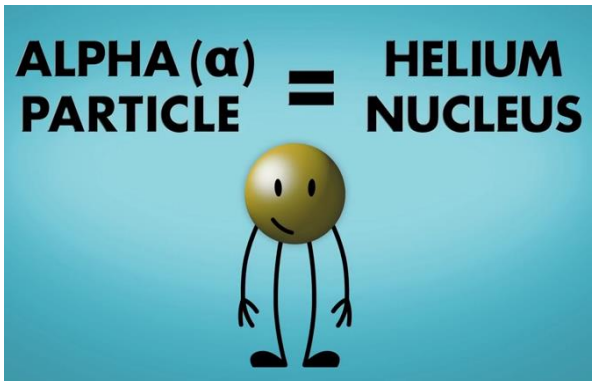
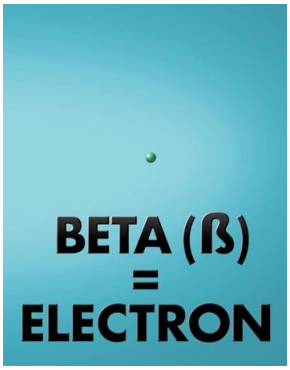
Radioactivity	
Key Points:	**Notes**
	What is radioactive decay? • The process by which a _____ _____. • Sometimes, atoms are a little bit unstable… Either _____ or _____ They _____ • Instantly become another element! • = radioactive Use this space to take notes on the video: **Alpha Decay:** • **Same as:** • **Symbol:** • **Mass:** • **Charge:**  **Law of Conservation of Mass:** the atomic mass on left side must EQUAL atomic mass on right side. When $^{59}_{27}Co$ loses an alpha particle, what atom will it turn into? • Write out the Alpha decay for – Meitnerium-270 – Rhenium-190 – Nickel-63

Beta Decay:

- **Same as:**
- **Symbol:**
- **Mass:**
- **Charge:**

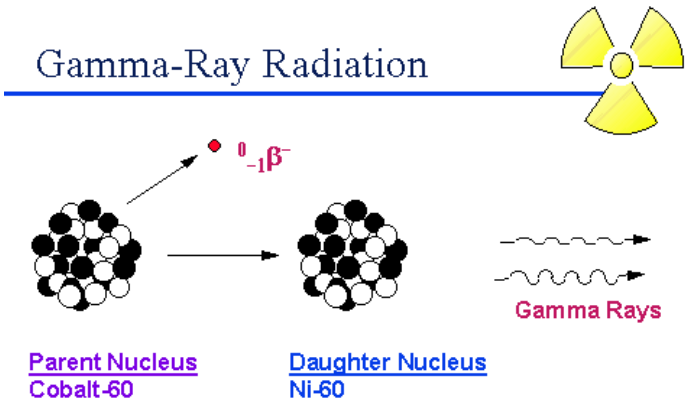


$$^{210}_{83}Bi \rightarrow {}^{0}_{-1}\beta + \_\_\_\_\_$$

- Write out the Beta decay for
  - Scandium-47
  - Zirconium-94
  - Tungsten-186

Gamma Decay:

- **Same as:**
- **Symbol:**
- **Mass:**
- **Charge:**



Summary:

Radioactivity Reading

Chemical reactions involve changing one substance into another substance by rearranging atoms. However, during a chemical reaction atoms of one element cannot change into atoms of another element. The reason this change cannot occur is that chemical reactions only involve an atom's electrons – the nucleus remains unchanged.

Recall that an atom's identity is based on its number of protons. Since protons are in the nucleus and chemical reactions do not involve the nucleus, the atom remains unchanged. However, there are some reactions that do involve changes in the nucleus. These are called nuclear reactions and do change one atom of an element into an atom of a different element.

1. Fill in the table below as a review. **You will need your periodic table for this**! Remember the atomic number (or # of protons) determines the element. If you have four protons and seven neutrons you have beryllium. The same is true if you have four protons and six neutrons...you still have beryllium.

Isotope	Total Protons (Atomic #)	Total Neutrons (Mass # - Atomic #)	Mass Number*	Total Electrons Outside Nucleus	Format for Nuclear Equation
K-40	19	21	40	19	$^{40}_{19}K$
Li-6					$^{6}_{3}Li$
	2	1			
					$^{131}_{53}I$
			90	38	

*NOTE: Do NOT use the mass numbers from your periodic table.

Radioactivity is when a substance spontaneously emits radiation. Radioactive atoms (or radioisotopes) emit radiation because their nuclei are unstable. Unstable nuclei lose energy by emitting radiation in a spontaneous process called radioactive decay. Unstable radioactive atoms undergo radioactive decay until they form stable nonradioactive atoms. There are several types of radiation emitted during radioactive decay.

Types of Radiation: Alpha, Beta, and Gamma

Three types of radiation have been discovered. The types are called alpha, beta and gamma. **Alpha** rays turned out to be small particles of matter with a charge of +2 and a mass of 4 amu. It has been proved that an alpha particle contains two protons and two neutrons – it is identical to the nucleus of a helium atom. In fact, when an alpha particle slows down and gains two electrons it becomes a helium atom. The Greek letter alpha (α) is used to represent this particle but in equations to keep track of mass and protons we must use $^{4}_{2}He$. **Betas** were also found to be particles; they are simply high speed electrons. We use the Greek letter beta (β), but in equations $^{0}_{-1}e$ is used. When a beta slows down it becomes an electron. **Gamma** rays (γ) are not particles; they are high energy electromagnetic radiation. They are photons (light) with no charge or mass so we simply write $^{0}_{0}\gamma$ in our equations.

Example 1: Thorium-232 decays by emitting an alpha and a gamma.

$^{232}_{90}Th \rightarrow {}^{4}_{2}He + \gamma + {}^{228}_{88}Ra$

Example 2: Uranium-239 decays by emitting a beta and a gamma.

$^{239}_{92}U \rightarrow {}^{0}_{-1}e + \gamma + {}^{239}_{93}Np$

NOTE: notice that 92 – [-1] = 93; there is always an increase in the atomic number with beta emission

In the previous examples you should notice that the sum of the masses on the left of the arrow equals the sum of the masses on the right of the arrow and that the sum of the protons on the left equals the sum of the protons on the right.

2. Complete the following table.

Name	Charge	Mass	Greek Symbol	Equation Symbol	Identity
ALPHA					
BETA					
GAMMA					

When an atom undergoes radioactive decay the product nucleus is often unstable and undergoes further decay. This occurs until a stable nucleus is produced. (There is no way for a student to know how an atom will decay. We will always tell you the mode of decay for equations.)

3. Write the nuclear equations for the following radioactive decay series. Use your periodic table.

uranium-235 emits an alpha _____

thorium-231 emits a beta and a gamma _____

protactinium-231 emits an alpha and a gamma _____

actinium-227 emits a beta _____

Th-227 emits an alpha and a gamma _____

Ra-223 emits an alpha _____

Rn-219 emits an alpha _____

Po-215 emits an alpha and a gamma _____

The product from above emits a beta _____

The product from above emits an alpha _____

The product from above emits a beta and a gamma _____

Alpha & Beta Decay

The following atoms all undergo alpha particle emission. Write the complete nuclear equation.

$^{210}_{84}Po \rightarrow$ _____ + _____

$^{238}_{92}U \rightarrow$ _____ + _____

$^{238}_{90}Th \rightarrow$ _____ + _____

$^{222}_{86}Rn \rightarrow$ _____ + _____

$^{106}_{47}Ag$ + _____ $\rightarrow$ _____

$^{116}_{50}Sn$ + _____ $\rightarrow$ _____

The following atoms all undergo beta decay. Write the complete nuclear equation.

$^{14}_{6}C \rightarrow$ _____ + _____

$^{90}_{38}Sr \rightarrow$ _____ + _____

$^{40}_{19}K \rightarrow$ _____ + _____

$^{13}_{7}N \rightarrow$ _____ + _____

$^{190}_{78}Pt$ + _____ $\rightarrow$ _____

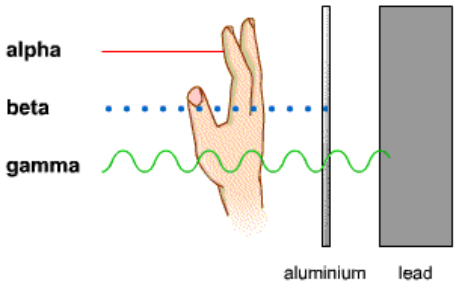
$^{123}_{53}I$ + _____ $\rightarrow$ _____

Radioactivity pt.2

Notes

Radiation – Harmful or helpful?

- When have you been asked to wear a thick, heavy protective apron?



Review:

- Alpha particles are the same as what? Beta particles are the same as what?

- What is each type of radioactivity used for?

- What is the most serious effect of radiation on humans?

- What happens if you ingest a radioactive nucleus?

How long does it take radioactive isotopes to decay…?

- Half-Life: _____
  _____

Half Life	[Radioactive substance remaining]
0	
1	
2	
3	

- **Ex1:** Os-182 has a half-life of 21.5 hours. How many grams of a 10.0-gram sample would have decayed after exactly three half-lives?

- **Ex. 2:** Os-182 has a half-life of 21.5 hours. How many grams of a 10.0 gram sample would have decayed after exactly three half-lives?

- **Ex. 3:** If 10 mg of iodine 131 is given to a patient, how much is left after 24 days? The half-life of iodine-131 is 8 days.

Practice makes perfect!

1. The half-life of Zn-171 is 2.4 minutes. If Sandy had 100 g at the beginning, how many grams would she have left after 7.2 minutes have elapsed?

2. Destiny has a sample of tritium with a half life of 12.26 years. How much time will be required for H-3 to lose 75% of its radioactivity?

3. Rn-222 has a half-life of 82 days. If you start with a 100 g sample, how much will remain after exactly 4 half-lives?

Summary:

Half-life Homework

1. The half-life of cobalt-60 is 5.26 years. How many half-lives have passed in 10.52 years?

2. 12.5% of a radioactive sample are left. How many half-lives have passed?

3. After 3 half-lives, how much of a 400 gram sample of radioactive uranium remains?

4. After 4 half-lives 10 grams of uranium remains. How much uranium did you start with?

5. How old is an artifact if four half-lives have occurred and the half-live of carbon-14 is 5730 years?

6. How much time has passed if carbon-14 has a half-life of 5730 years and 2 half-lives have passed?

7. A rock that originally had a mass of 1.00 gram of uranium-238 now has only 0.50 grams. How old is the rock if the half-live of uranium-238 is 4.5 billions of years.

8. The radioisotope radon-222 has a half-life of 3.8 days. How much of a 10 g sample of radon-222 would be left after 15.2 days?

9. A piece of wood found in an ancient burial mound contains only half as much carbon-14 as a piece of wood cut from a living tree growing nearby. It the half-life for carbon-14 is 5730 years, what is the approximate age of the ancient wood?

10. Iodine-131 has a half-life of 8 days. If the amount of iodine-131 in a sample is 8 g, how much iodine-131 will remain after 32 days?

Fission v. Fusion

Notes

- **There are two ways that nuclear energy can be released from an atom:**
  - **Fission: _____**
  - **Fusion: _____**

Fission	Fusion

Pros	Cons

Pros	Cons

Summary:

The Eyes of Nye: Nuclear Reactions

1. What are the three main sections of a nuclear power plant?

2. What starts the nuclear chain reaction?

3. What does fission mean?

4. What two products are formed from the fission of uranium?

5. How much nuclear waste is produced in 60 years of a power plant operating?

6. How much waste would a coal plant produce?

7. Where are most of the nuclear waste and spent fuel rods currently?

8. What is the estimate for how long it takes nuclear waste to completely decay?

9. What materials are used to shield or block nuclear radiation?

10. Why is Yucca Mountain such an attractive location for nuclear waste storage?

11. What is the half-life of Plutonium, part of nuclear waste?

12. Why was the 10,000 year standard ruled invalid?

13. Give two positive and negative arguments involving the usage of nuclear energy.

14. How much total nuclear waste exists worldwide?

15. What are two other ideas for dealing with nuclear waste?

16. Why can't the nuclear waste be shot into space?

17. Describe transmutation.