

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

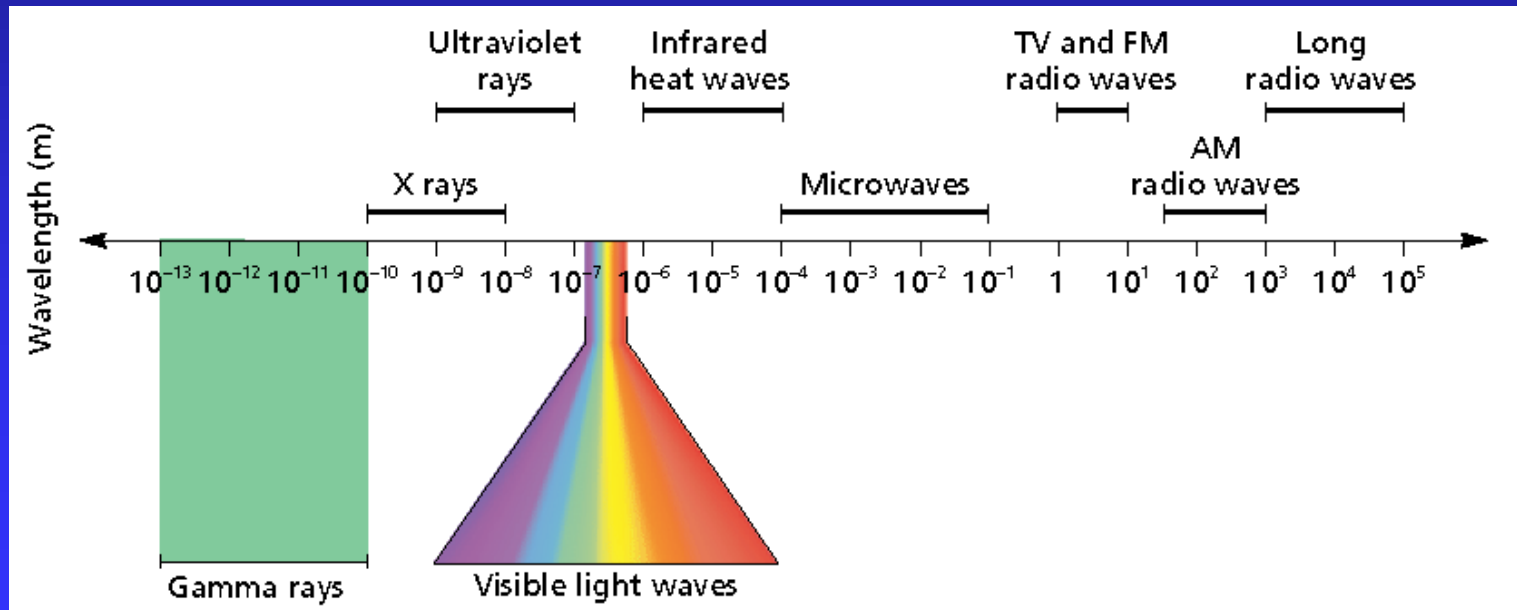
Decreases the number of neutrons by converting a neutron into a proton and an electron.

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

Forms of radiation cont.

3. Gamma Radiation

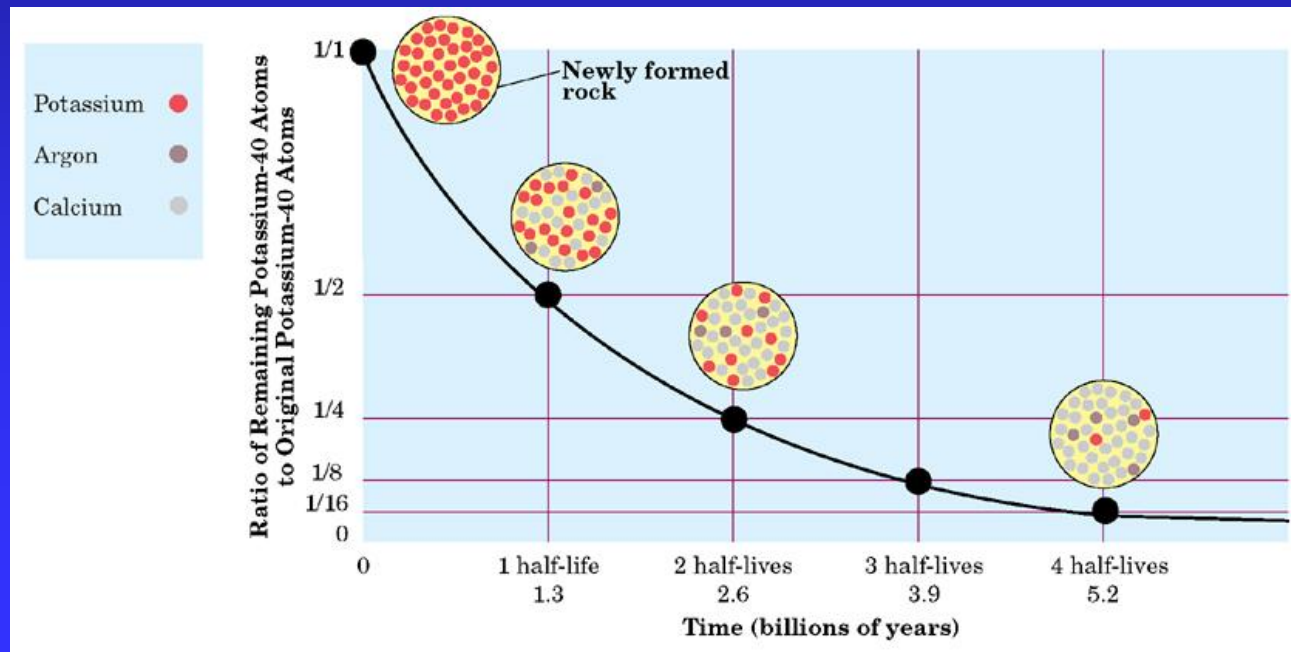
Gamma rays (γ) are high-energy electromagnetic waves emitted from a nucleus. They have no mass or charge.



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

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

URANIUM 238 (U238) RADIOACTIVE DECAY

type of radiation	nuclide	half-life
α	uranium-238	4.47 billion years
β	thorium-234	24.1 days
β	protactinium-234m	1.17 minutes
α	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
β	lead-214	26.8 minutes
β	bismuth-214	19.7 minutes
α	polonium-214	0.000164 seconds
β	lead-210	22.3 years
β	bismuth-210	5.01 days
α	polonium-210	138.4 days
	lead-206	stable

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

Amount of Gold-191 remaining:

$$7.50 \div 2 \div 2 \div 2 \div 2 = \mathbf{0.469 \text{ mg}}$$

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.

$$1) 1.875\text{g} \times 2 = 3.75\text{ g}$$

$$2) 3.75\text{g} \times 2 = 7.50\text{ g}$$

$$3) 7.50\text{g} \times 2 = 15.0\text{ g}$$

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

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