

Ch 28 HW: Sec Rev 6,10,34-36,49,59
 Sec 28.2

obj: Use half-life to calculate the amount of a radioisotope remaining after a period of time.

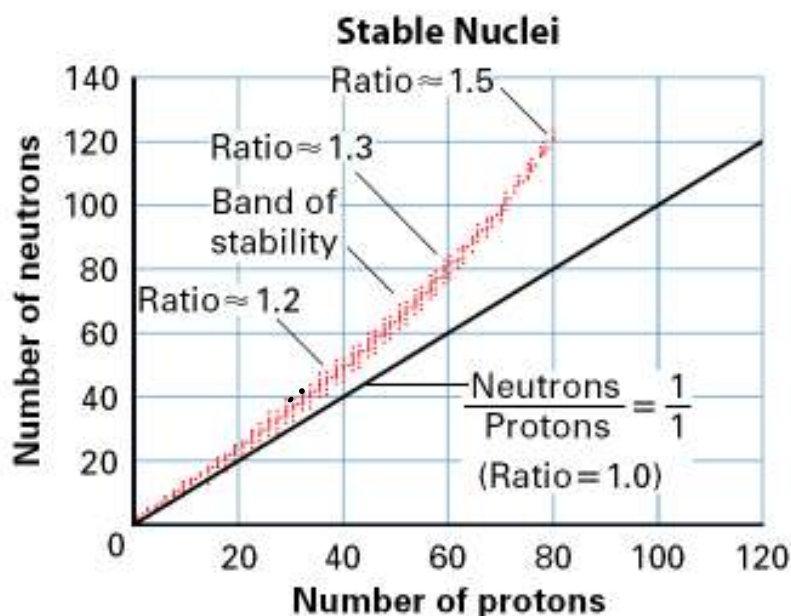
Nuclear Stability

- The stability of a nucleus depends on the proton-neutron ratio.

* Ratio of 1 to 1 is stable for atomic numbers 20 or less.

* As the atomic number increases the proton-neutron ratio increases for stable nuclei.

Number of Neutrons vs. Number of Protons for Stable Nuclei



Decay Processes	
Beta Emission	
${}^{66}_{29}\text{Cu} \longrightarrow {}^{66}_{30}\text{Zn} + {}^0_{-1}\text{e}$	
${}^{14}_6\text{C} \longrightarrow {}^{14}_7\text{N} + {}^0_{-1}\text{e}$	
Electron Capture	
${}^{59}_{28}\text{Ni} + {}^0_{-1}\text{e} \longrightarrow {}^{59}_{27}\text{Co}$	
${}^{37}_{18}\text{Ar} + {}^0_{-1}\text{e} \longrightarrow {}^{37}_{17}\text{Cl}$	
Positron Emission	
${}^8_5\text{B} \longrightarrow {}^8_4\text{Be} + {}^0_{+1}\text{e}$	
${}^{15}_8\text{O} \longrightarrow {}^{15}_7\text{N} + {}^0_{+1}\text{e}$	
Alpha Emission	
${}^{226}_{88}\text{Ra} \longrightarrow {}^{222}_{86}\text{Rn} + {}^4_2\text{He}$	
${}^{232}_{90}\text{Th} \longrightarrow {}^{228}_{88}\text{Ra} + {}^4_2\text{He}$	

Radiation

- Elements w/ atomic numbers below 83 will emit Beta particles.
 - * Ratio of Protons to Neutrons is closer to 1-1.
- Positron - Radiation particle identical to a beta particle except for the charge.
 - * Changes a Proton into a neutron.

- Elements w/ atomic number 83 or greater will emit alpha radiation.

Half-Life

- The amount of time needed for 1/2 of the radioactivity isotopes to decay.
 - * A physical property.

Decay Curve for a Radioactive Element

The graph illustrates the exponential decay of a radioactive element. The y-axis represents the percentage of the radioisotope remaining, starting at 100% and decreasing to approximately 6.25% after 4 half-lives. The x-axis represents the number of half-lives, from 0 to 4. Key points on the curve are marked: 100% at 0 half-lives, 50% at 1 half-life, 25% at 2 half-lives, and 12.5% at 3 half-lives. Red arrows labeled $t_{1/2}$ indicate the time intervals between these points. Diagrams of containers with blue dots represent the remaining amount of the radioisotope at each stage: 100 dots initially, 50 dots after 1 half-life, 25 dots after 2 half-lives, and 12.5 dots after 3 half-lives.

- Calculating Half-Lives

1) The time elapsed for a # of half-lives.

Half life times the # of half-lives

2) Amount of substance left.

$$A = m \times \frac{1}{2}^{\wedge \# \text{ half-lives}}$$

A radioisotope has a half-life of 12 minutes. How long does it take for the radioisotope to go through 3.8 half-lives?

Given	
$\frac{1}{2}$ Life = 12 min	time = half life \times # of $\frac{1}{2}$ Lives
$\# \frac{1}{2}$ Lives = 3.8	= 12 min \times 3.8
	=

Find the mass of a radioisotope that is left from a 100 g sample after 3 half-lives.

Given	
$m = 100\text{g}$	$A = m \times \frac{1}{2}^{\wedge \# \frac{1}{2} \text{ lives}}$
$\# \frac{1}{2}$ Lives = 3	= $100\text{g} \times \frac{1}{2}^{\wedge 3}$
Wanted	
A = ?	