1. Make a K-W-L Chart about atoms

Know	**W**ant to know	**L**earned

Bellringer:

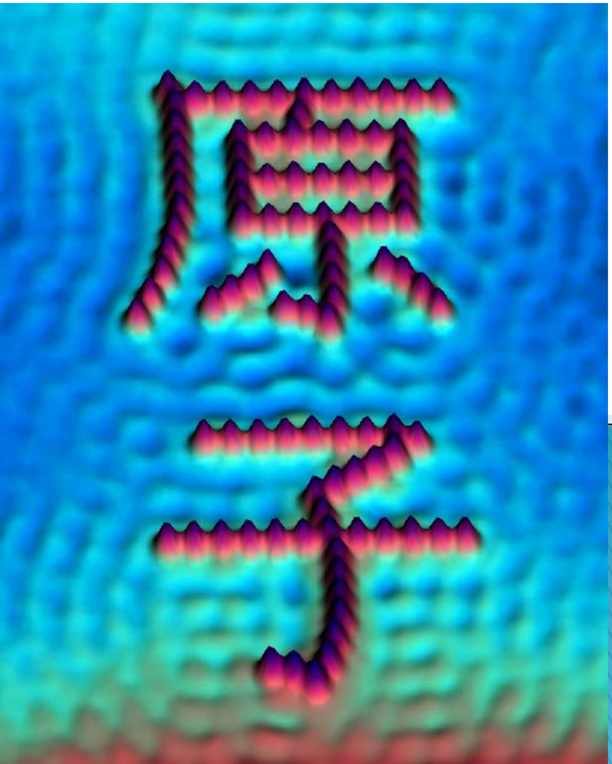
You have an ELEMENT QUIZ today!

1. Write down as many of your elements as you can without looking.
2. Quiz your neighbor!
3. STOTD

Friday: **ELEMENT QUIZ**, Start Unit 2: The atom

Atomic Structure and Nuclear Chemistry

Chapters 3 and 22

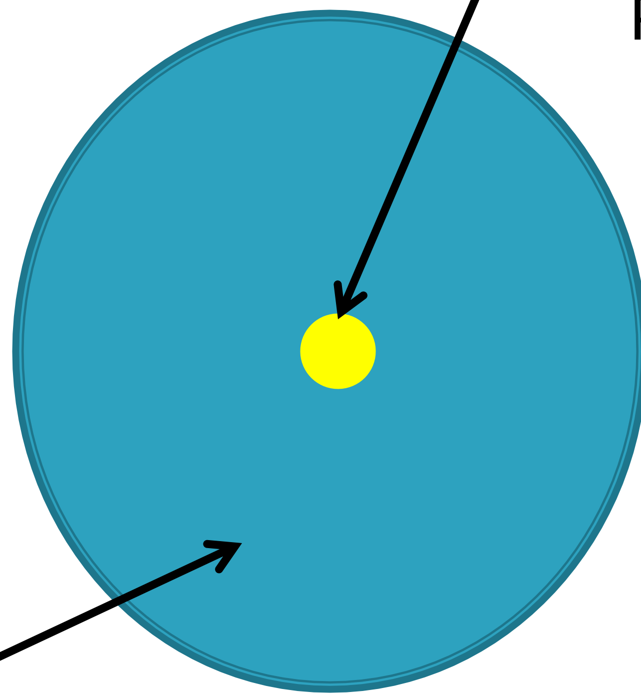


Atomic Structure

- <u>Atom</u>
  - The smallest particle of an element that retains the chemical properties

•<u>Nucleus</u>

- •Contains Protons and Neutrons
- •Small, Dense, and Positive



•Electron Cloud

end

Atomic Structure

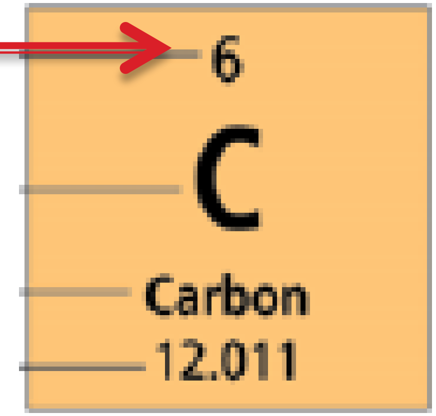
Particle	Symbol	Location	Relative Charge	Relative Mass (amu)	Change in Number
Electron	e^- $^{0}_{-1}e$	Outside the nucleus	-1	~1/2000 0	Ions
Proton	p^+ $^{1}_{1}H$	Nucleus	+1	1	Elements
Neutron	n^0 $^{1}_{0}n$	Nucleus	0	1	Isotopes

1 amu (atomic mass unit) = 1.661×10^{-27} kg

end

Counting Atoms

- Atomic Number
  - **Number of Protons**
  - Defines an element
  - Whole number on the periodic table



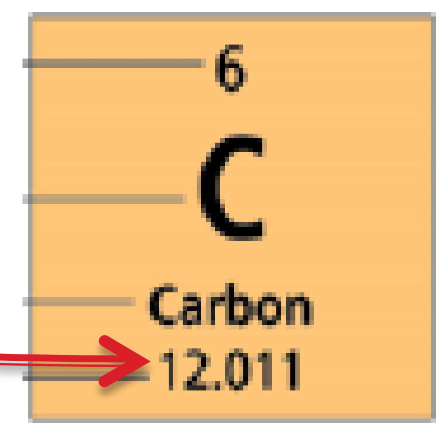
- Mass Number
  - Mass #= (protons) + (neutrons)
  - Different for each isotope
  - **NOT found on the Periodic Table!!!**
- Isotopes
  - Atoms of the **same element with different masses**
  - Different numbers of neutrons
  - All elements exist as a mixture of isotopes

**Phet Simulation

end

Counting Atoms

- The **Atomic Mass Unit (amu)** was created to measure the mass of p^+, n^0, and e^-.
  - 1 amu = 1/12 the mass of a carbon-12 atom
    - 1.661×10^{-27} kg
- Average Atomic Mass
  - Weighted average of atomic masses of all isotopes of an element
  - FOUND ON THE PERIODIC TABLE!!!



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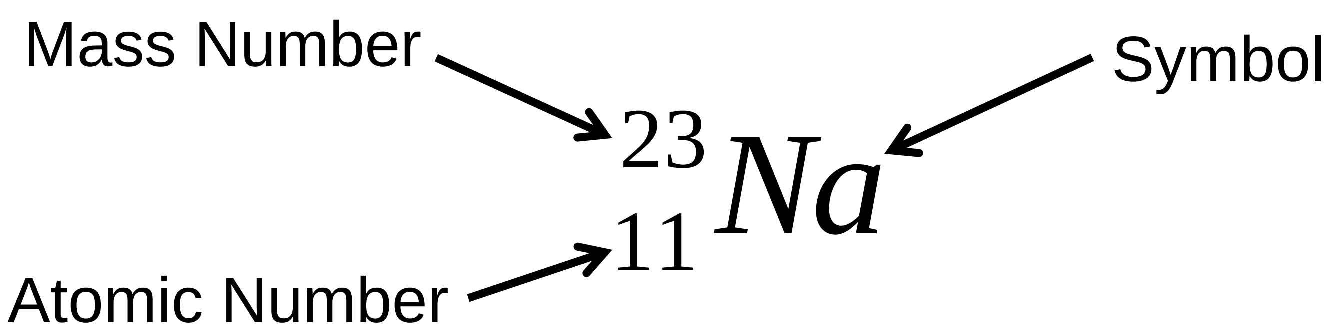
Counting Atoms

- 2 ways to identify isotopes
  1. Hyphen Notation
     - **Name – Mass #**
     - Example: Carbon– 12
     - Example: Carbon– 14
  2. Nuclear Notation
     - Helpful to find the number of neutrons



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Counting Atoms

Name	Symbol	Protons	Neutrons	Electrons	Atomic Number	Mass Number
Chlorine-37						
	$^{136}_{55}Cs$					
		76				186
			115		76	

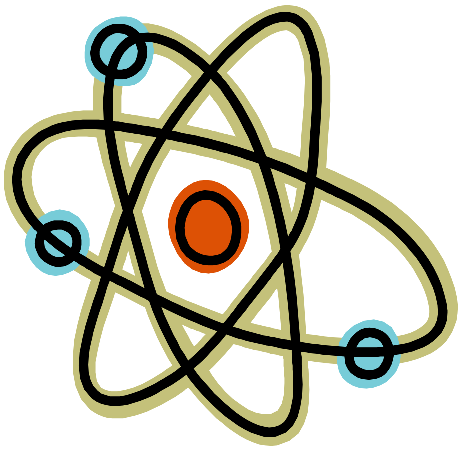
1. I have 25 protons and 23 neutrons. What atom am I?
2. I have a mass number of 238 and 146 neutrons. How many protons do I have? What element am I?
3. I have 20 protons and 20 neutrons. What atom am I?

Refer to Bellringer

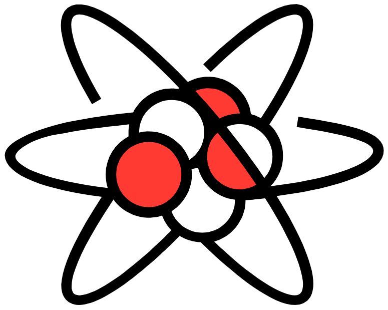
- Now you can fill out the “L” portion of the KWL chart about atoms

Reviewing Atomic Structure

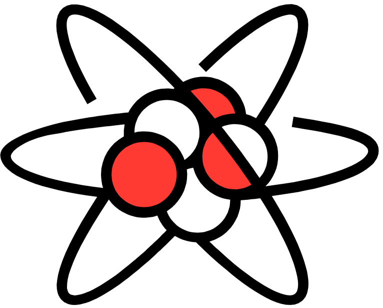
- Atoms are made up of 3 particles
  - Protons, Electrons, and Neutrons
  - Called **subatomic particles**



- The Nucleus
  - Small, dense region in the center of an atom
  - Contains:
    - Protons and Neutrons
    - All of an atom's positive charge
    - Almost all of an atom's mass.



Reviewing Atomic Structure

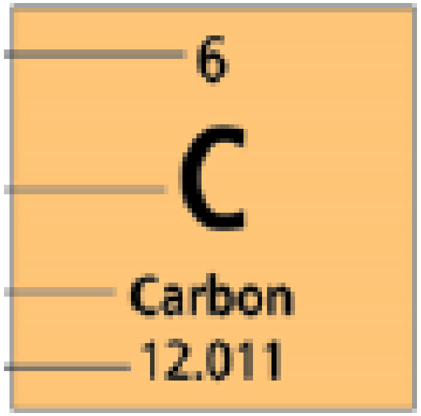


- **Proton (p^+)**
  - Charge of +1
  - Found inside the nucleus
  - Mass of 1amu (same as a neutron)
  - The number of protons defines an element
    - **Change the # of protons and you get a different element**
- **Neutron (n^0)**
  - No charge
  - Found inside the nucleus
  - Mass of 1 amu (same as a proton)
  - The number of neutrons controls the isotope
    - **Change the # of neutrons and you get different isotopes**
- **Electron (e^-)**
  - Charge of –1
  - outside the nucleus
  - Mass ~ 0 amu
  - The number of electrons controls the electrical charge
    - **Change the # of electrons and you get a charge (an ion)**

Reviewing Atomic Structure

- Atomic Number
  - The **number of protons**
    - This defines each element
  - **Equals the number of electrons** in a neutral atom
- Mass Number
  - The **relative mass** of each atom

  Mass # = (Atomic #) + (# of neutrons)



- Isotopes
  - Atoms of **the same element**
  - With **different numbers of neutrons**
    - Which means **different mass numbers**
- All elements have isotopes
- Elements occur naturally as a mixture of isotopes
- Average Atomic Mass
  - **Weighted average mass** for all isotopes of each element
  - **NOT the same as the Mass Number**

Bellringer: 2/14/2017

1. Describe the 3 subatomic particles in terms of location, Charge, and Mass
2. Write Nitrogen-15 in Nuclear Notation. Then determine the following:
   a) Atomic Number
   b) Number of Electrons
   c) Number of Neutrons
   d) Mass number

3. STOTD

Updates:

Tuesday: Average Atomic Mass with Activity

Wednesday: Nuclear Chemistry; **PBIS Celebration 4th period**

Thursday: Nuclear Chemistry; **Academic Celebration 4th period**

Friday: Half-life Activity; **½ day of school**

Counting Atoms

- Average Atomic Mass
  - Weighted average of all isotopes of an element
    - FOUND ON THE PERIODIC TABLE!!!
  - Tells which isotope is more abundant
    - Chlorine's avg. atomic mass = 35.45 amu
      - Which isotope is more abundant: Cl-35 or Cl-37?
    - Sodium's avg. atomic mass = 22.99 amu
      - Which isotope is more abundant: Na-23 or Na-22?

end

**Honors: Counting Atoms

- To Calculate the Average Atomic Mass:
  - Multiply the **Mass** (in amu's) by the **abundance** for each isotope
  - Add the products together

Isotope	Mass	Abundanc e	Average Atomic Mass
^{63}Cu	62.930	69.17%	63.546
^{65}Cu	64.928	30.83%	

end

**Honors: Counting Atoms

Ge-70	69.924	21.23	72.59
Ge-72	71.922	27.66	
Ge-73	72.923	7.73	
Ge-74	73.921	35.94	
Ge-76	75.921	7.44	

end

**Honors: Counting Atoms

Isotope	Mass (amu)	Relative abundance
^{69}Ga	68.926	60.108%
^{71}Ga	70.925	39.892%

Isotope	Mass (amu)	Relative abundance
^{36}Ar	35.97	0.337%
^{38}Ar	37.97	0.063%
^{40}Ar	39.96	99.6%

end

BEANIUM!!!

Bellringer:

- Calculate the average atomic mass for:

Isotope	Mass (amu)	Relative abundance
^{36}Ar	35.97	0.337%
^{38}Ar	37.97	0.063%
^{40}Ar	39.96	99.6%

- STOTD

Bellringer:

- Calculate the average atomic mass for:

Isotope	Mass (amu)	Relative abundance
^{69}Ga	68.926	60.108%
^{71}Ga	70.925	39.892%

- STOTD

Bellringer:

1. Compared to the charge and mass of a proton, an electron has:
   A. The same charge and a smaller mass
   B. The same charge as the same mass
   C. An opposite charge and a smaller mass
   D. An opposite charge and the same mass.
2. Which symbols represent atoms that are isotopes?
   A. C-14 and N-14
   B. O-16 and O-18
   C. I-131 and I-131
   D. Rn-222 and Ra-222

3. Write I-131 in nuclear notation.

4. How many protons, neutrons and electrons does C-14 have?

5. What is the mass number of an atom that has 31 protons, 31 electrons, and 30 neutrons?

What element is this?

What isotope is this?

Nuclear Chemistry

Chemistry Honors

- In Nuclear Chemistry:
  - Atoms are called **Nuclides**
  - The protons and neutrons are referred to as **Nucleons**

  - Why? Because the only thing that Nuclear Chemists care about is the NUCLEUS

What is Nuclear Chemistry??

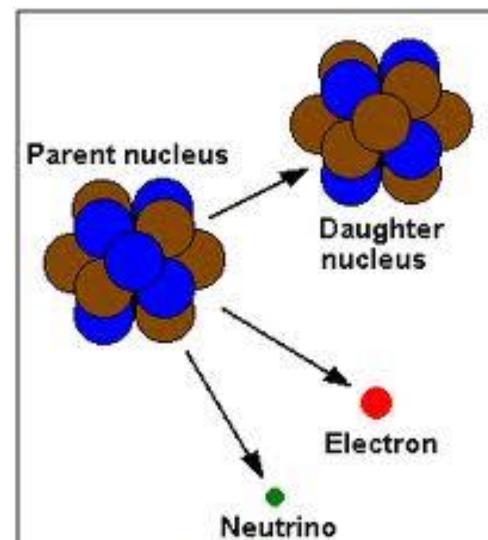
- The study of the **nucleus** of an **atom**

- Nuclear Chemistry is all about the stability of the nucleus

- **Stable nuclei**: have even numbers of (protons and neutrons)
- **Unstable nuclei**: have uneven numbers of p^+ and n^0, these nuclides must go through nuclear radiation

Nuclear Chemistry

- Nuclear Reaction
  - Reactions that change the nucleus (**Transmutation**)
    - Remember: Change # of protons = New Element!
- Radioactivity
  - Spontaneous emission of radiation
- Radiation
  - Rays and particles that are given off



Beta decay

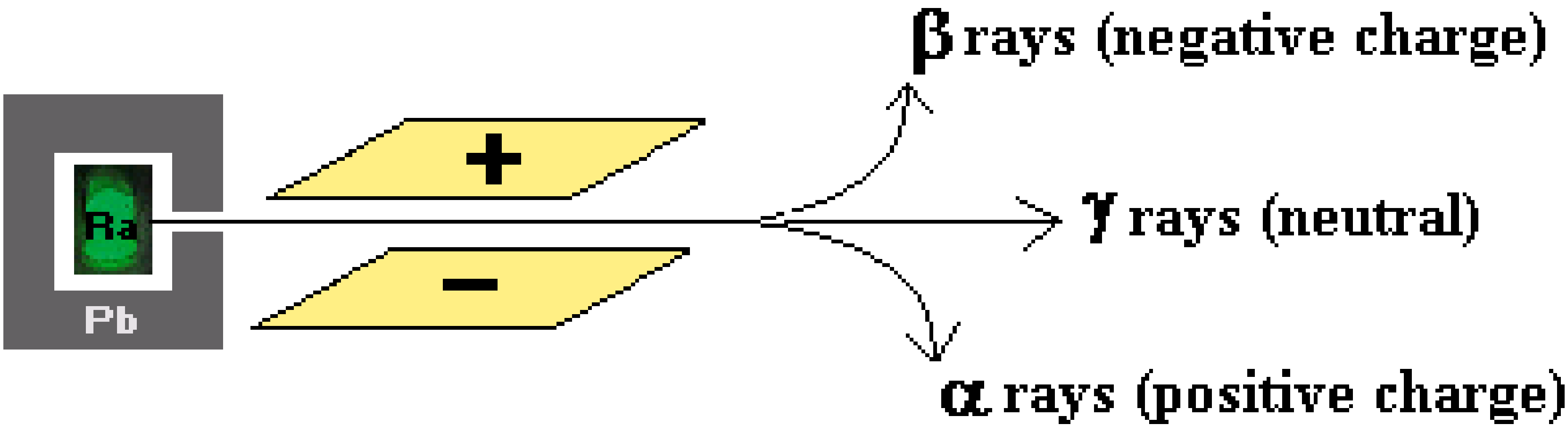
end

Bellringer:

1. How do subatomic particles relate to the periodic table?
2. How do you identify isotopes?
3. How are mass number, number of neutrons, and isotopes related?
4. STOTD

Nuclear Chemistry

- Three types of radiation:
  1. Alpha
  2. Beta
  3. Gamma



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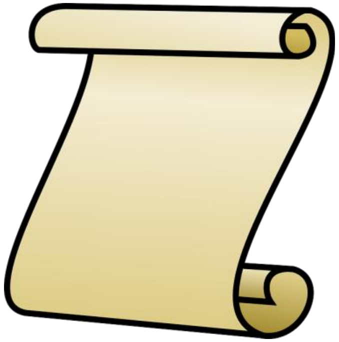
Types of Nuclear Radiation

- Alpha (α) Particle
  - Given off during when both protons and neutrons need to be released (Heavy elements ONLY)
  - Made of 2 p^+ and 2 n^0
    - Charge = 2+
    - Mass = 4 amu
    - AKA The Nucleus of Helium!!!
  - Written as either: α or ${}^{4}_{2}He$
  - Least penetrating (weakest)
    - Stopped by paper or clothing



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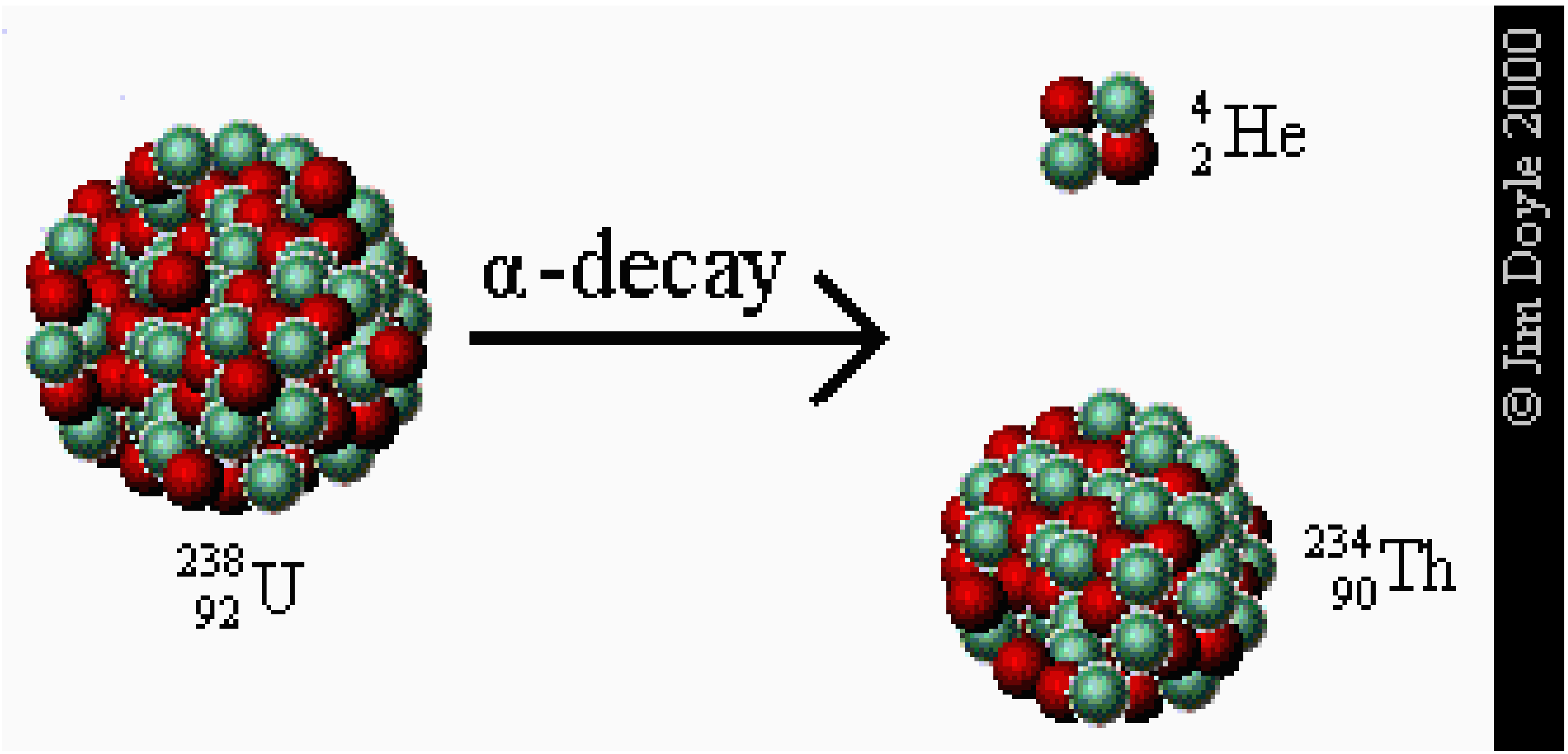
Alpha Decay

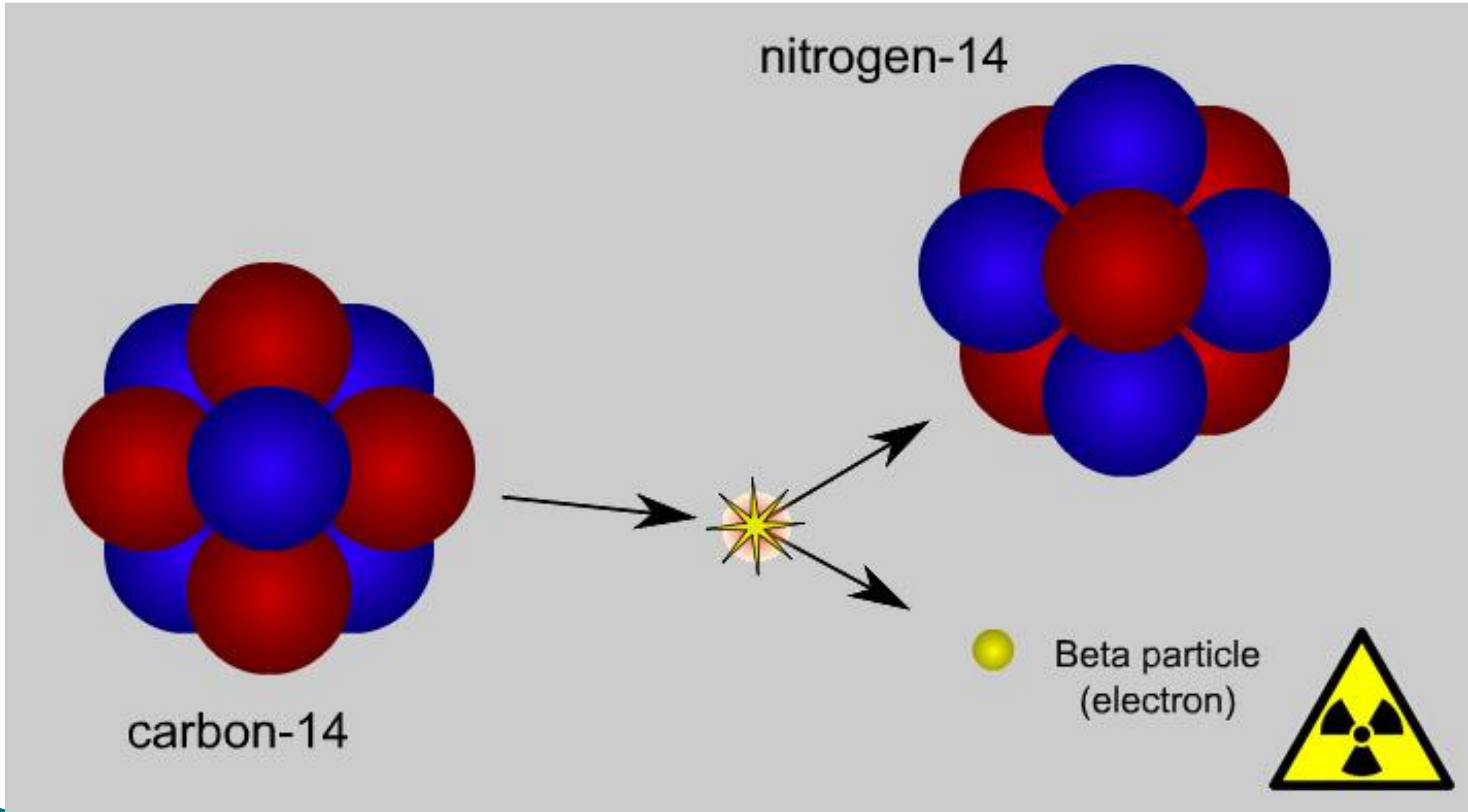


Types of Nuclear Radiation

- Beta (β) Particle
  - Given off when there are too many neutrons in the nucleus
  - Given off as an Electron!!!
    - Charge = 1-
    - Mass = 0
  - Written as either: ${}^{0}_{-1}e$ or β
  - Stopped by a thin sheet of metal
    - Al foil

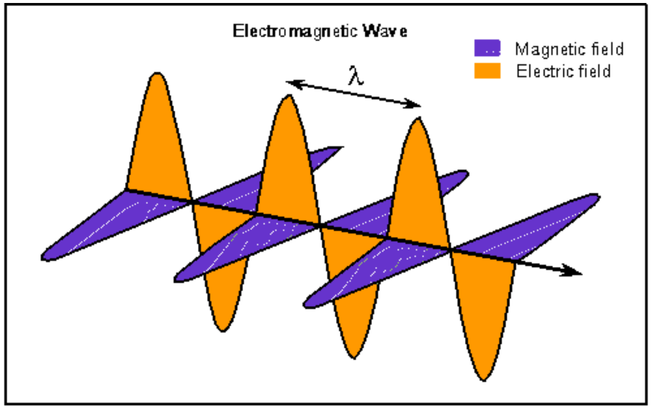
end

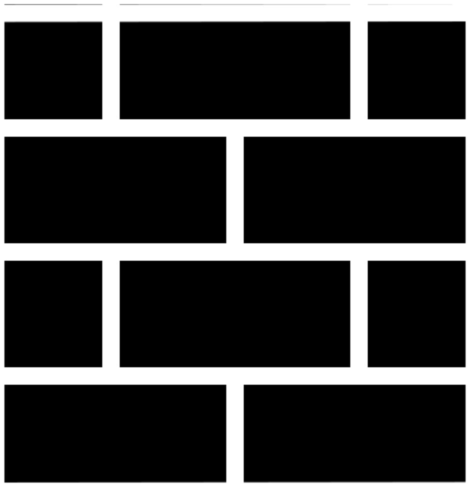
Beta Decay



Types of Nuclear Radiation

- Gamma (γ) Ray
  - Produced during all nuclear decay
  - High Energy Electromagnetic Wave (Light)
    - No particles
    - Charge = 0
    - Mass = 0
  - Written as:
  - Most penetrating
    - Stopped by several meters of lead or concrete
  - DOES NOT CREATE A NEW ELEMENT!





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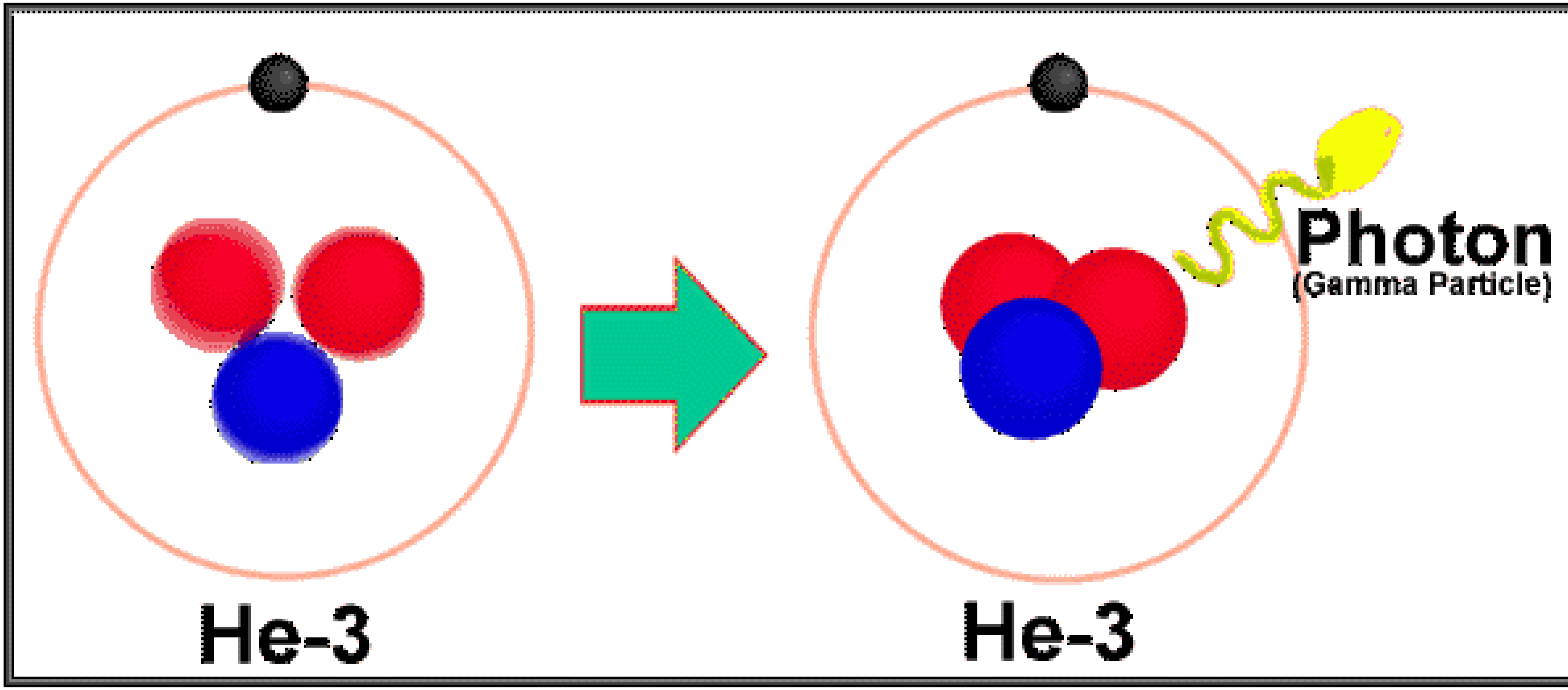
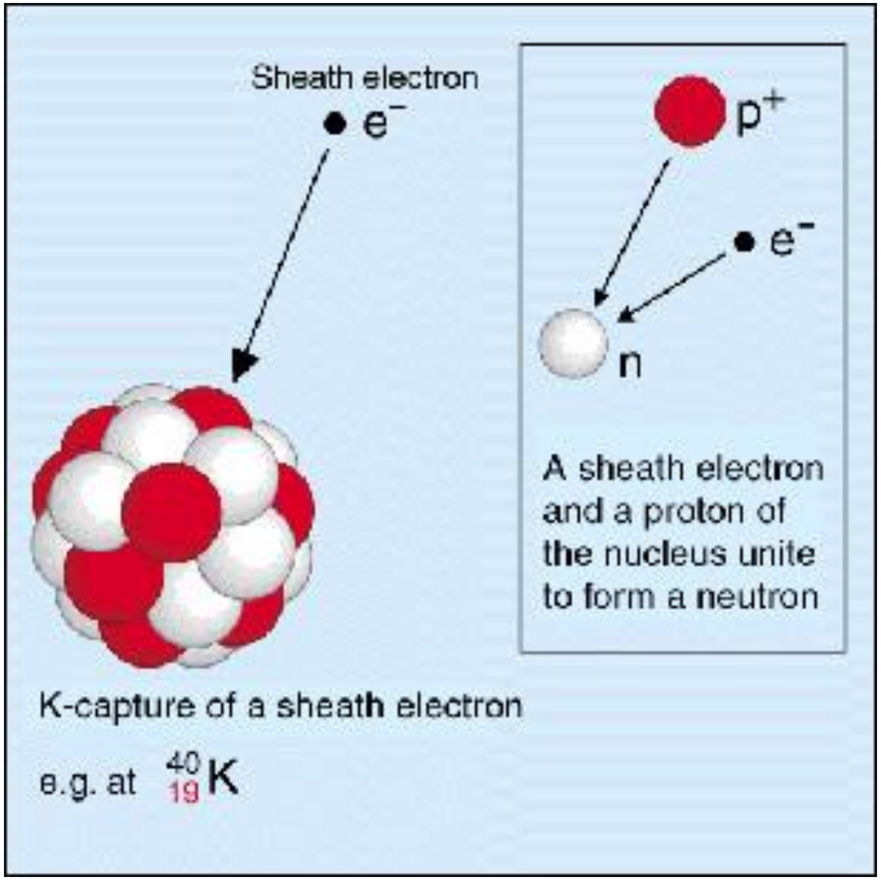
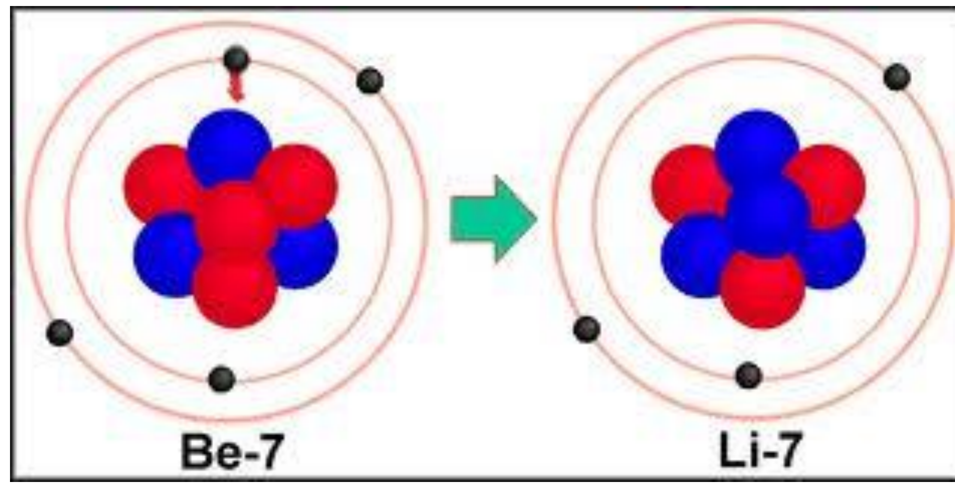
Gamma Decay



Chemistry Honors





Nuclear Equations

1. Shows the break down of a radioactive element
2. Includes the atomic number and the mass number
3. The total mass number and atomic number must be equal on each side of the equation
4. Remember Nuclear Notation??

Bellringer:

1. How can you determine the number of protons an element has?
2. How can you determine the number of neutrons an element has?
3. An atom has 11 protons and 12 neutrons.
   a) What element is this?
   b) Write this isotope in hyphen notation
   c) Write this isotope in nuclear notation
4. STOTD

** You will need a calculator for today.

Nuclear Reactions

- Nuclear Equations
  - Shows the transmutation
  - Total Mass Number and Total Atomic Number **must be equal** on each side of the equation

$$^{94}_{41}Nb \rightarrow ^{0}_{-1}\beta + ?$$

$$^{210}_{82}Pb \rightarrow ^{4}_{2}He + ?$$

$$^{135}_{53}I \rightarrow ? + ^{135}_{54}Xe$$

$$^{237}_{93}Np \rightarrow ? + ^{233}_{91}Pa$$

end

**Honors: Practice Problems:

1. $^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P +$ _____
2. $^{99}_{43}Tc \rightarrow$ _____ $+ ^{0}_{-1}e$
3. $^{37}_{19}K \rightarrow$ _____ $+ ^{0}_{+1}e$
4. $^{6}_{3}Li + ^{1}_{0}n \rightarrow ^{0}_{-1}e + ^{4}_{2}He +$ ____

Chemistry Honors

- There are a 3 other types of radiation you need to know!

1. Positron
   a) Released to decrease the number of p^+
   b) Mass of 0
   c) +1 charge
   d) Written as: $^{0}_{+1}e$

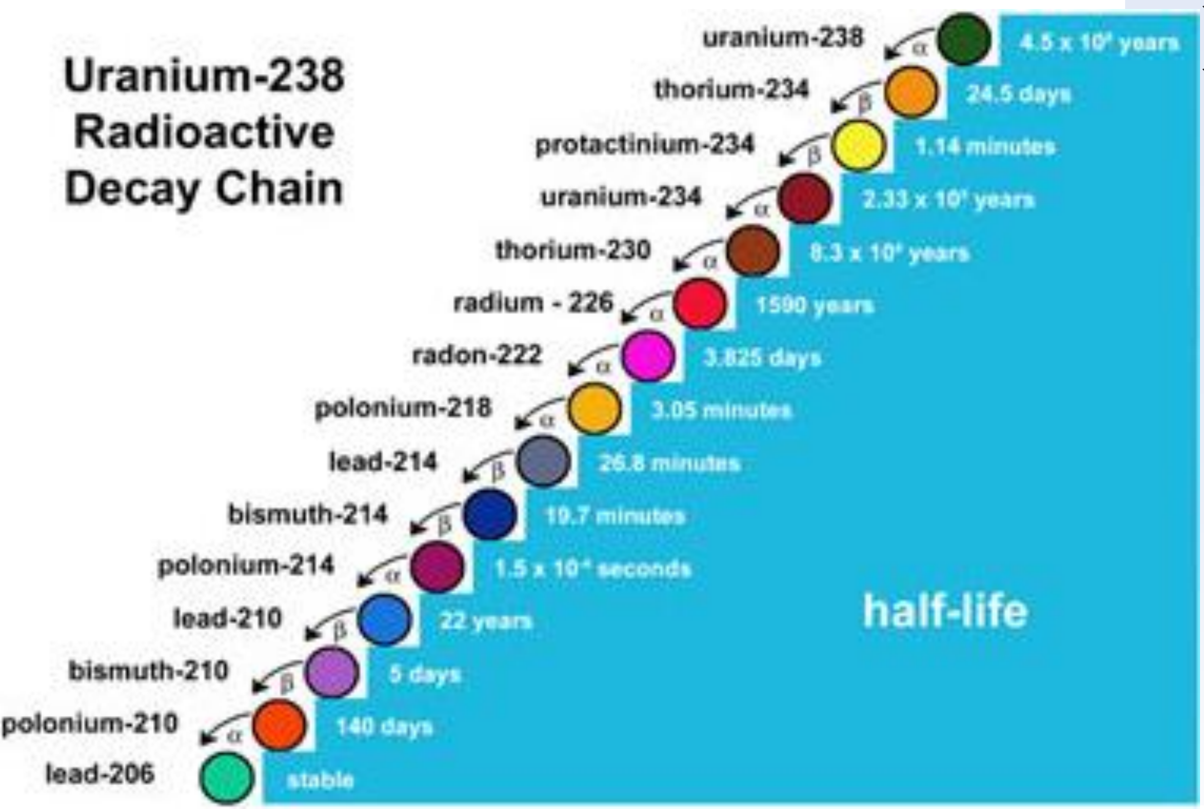
2. Neutron

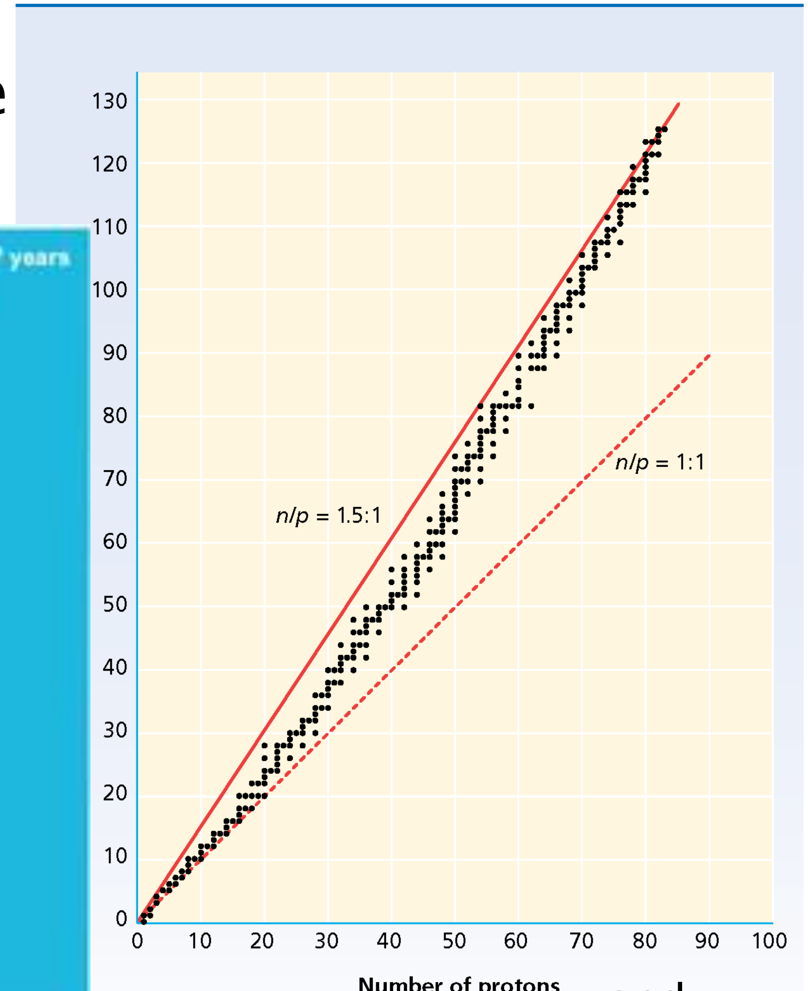
   Written as: $^{1}_{0}n$

3. Electron Capture: inner core electron is pulled into the nucleus and combines with a proton to become a neutron

Radioactive Decay

- Radioactive isotopes decay to become more stable
  - Change the n^0 to p^+ ratio
  - Continues until nucleus is stable





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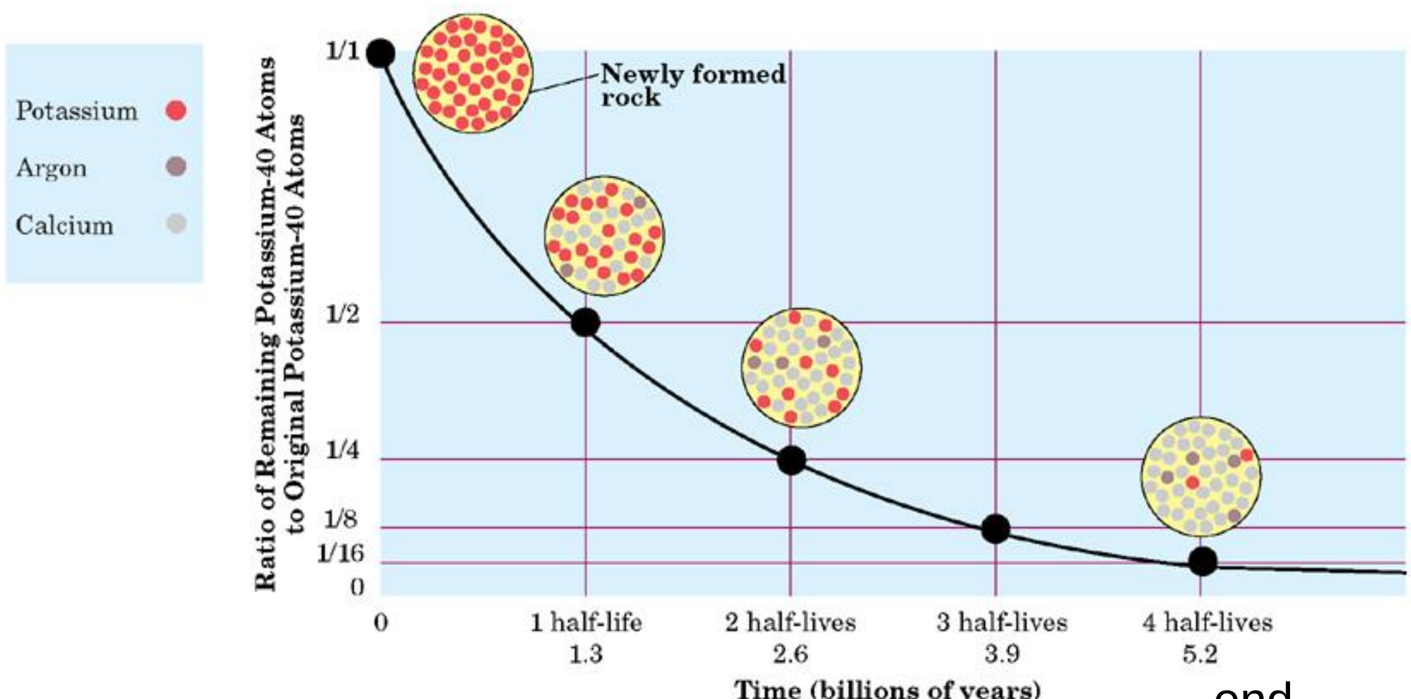
Radioactive Decay

- Half-life
  - Rate of Decay
  - The time for half of the nuclei to decay
  - Random event that CANNOT be CHANGED!!!



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Formulas for Half-lives

When given number of half lives:

$$\frac{Initial}{Final} = 2^n$$

- n = # of half-lives
- Initial mass
- Final mass

- *When looking for number of half lives:*

- $n = \frac{\ln(\frac{inital}{final})}{\ln(2)}$

Radioactive Decay

1. If you had 25 g of gold-198 how much is left after it has gone through 12 half-lives?

2. You have 10.0 g of francium-210. How many half-lives must pass for 8.00 g to be left?

3. If you start with 200.0 g of Pu-239 and there are 3.125 g left, how many half-lives have passed?

end

1. $^{37}_{19}K \rightarrow$ _____ $+ \, ^{0}_{-1}e$

2. If you start with 200.0 g of Pu-239 and there are 3.125 g left, how many half-lives have passed?

Radiochemical Dating

- Half-lives and % abundance allow us to date objects
  - The estimated age determines which isotopes are examined

Polonium-215	0.0018 seconds
Sodium-24	15 hours
Iodine-131	8.07 days
Carbon-14	5730 years
Uranium-235	704,000,000 years
Uranium-238	4,470,000,000 years

end

Bellringer:

1. $^{99}_{43}Tc \rightarrow$ _____ + $^{0}_{-1}e$
2. $^{6}_{3}Li + ^{1}_{0}n \rightarrow ^{0}_{-1}e + ^{4}_{2}He +$ ____
3. How do you identify the type of radiation that took place in a nuclear decay chemical reaction?
4. How do you determine the half-life of a radioactive isotope?
5. STOTD

Fission vs. Fusion

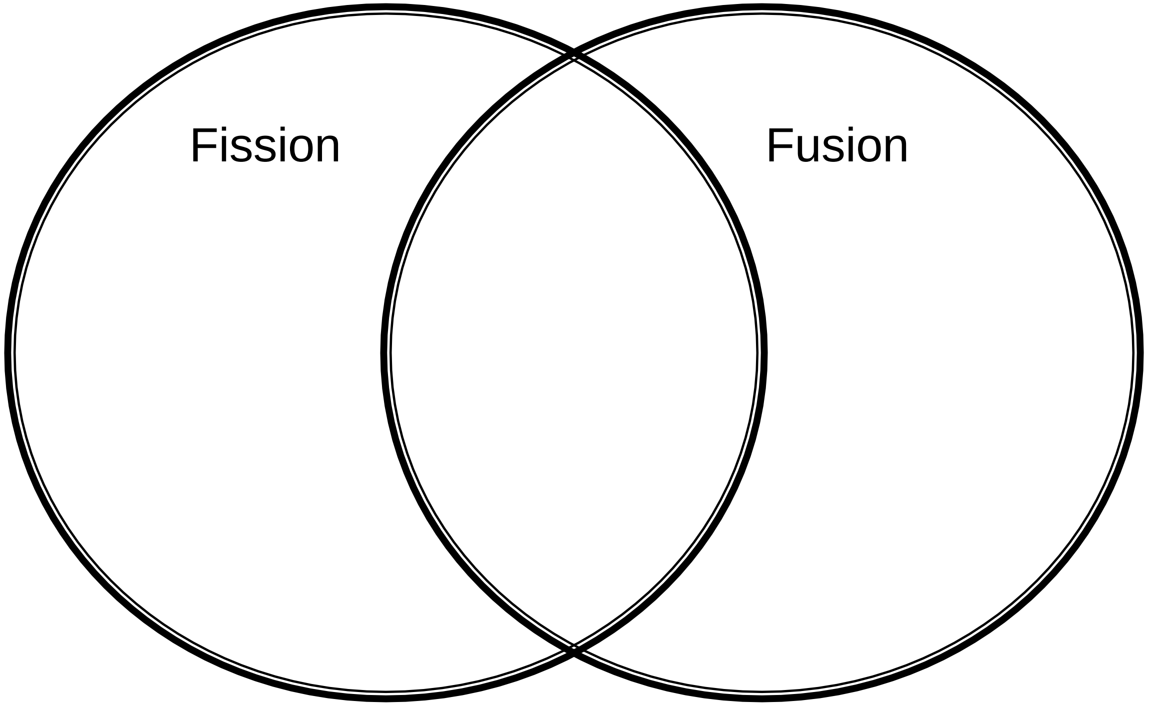
- p^+ are held in the nucleus by a strong Nuclear Force
  - Pulling them apart releases a lot of energy
- Fission
  - Splitting of a nucleus into fragments
  - Used in nuclear power plants and nuclear weapons
  - 1 kg of U-235 = 17,000 kg of coal!!!

Fission vs. Fusion

- Fusion
  - Combining to form larger nuclei
  - Products are generally NOT radioactive
  - Used in the Stars and in H-Bombs

Bellringer:

1. Make a Venn Diagram to compare and contrast Fission and Fusion. Have a minimum of two facts for each.



2. STOTD

Bellringer:

1. Write an equation for the alpha decay of Uranium-238

2.

Isotope	Mass	Abundance	Average Atomic Mass
^{63}Cu	62.930	69.17%	
^{65}Cu	64.928	30.83%	

3. STOTD

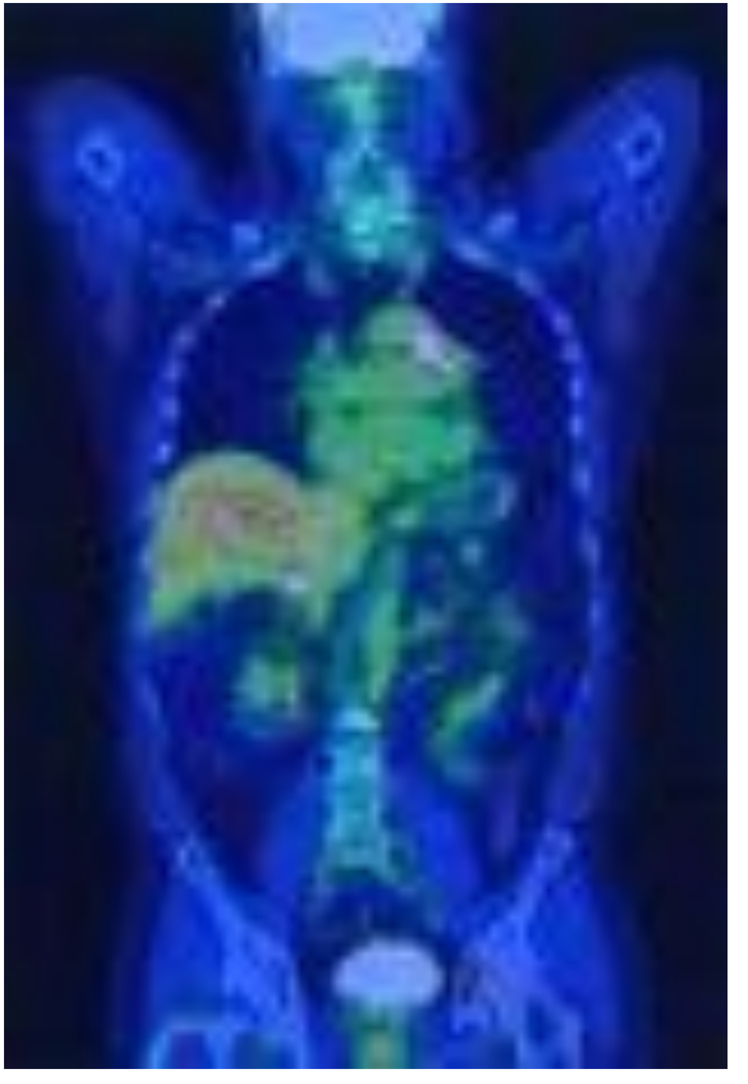
Radiation Detection

- Film badge
  - Wear on your clothes
  - If it changes color you run!
- Geiger counter
  - Detects ionizing radiation
  - Creates an electrical current
- Scintillation counter
  - Detects scintillating light
  - Produces an electrical current

end

Uses for Radiation

- Medical Radiotracers
  - Track movement inside the body
  - PET scans
- Cancer therapy
- Identification of substances
- Power
- Chemical Radiotracers
- Sterilization



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Effects of Radiation

- Effects depend on:
  - Type of radiation
  - Distance from source
  - Time exposed
  - Type of tissue
- The average yearly radiation exposure ~360 **mrem**/year
- Effects are seen when exposed to >5 rem/year

end