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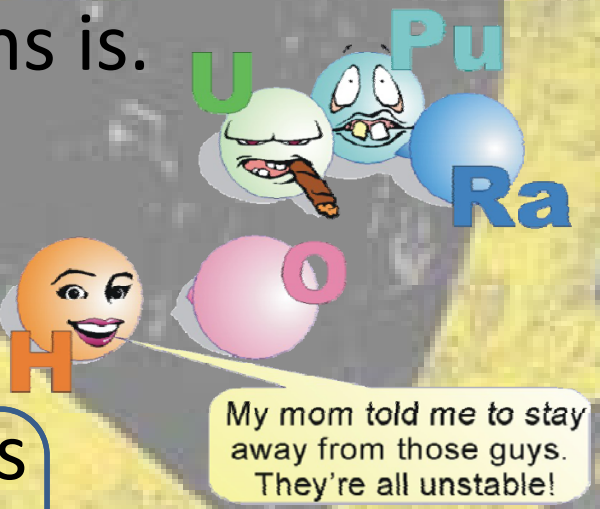
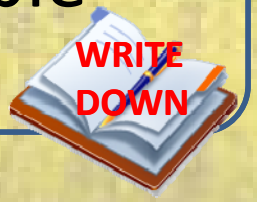
Nuclear Instability

- Protons are all positively charged.
- As a result, protons repel each other.
- The higher the atomic number is, the greater the repulsion among protons is.
- The larger the nucleus, is the more unstable it is.
- As a result:

Atoms with atomic numbers above 82 have no stable isotopes.



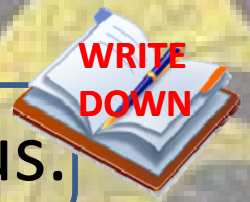


Neutrons to the Rescue

- What is the ratio of neutrons to protons for each of the following:
  - Ca?
  - Zn?
  - Ag?
  - Pb?

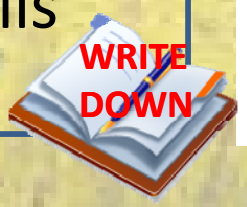
Element	Protons	Neutrons	N/P Ratio
Ca	20	20	1.0
Zn	30	35	1.2
Ag	47	61	1.3
Pb	82	125	1.5

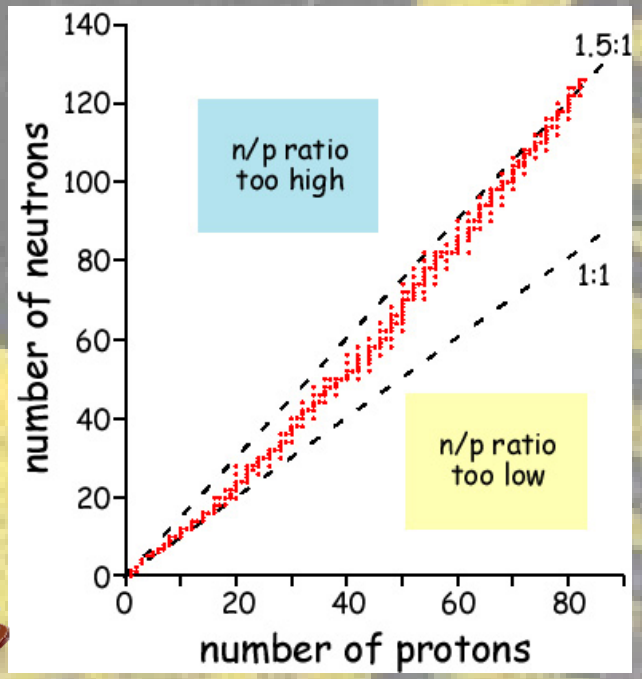
- As the number of protons increases, and the repulsion between them increases, the ratio of neutrons to protons increases.
- Neutrons help to stabilize the nucleus.



The Belt of Stability

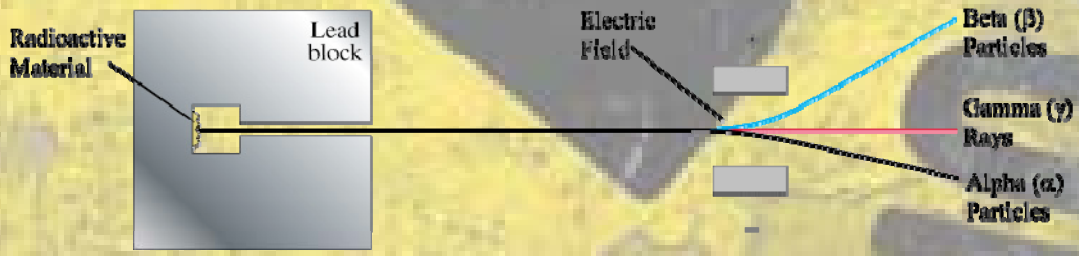
- Hydrogen is the only element that does not have neutrons.
- As the number of protons increases, the number of neutrons needed to keep the nucleus stable increases.
- The ratio of neutrons to protons in stable nuclei is between 1:1 and 1.5:1 (the higher ratio being associated with larger nuclei that have larger repulsive forces).
- Stable atoms have a ratio of neutrons to protons that falls within this belt of stability.





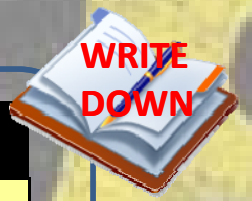
Radioactive Decay

- Unstable nuclei break apart or decay.
- Decaying nuclei release high speed particles and energy called radioactive emissions.
- Radioactive emissions separate in an electric field into three main types.
  - o Alpha particles
  - o Beta particles
  - o Gamma rays



Types of Emissions

- Alpha particle – helium nucleus
- Beta particle – electron emitted from the nucleus when a neutron decays
- Gamma ray – energy
- Positron – same as a beta particle, but with a positive charge



Emission	Charge	Mass	Symbol	
Alpha Particle	+2	4	α	${}^{4}_{+2}He$
Beta Particle	–1	0	β^-	${}^{0}_{-1}e$
Gamma Ray	0	0	γ	γ
Positron Emission	+1	0	β^+	${}^{0}_{+1}e$