Today

- Refresher on isotopes
- Start nuclear decay

Helium-3	# p^+	# n^0	Naturally occurring	If 1,000,000 atoms, how many?
$^{3}_{2}He$	2	3-2=1	yes	1

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

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

$$= 1.37$$

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%

$\# = \frac{\text{\# atoms} \times \%}{100} = \frac{800 \times 75.77\%}{100} = 606$

^{37}Cl 24.23%

$\# = \frac{800 \times 24.23\%}{100} = 194$

$606 + 194 = 800$ ✓

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: Occurs when a large nucleus kicks out an α-particle ($2p^+, 2n^0$ → same as a helium nucleus) to become more stable.

α ← Greek letter alpha

Example: $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}\alpha$ (loses 4 mass; loses 2 p^+)

α radiation is the least dangerous to humans unless it is ingested or inhaled.
- a piece of paper or skin will stop α-particles

Beta Negative Decay: Can happen with small or large nuclei. This occurs when the nucleus has too many neutrons compared to protons. The nucleus "kicks out" an e^- (β^- particle) and a n^0 becomes a p^+.

β^- ← Greek letter beta

$n^0 \rightarrow p^+ + \beta^- + \bar{\nu}$ (β^- ← e^-; $\bar{\nu}$ ← anti neutrino)

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

β^- particles have similar energies as X-rays and can be stopped with a thin piece of lead.

Beta Positive Decay: Similar to β^- except there are too many p^+s for the # of neutrons. A proton becomes a n^0 and a β^+ (a positron, or antielectron) is kicked out of the nucleus.

β^+

$p^+ \rightarrow n^0 + \beta^+ + \nu$ (β^+ ← e^+ (positron - same mass as e^-); ν ← neutrino)

$^{36}_{17}Cl \rightarrow ^{36}_{16}S + \beta^+ + \nu$

Gamma radiation: An unstable nucleus emits high energy light to become more stable, without changing the # of p^+ or e^-

γ ← Greek letter gamma

$^{222}Rn \rightarrow ^{222}Rn + \gamma$

This is the most penetrating of radiation. It takes about 6 feet (2m) of concrete or several cm of lead to stop γ-rays.

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!