Today

- Refresher on isotopes
- Start nuclear decay

	#p^+	#n°	Naturally Occurring	If we have 1,000,000 atoms how many do we expect?
Helium-3				
^3_2He	2	3-2=1	Yes	1

$$\text{predicted \#} = \frac{\text{\# of atoms} \times \%}{100}$$

$$= \frac{1000000 \times 0.000137\%}{100}$$

$$= 1.37$$

Remember this?

A natural sample of chlorine contains 800 atoms. What different isotopes would you expect to find and how many of each?

^{35}Cl - 75.77% $\quad \# = \frac{\# \text{ atoms} \times \%}{100} = \frac{800 \times 75.77\%}{100} = 606$

^{37}Cl - 24.23% $\quad \frac{800 \times 24.23}{100} = 194$

800

We've been working with naturally occurring isotopes. These are generally stable.

Many isotopes are not stable! They will eventually decay.
(nuclear decay)

Decay causes the nucleus to change into a different nucleus (and often times a different element altogether) by emitting a particle.

Types of Decays

Alpha Decay: α^{+2} A nucleus (usually a large one) emits a helium nucleus ($_2^4He^{+2} = \alpha$) to become more stable.

$$^{238}_{92}U \longrightarrow ^{234}_{90}Th + ^4_2\alpha^{+2} + 2e^-$$

loses 4 mass; lose 2 p+; element 90 on periodic table

Least dangerous of the particles, unless it's internal. They can be stopped by a sheet of paper.

Beta Negative Decay: $\beta^- = (e^-)$ Can happen with both small and large nuclei. In general, there are too many neutrons for the number of protons. An electron is "kicked" out of the nucleus and a neutron changes to a proton.

$$n^0 \longrightarrow \beta^- + p^+ + \bar{\nu}$$ ← antineutrino (really small mass - hard to detect)

Example: $^{14}_{6}C \longrightarrow ^{14}_{7}N + \beta^- + \bar{\nu}$

fast moving electrons, similar energy to X-rays, can be stopped by a thin sheet of lead.

Beta Positive Decay: β^+ Can occur with both large and small nuclei - too many protons for number of neutrons. A β^+ particle is a positron - an anti-electron (same mass but opposite charge)

$$p^+ \longrightarrow \beta^+ + n^0 + \nu$$ ← neutrino.

Example $^{36}_{17}Cl \longrightarrow ^{37}_{16}S + \beta^+ + \nu$

Gamma radiation: γ Any size nucleus - becomes more stable by giving off high energy light (γ)

$$^{237}_{92}U \longrightarrow ^{237}_{92}U + \gamma$$

The most penetrating. Requires 6 ft (2m) of concrete or several centimeters of lead to stop it.

https://phet.colorado.edu/sims/html/build-a-nucleus/latest/build-a-nucleus_all.html

Or Google: Build a nucleus pHet

Example: Decay of Carbon 14

Using the pHet simulation, for each of the following, give the decay type and the resulting atom after the decay.

$^{92}_{36}\mathrm{Kr}$

$^{49}_{23}\mathrm{V}$

$^{184}_{82}\mathrm{Pb}$

note: there are two for this one!