Name: _____ Date: _____

Unit 13 - Topic 3

Nuclear Instability & Radioactive Decay

Sources of Nuclear Radiation

To date, 118 elements have been observed (atomic numbers 1-118). Of those, only the first 92 elements occur in nature. The rest are the result of nuclear reactions in power plants or super-accelerators. Certain isotopes are more stable than others.

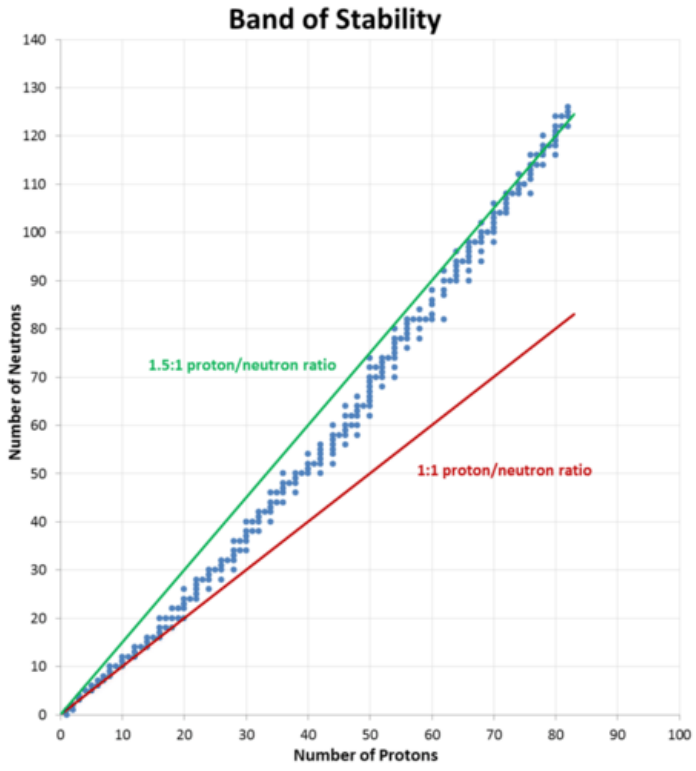
Their stability is determined by the ratio of the number of neutrons to the number of protons in the nucleus. At low atomic masses, the stable ratio is approximately **1:1**. At about an atomic mass number of 20 this starts to increase until it is around **1.5:1** for the very heavy elements. This is due to the fact that with higher numbers of protons more neutrons are needed due to the repulsion of the protons from electrostatics. The details of this are a matter of high energy physics and there are many "rules" for predicting stability. Here is it useful to know that 1:1 is stable only below Z=20 and that after that the stable nuclei become neutron rich.

This ratio is not exact but represents a "band of stability" around which unstable isotopes cluster. There are a large number of unstable isotopes both above the band (too high a number of neutrons) and below the band (too high a number of protons).

At some point there are no longer any stable isotopes regardless of the neutron to proton ratio. This can be seen at very high atomic numbers. Above mass 208 there are no stable isotopes.

Look up the atomic number (Z) on the Periodic Table. Subtract the atomic number from the mass number (A) to get the number of neutrons (N).

Lead-206
A = 206
Z = 84
N = A – Z = 122
N/Z = 122/84 = 1.45
This is a stable isotope.



Name: _____ *Date:* _____

1. Investigate how the balance of neutrons (N) and protons (Z) in the nucleus influences the stability of an atom by using the simulation at https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html to build the atoms shown in the table. Determine whether each of the isotopes below is stable or unstable by first determining the N/Z ratio.

Element	N/Z Ratio	Stable or Unstable?
^{3}H		
^{14}N		
^{14}O		
^{97}K		
^{206}Pb		
Cesium-137		
Calcium-42		
Gold-198		
Chlorine-35		
Radium-226		
Uranium-238		

2. Why are all elements with atomic numbers above 82 unstable?

_____

_____

_____

_____

3. What is radioactivity? _____

_____

_____

4. What are three common types of radioactivity given off by unstable atoms? How are they different?

_____

_____

_____

_____

Fill in the following Table. The objective of this exercise is to learn the material. Use the information from the text, p. 800-802 and/or the ChemComm book, p. 438-440.

	Alpha	Beta	Positron	Gamma
Greek Symbol (Table O)				
Mass Number				
Atomic Number				
Chemical Symbol (Table O)				
Electrical Charge				
Energy (realitiely high or low?)				
Ability to Damage Human Tissue				
Penetrating Ability				
Can be blocked by:				

<u>Study the diagram on p. 800 of your textbook</u>
The type of radiation can be determined by the response of the radiation when it is passed through an electrical field.

1. Positive electrical charge is _____ (*attracted or repelled?*) by negative charge.

2. Sketch the picture from p. 800 below. ***<u>You need to really know this diagram!!</u>***

3. On your sketch, draw the path that a positron would take. Would it be deflected more than or less than an alpha particle? _____ Why? _____