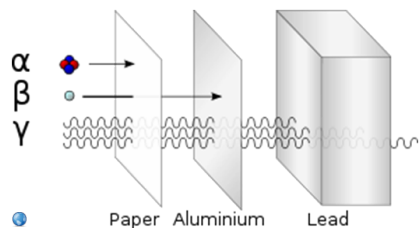


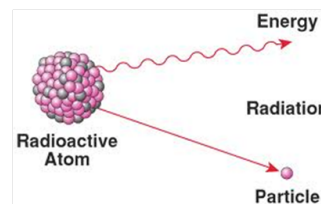
### 3.4 Unstable Nuclei and Radioactive Decay



### Radioactive Decay

Process by which unstable nuclei lose energy by emitting radiation as particles and/or energy.

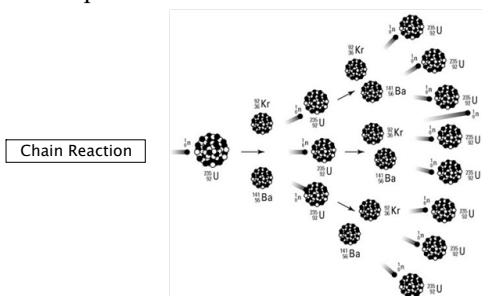
As an atom decays, it forms one or more daughter products, and eventually becomes stable (and radioactivity stops).



### Nuclear Reactions

Reaction involving a change in an atom's nucleus. NOT a chemical reaction.

Balancing: the sum of both atomic and mass numbers must be equal on both sides of the reaction.

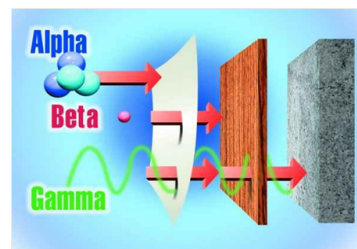


### 3 Types of Radiation

Alpha – stopped by paper.

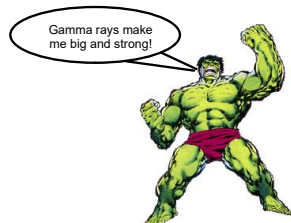
Beta – stopped by 2 cm of wood, or a few pieces of aluminum foil.

Gamma – 1 cm of lead reduces gamma rays by  $\frac{1}{2}$ ; 2 cm by  $\frac{3}{4}$ ; etc.



### Health Assessment:

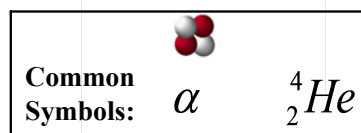
1. Which of the three types of radiation do you think causes the most damage to living tissue and why? Gamma rays can penetrate deeper into a body, but alpha particles have quite a punch when they hit.



### Alpha Particles

Contain two neutrons and two protons: essentially a helium - 4 nucleus (with no electrons).

It carries a + 2 charge.

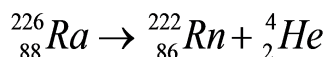


## Chem 3.4 Notes - Unstable Nuclei and Radioactivity.notebook

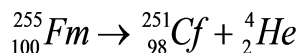
### Alpha Decay Examples

2. Radium-226 decays, emitting an alpha particle. What is the daughter product?

Write an equation: list isotopes in superscript/subscript form, then solve for the daughter.



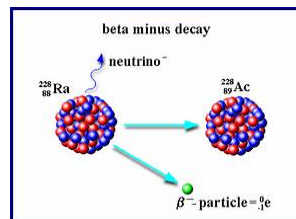
3. What is the parent of this alpha decay?



### Beta Particle: Symbol = $\beta$ or $\beta^-$

Electrons ejected from a nucleus, carrying a charge of  $-1$ .

How can an electron come out of a nucleus?



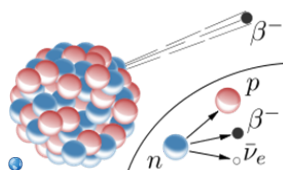
### More on Beta Decay

What happens: a neutron spontaneously changes to a proton, ejecting an electron in the process.

The symbol used in equations is here: atomic number increases by 1; mass number stays the same.

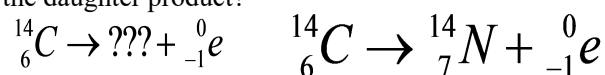
No change in mass number

Gain of a proton

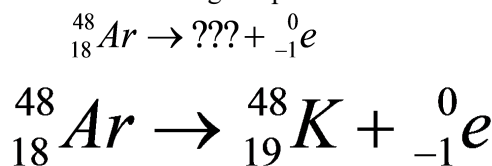


### Beta Decay Examples

4. When carbon 14 undergoes beta decay, what is the daughter product?



5. What is the daughter product?



### Gamma Ray: Symbol = $\gamma$

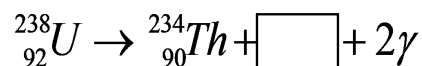
Energetic photon (energy packet): no mass or charge.

Usually accompanies alpha or beta decay; sometimes occurs as nucleons shift.

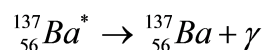


### Gamma Decay Examples

6. Uranium-238 decays to thorium-234, releasing two gamma rays. Write the complete nuclear reaction.



7. Barium-137 undergoes gamma decay without releasing particles.

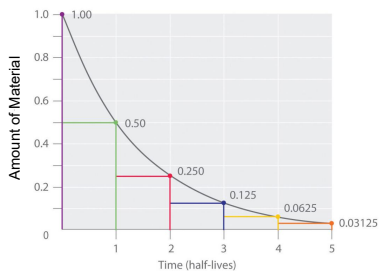


Represented with an asterisk '\*'.

## Chem 3.4 Notes - Unstable Nuclei and Radioactivity.notebook

### Half-Life

**Def:** Time required for 50% of an isotope to decay.  
 Some half lives are long: U-238 = 4.5 billion years.  
 Some are short: Rn-222 = 3.8 days.  
 Carbon-14 = 5730 years: can determine artifact ages up to 60,000 years old.



### Half-Life Calculations

A. Determine number of elapsed half-lives ( $n$ ):

$$n = \frac{\text{total time}}{\text{isotope's half-life}}$$

B. Divide original sample mass thusly:

$$\text{Sample Left Over} = \frac{\text{Original Mass}}{2^n}$$

### 8. Half-Life Example

Radon-222 has a half life of 3.8 days.  
 How much Rn-222 is left after 11.4 days if the original sample is 25.0 grams?

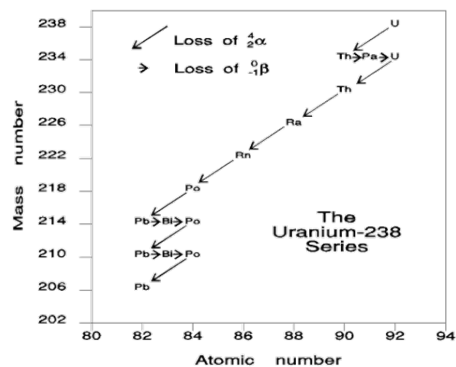
$$n = \frac{11.4 \text{ days}}{3.8 \text{ days / half-life}} = 3 \text{ half-lives}$$

$$\text{Sample Left Over} = \frac{\text{Original Mass}}{2^n} = \frac{25.0 \text{ g}}{2^3} = 3.13 \text{ g}$$

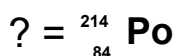
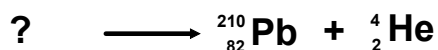
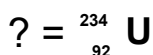
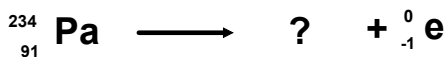
### Nuclear Stability: Decay Series

Unstable isotopes decay until they are stable.

Uranium-238 decays to Lead-206 with a half-life of 4.46 billion years.



### 9. Balance the Following Reactions:



### Homework

3.4 Problems in your Booklet

AND

Unit 3 Review (Page 44)

AND

Isotopes Essential Skills Worksheet P. 44 - 45

**Due: Next Class**

Test Review First Block Day (10/2 or 10/3)

U. 3 Test & Element Quiz 2nd Block Day (10/3 or 4)