# Unit 11: Predicting Radioactive Decay Reactions

Radioactivity: Zone of Stability
All nuclides with 84 or more protons are unstable (radioactive).
Light elements like the neutron to proton ratio to be equal to one.
Heavier elements like the neutron to proton ratio to be greater than one.
Even numbers of protons and neutrons are more stable than odd numbers of protons and neutrons.
The "magic" (stable) numbers for protons and neutrons are 2, 8, 20, 28, 50, 82, 126.
The "magic" (stable) numbers for electrons are 2, 10, 18, 36, 54, 86 (noble gas configurations.)

Light elements like the neutron/proton ratio to be 1:1.

Ex. 1) For $^{12}_{5}B$ write out the decay reactions for β-, β+, α and e.c. (electron capture).

$^{12}_{5}B \rightarrow ^{0}_{-1}e + ^{12}_{6}C$ **β- reduces the n/p ratio**, getting to/closer to 1:1.
7n:5p (1.4:1) 6n:6p (1:1)

$^{12}_{5}B \rightarrow ^{0}_{+1}e + ^{12}_{4}Be$ **β+ increases n/p ratio**.
7n:5p (1.4:1) 8n:4p (2:1)

$^{12}_{5}B \rightarrow ^{4}_{2}He + ^{8}_{3}Li$ **α increases n/p ratio, but not as much as β+.**
7n:5p (1.4:1) 5n:3p (1.7:1) **It helps large elements, decrease to smaller elements (reduces atomic #, for elements > #84).**

$^{12}_{5}B + ^{0}_{-1}e \rightarrow ^{12}_{4}Be$ **e.c. is the same as β+ emission**.
7n:5p (1.4:1) 8n:4p (2:1)

B-12 really decays by β-.

Ex. 2) How do Mg-21 and Mg-28 decay? (β- or β+)

$^{21}_{12}Mg \rightarrow ^{0}_{+1}e + ^{21}_{11}Na$ Mg-21 really decays by β+.
9n:12p (0.75:1) 10n:11p (0.91:1) It's getting closer to 1:1.

$^{28}_{12}Mg \rightarrow ^{0}_{-1}e + ^{28}_{13}Al$ Mg-28 really decays by β-.
16n:12p (1.3:1) 15n:13p (1.15:1) It's getting closer to 1:1.

Heavier elements like the n/p ratio to be greater than 1, but want their atomic # to get smaller.
(elements greater than #84)

Ac 223 decays by α and e.c.

$^{223}_{89}Ac \rightarrow {}^{4}_{2}He + {}^{219}_{87}Fr$

134n:89p (1.5:1)    132n:87p (1.5:1)

$^{223}_{89}Ac + {}^{0}_{-1}e \rightarrow {}^{223}_{88}Ra$

134n:89p (1.5:1)    135n:88p (1.5:1)

Then    $^{223}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{219}_{86}Rn$

135n:88p (1.5:1)    133n:86p (1.5:1)

***End of Notes***