Unit 3

Chapter 25 Nuclear Chemistry

(Chemistry of the nucleus - forget about electrons for a while)

**Radiation** – rays and particles given off by radioisotopes (Radioisotopes)

**Radioisotope**- radioactive isotope Have thousands of uses! (they can be natural or artificial)

Remember an isotope is the same element (same # of protons or atomic #), different mass (different # of neutrons or different mass #)

Radioisotopes produce radiation that means they are unstable!

Atoms are stable when they have close to a 1 to 1 ratio of neutrons and protons. (Really large nuclei are all unstable) (also means 2:1 mass #/atomic # ratio)

Anything with an atomic number higher than Pb has no stable isotopes.

Using radioisotopes:

|  |  |
| --- | --- |
| Pro’s | Con’s |
| Can detect issues using ‘tracers’ | Can kill healthy cells |
| Can kill cancer cells | Can actually cause Cancer |
| Note: It is helpful to use isotopes with short half lives, and that are quickly eliminated from the body (Drink and pee a lot!) |

KNOW THESE – MEMORIZE THESE!

4 Radioisotopes that may be found on the Regents Exam

Co – 60 Also used to treat cancer

C – 14 Used to date the age of organic materials (Shroud, Lewis and Clark’s campfire)

I – 131 Used to trace Thyroid disorders

U – 238 to lead (Pb-206) disintegration series is used to date rocks (earth)

Naturally occurring radiation types

see table o and write down ALL the symbols in your notes

**Alpha-** α $$

**Beta- β-** $$ **or β+** $$

**Gamma**- γ $$ (high powered light)

The process of transforming an element into a different element is called **transmutation**.

When it happens naturally it is called **natural** **transmutation**

**For Examples of natural transmutation see table n**

**All reactions must obey the law of conservation of charge and law of conservation of mass.**

**Conservation laws – basically means mass and charge can’t be created or destroyed**

**Applying the Concept: What goes in = what comes out**

**Mathematically means: left side = right side**

**In Science we write equations as a before and after….**

**before after**

**(The arrow is verbally stated yields)**

**Radium-226**

**22688Ra 42He + 22286Rn**

**“alpha decay”**

Note: 226 = 4 + 222 (conservation of mass)

And: 88 = 2 + 86 (conservation of charge)

Potassium-42

**“Beta minus decay”**

Potassium-37

**“beta postitve (positron) decay”**

“Gamma decay”

99Tc 99Tc + γ

**Recognizing reactions:**

1. **all natural transmutations have one term on the left of the arrow**

**Artificial Transmutation When a nucleus is bombarded by particles in a lab. (Particle accelerators)**

**147N + 0-1e 146C**

**Target Bombarding with beta minus…**

**(electron capture)**

**Fission (is division)** Splitting a larger nucleus into smaller ones (artificial)

10[n](http://en.wikipedia.org/wiki/Neutron) + 23592U → 14156[Ba](http://en.wikipedia.org/wiki/Barium) + 9236[Kr](http://en.wikipedia.org/wiki/Krypton) + 3 10n + **ENERGY**

**Fusion** combining smaller nuclei into a larger one

Artificial in atomic bombs / natural on the sun (star)

31H + 21H 42He + 10n + **MORE ENERGY**

**Half life –**

Is the amount of **time**

For ½ of any radioisotope to decay into another element

(Decay = Transmutate)

(you have been writing these reactions)

**example:**

**22688Ra 42He + 22286Rn**

**(This is the decay of Ra into Rn)**

See Table N:

Tip: find the number of half lives THEN use ‘common sense’ to multiply or divide.

Ways to determine half lives

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # of half lives | Fraction of initial mass | % of initial mass | Example for Mass remaining: initially 200. g in the sample | CalculatingTime elapsed | For example: if the half life is 2.20 daysTime elapsed: |
| 0 | 1 | 100% | 200 | 0  | 0 |
| 1 | ½ | 50% | 100 | 1 x half life | 2.20 days |
| 2 | ¼ | 25% | 50.0 | 2 x  | 4.40 |
| 3 | 1/8 | 12.5% | 25.0 | 3 x  | 6.60  |
| 4 | 1/16 | 6.25% | 12.5 | 4 x  | 8.80  |
| 5 | 1/32 | 3.125 | 6.25 | 5 x | 11.0 |
| 6 | 1/64 | Etc… | 3.13 | 6 x | 13.2 |

|  |  |  |
| --- | --- | --- |
|  | Pro’s | Con’s |
| Fission | Produces millions of times more energy than chemical reactions | Produces radioactive wastes (isotopes) with long half lives (where do we store it?) |
|  | Requires no use of fossil fuels (no air pollution) | Small possibility of melt downs / natural disasters |
|  | Safer than mining has historically been | Increases water temperature of nearby bodies. |
| Fusion | Produces even more energy than fission | Too high pressure and temperature to be contained  |
|  | More readily available fuel (hydrogen isotopes) | “cold” fusion is too costly |
|  | Virtually no waste |  |
| Note: remember both nuclear fission and fusion convert a very very small amount of mass into energy according to E=mc2. C = 300,000,000! |

**Penetrating power**



Pb

**Smaller particles penetrate better**

**Alpha- α** $$ **least penetrating**

**Beta- β-** $$

**Gamma- γ** $$ **most penetrating**