Nuclear Chemistry

Nuclear Chemistry

- Nuclear reactions occur when changes are made involving the nucleus – the number of protons and/or neutrons changes
  - When the changes occur spontaneously it is called radioactivity

Nuclear Chemistry

- The half-life is the amount of time it takes for half of an unstable parent material to decay into a stable daughter product
- Example: If you have a 100g sample of C-14, after 5730 years, you would have 50g of C-14 and 50g of N-14, its daughter product

Nuclear Chemistry

- Half-Life Formula

$$A_f = A_i * (2)^{-t/h}$$

A_f is the final amount

A_i is the initial amount

t is the amount of time that has passed

h is the half-life of the substance

Half-Life Example Problems

hl

A_1

1. Yttrium-90 as a half-life 64.1 hours. How much of a 100g sample of Y-90 would remain unchanged after 128.2 hours?

T

$$\frac{128\ h}{64.1\ h} = 2$$

$$\frac{100g}{2} = \frac{50g}{2} = 25g$$

Half-Life Example Problems

2. A sample contains 5g of Ca-45, which has a half-life of 162.6 days. How much calcium-45 did the sample originally contain if it has been 487.8 days?

$$\frac{487.8\ d}{162.2\ d} = 3$$

(5g)2 = 10g

(10g)2 = 20g

(20g)2 = 40g

Half-Life Example Problems

3. What is the half-life of Tc-99 if only 10g remained of a 160g sample after 24 hours?

$$\frac{160g}{2} = \frac{80g}{2} = \frac{40g}{2} = \frac{20g}{2} = 10g \text{ 4 half-lives}$$

$$\frac{24h}{4} = 6h$$

Radioactive Decay

- Alpha Decay
  - Basically a helium nucleus, so it has a positive charge and is attracted to negative electric fields
  - Large, slow, and relatively easy to stop, but an cause burns to the skin
  - Greek Symbol: α
  - Atomic Symbol:

Radioactive Decay

- Beta Decay
  - Basically an electron, so it has a negative charge
  - Small and fast, relatively hard to stop, but usually does little damage
  - Greek Symbol: β
  - Atomic Symbol:

Radioactive Decay

- Gamma Decay
  - Not a particle, just high energy
  - Very fast and extremely difficult to stop, usually requiring thick sheets of lead, and is very dangerous
    - Does not give you Hulk-like powers
  - Usually occurs along with other types of decay
  - Greek Symbol: γ
  - Atomic Symbol:

Balancing Nuclear Reactions Examples

1. What isotope is produced when radium-222 undergoes alpha decay?

$$^{222}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{218}_{86}Rn$$

Radon-218

Balancing Nuclear Reactions Examples

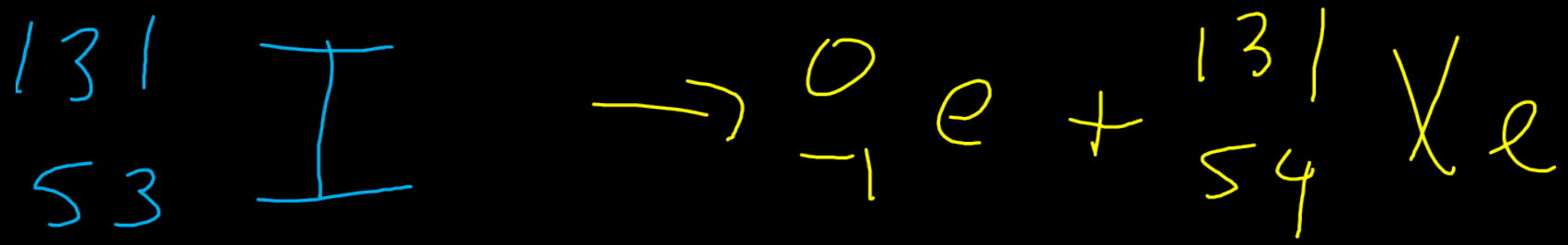
2. What isotope is produced when carbon-14 underdoes beta decay?

$$^{14}_{6}C \rightarrow ^{0}_{-1}e + ^{14}_{7}N$$

Nitrogen-14

Balancing Nuclear Reactions Examples

3. Xenon-131 is the product of the beta decay of what isotope?



Balancing Nuclear Reactions Examples

4. Thorium-234 is the product of the alpha decay of what isotope?

$$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$$

Uranium-238

Balancing Nuclear Reactions Examples

5. How does plutonium-240 become uranium-236?

$$^{240}_{94}Pu \rightarrow ^{236}_{92}U + ^{4}_{2}He$$

Alpha

Nuclear Chemistry

- Nuclear Fission vs. Nuclear Fusion
  - Fission: Splitting of a large nucleus into smaller ones
    - Performed in our nuclear reactors
  - Fusion: Combining of small nuclei into one large one
    - Performed in all stars, including the sun