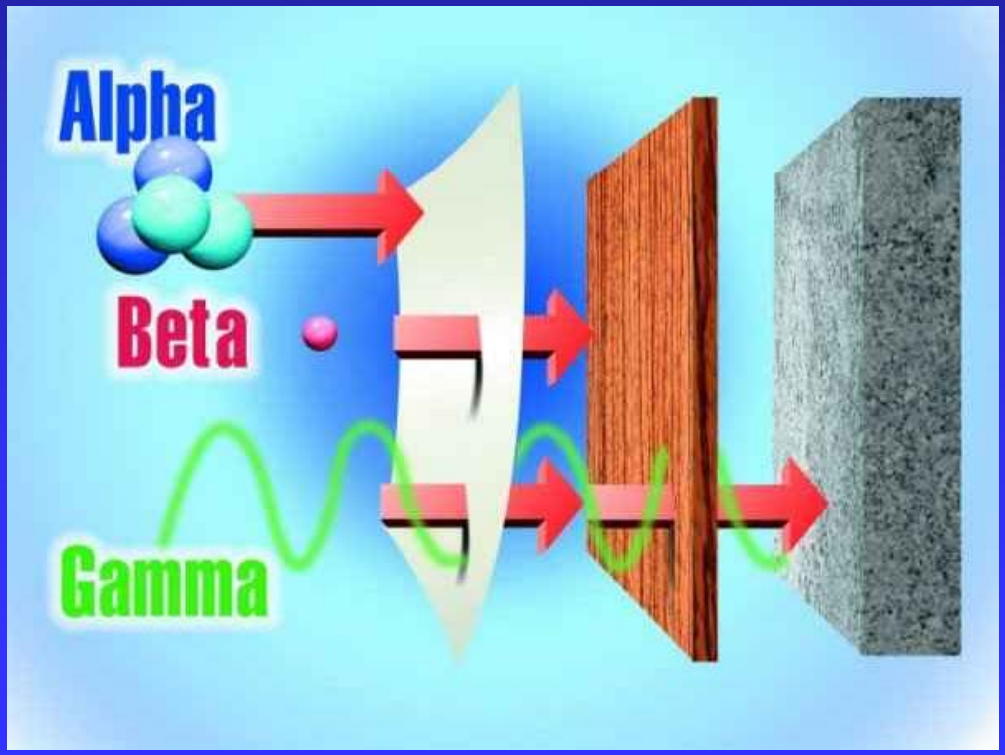
Forms of radiation cont.

3. Gamma Radiation

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



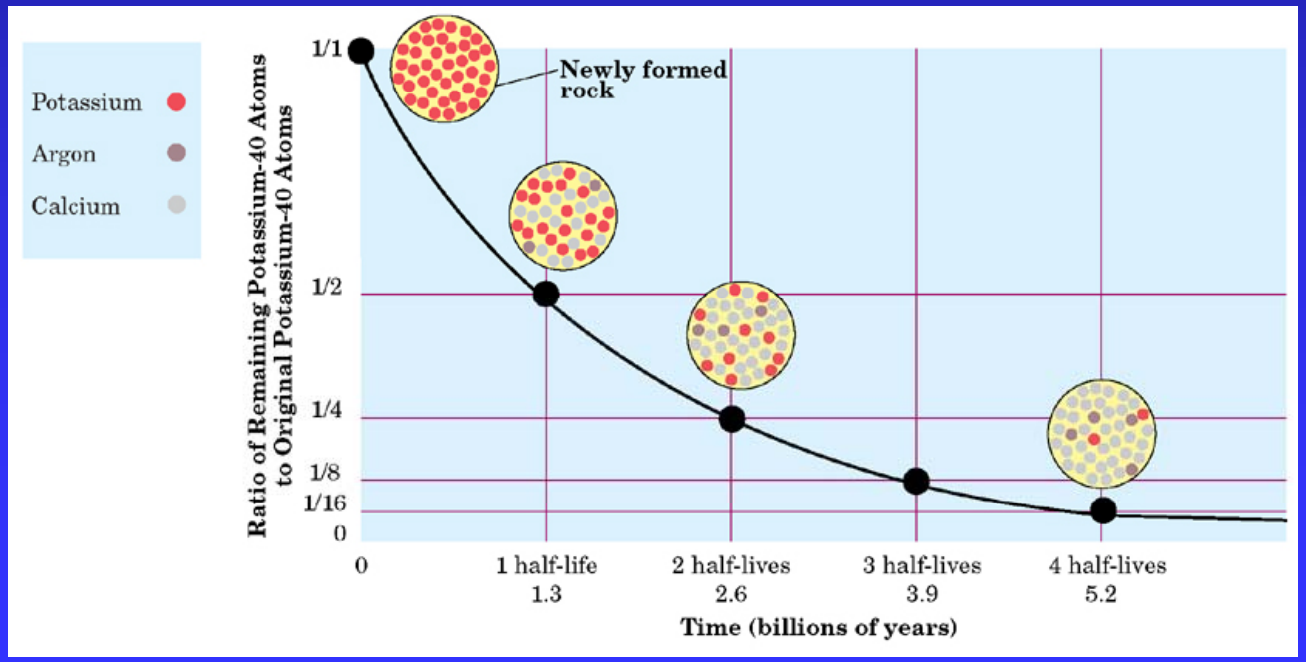

Alpha
Beta
Gamma
Aluminium
Lead


Alpha
Beta
Gamma

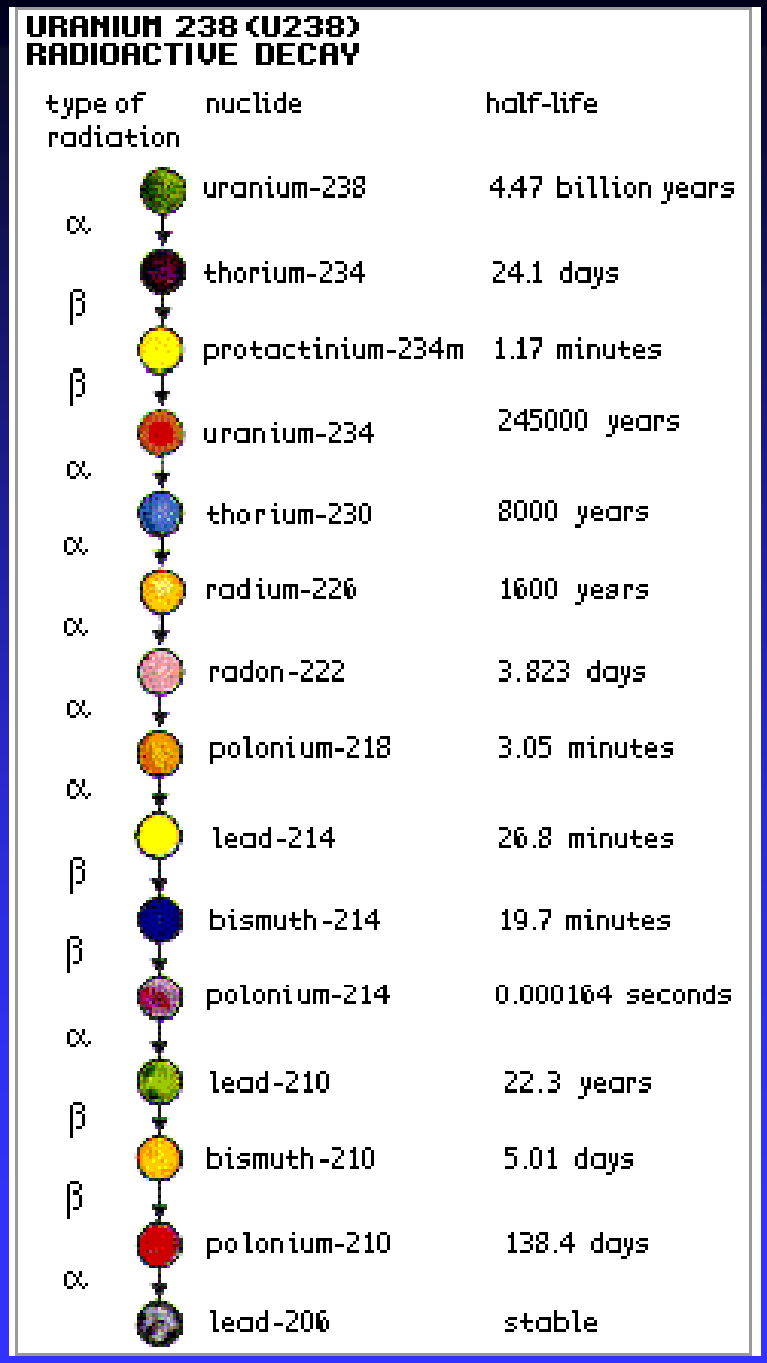
Half-life

Half-life, $t_{1/2}$, is the time required for half the atoms of a radioactive isotope to decay.

Potassium-40 Half-Life



Isotope	Half Life
Barium-133	10.7 years
Cadmium-109	453 days
Cobalt-57	270 days
Cobalt-60	5.27 years
Europium-152	13.5 years
Manganese-54	312 days
Sodium-22	2.6 years
Zinc-65	244 days
Technetium-99	6.01 hours
Carbon -14	5730 yrs



Sample Problem

Gold-191 has a half-life of 12.4 hours. How many milligrams of gold-191 remain after 49.6 hours if you start with 7.50 mg of the isotope?

Given: original mass of gold -191 = 7.50 mg
half-life of gold-191 = 12.4 hrs
time elapsed = 49.6 hours

Solution:

Number of half-lives = $\frac{49.6 \text{ hrs}}{12.4 \text{ hrs}}$ = 4 half-lives

Amount of Gold-191 remaining:

7.50 ÷ 2 ÷ 2 ÷ 2 ÷ 2 = **0.469 mg**

Sample Problem

After 39 days, a 15.0 gram sample of iodine-126 decays to only 1.875 g. What is the half-life of iodine-126?

Given: Original mass of iodine-126 = 15.0 g

Amount of iodine-126 remaining = 1.875 g

Time elapsed = 39 days

Solution:

Determine how many half-lives have passed.

1) 1.875g x 2 = 3.75 g
2) 3.75g x 2 = 7.50 g
3) 7.50g x 2 =15.0 g

Total elapsed time divided by number of $t_{1/2}$

$$t_{1/2} = \frac{39 \text{ days}}{3} = \textbf{13 days}$$