<u>Radioactive Decay – Tutorial</u> Chapter 4.4
Std 11c,d

The goal of this tutorial is to give you a solid understanding of the process of radioactive decay and to allow you to be able to identify the four major types.

First let's make sure you understand the terms we will be using. Some things are the same in **nuclear equations** and some are different.

nucleons – these are the particles in the nucleus we call **protons** and **neutrons**
atomic number – called the **Z** number. Z = # of protons = # of electrons . This is the same as normal chemical equations.
mass number – called the **A** number. A = # of protons + # neutrons
isotopes – atoms with identical atomic numbers (Z) but different mass numbers (A)

mass number ------>	A	
	X	<----- symbol for element
atomic number ----->	Z	

In all types of radioactive decay, atomic particles or energy are given off. However, in all types of decay, the <u>total mass number (A) and atomic number (Z) must be in balance on each side of the nuclear equation</u>.

<u>Major types of radioactive decay with their atomic equations:</u>

1. **beta particle emission** (β particle) - Here are two examples of β particle emission, one with a negative β particle (electron) and one with a positive β particle (positron):

   a. Negative β particle emission – is an **electron** with essentially no mass, and a (-) charge. The negatively charged β particle is the more common β particle.

$$ {}^{234}_{90}\mathrm{Th} \text{ -------> } {}^{234}_{91}\mathrm{Pa} + {}^{0}_{1-}\mathrm{e} \quad \text{<------ } \textbf{β particle} \text{ (negative)} $$

Now, you fill in the chart below based on what you see in the atomic formula above for the result of negative β particle emission from Th 234 (thorium):

	LEFT Th	**RIGHT Pa**	**RIGHT e (1-)**
# **protons**			XXXXX
# neutrons			XXXXX
Atomic #			

What was the net result of an electron emission?________________________
(hint: what changed to what?)

b. Positive β particle emission – is a **positron** with no mass, but a (+) charge. It is like an electron but with the opposite charge.

$^{22}_{11}\text{Na} \text{ ------> } ^{22}_{10}\text{Ne} + ^{0}_{1+}\text{e}$ <------ **β particle** (positive)

Now, you fill in the chart below based on what you see in the atomic formula above for the result of the positive β particle emission from Na 22 (sodium):

	LEFT Na	**RIGHT Ne**	**RIGHT e (1+)**
# **protons**			XXXXX
# neutrons			XXXXX
Atomic #			

What was the net result of positron emission?________________________
(hint: what changed to what?)

2. **alpha particle (**α particle) emission

$^{222}_{88}\text{Ra} \text{ -------> } ^{218}_{86}\text{Rn} + ^{4}_{2}\text{He}$ <--------- **α particle** (He nucleus)

Now, you fill in the chart below based on what you see in the atomic formula above for the result of the α particle emission from Ra 222 (radium):

	LEFT Ra	**RIGHT Rn**	**RIGHT He**
# **protons**			
# neutrons			
Atomic #			

Notice that the net result of the α particle emission did not change any protons to neutrons or vice versa.

3. **gamma ray emission** (γ ray) - this is a **photon** of light, has not mass and no atomic number (both are zero):

$$^{238}_{92}\text{U} \text{ -------->} \ ^{234}_{90}\text{Th} + \ ^{4}_{2}\text{He} + 2\ ^{0}_{0}\gamma$$ <------ **gamma ray** (photon of light)

Now, you fill in the chart below based on what you see in the atomic formula above for the result of both α particle and γ ray emissions from U 238 (uranium).

	LEFT U	**RIGHT Th**	**RIGHT He**	**RIGHT γ**
# **protons**				**XXXXX**
# neutrons				**XXXXX**
Atomic #				

Notice again, that the net result of the α particle emission plus a γ ray did not change any protons to neutrons or vice versa.

4. **electron capture** - literally, an electron is captured from the area surrounding the atom, called an **interorbital electron**

$$^{201}_{80}\text{Hg} + \ ^{0}_{1-}\text{e} \text{ ------->} \ ^{201}_{79}\text{Au} + \ ^{0}_{0}\gamma$$ <------- gamma ray (photon of light)

Now, you fill in the chart below based on what you see in the atomic formula above for the result of the electron capture and the γ ray emission from Hg 201 (mercury).

	LEFT Hg	**LEFT e (1-)**	**Au**	**γ**
# **protons**		**XXXXX**		**XXXXX**
# neutrons		**XXXXX**		**XXXXX**
Atomic #				

What was the net result of positron emission?________________________
(hint: what changed to what?)