Types of Nuclear Reactions

Name _____
Period _____

In this activity we are going to explore the different types of nuclear reactions. Read the instructions and questions carefully. Answer each question to the best of your understanding of what is presented to you.

UNSTABLE ATOMS:

- Unstable atoms occur when the ratio of _____ to _____ are not correct in order for the protons to repel each other
- Unstable atoms are also known as Radioactive isotopes
- Unstable atoms must undergo nuclear decay

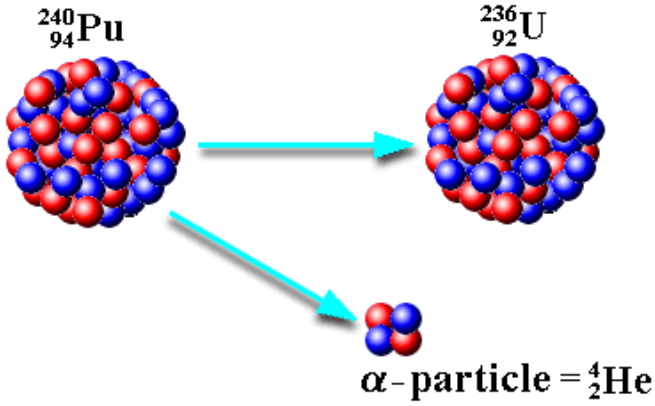
NUCLEAR DECAY

- The **spontaneous** disintegration of a nucleus into a slightly lighter nucleus
- Nuclear decay is also known as radioactive decay because particles and electromagnetic radiation are emitted
- 5 types of decay
    - Alpha Emission
    - Beta emission
    - Positron emission
    - Electron capture
    - Gamma emission
- Just like in other chemical reactions we've looked at, **mass must be conserved** (total mass & atomic # on both sides of the arrow must be equal).

In this course, we will only focus on Alpha emission, Beta emission, and Gamma emission.

Alpha emissions:

- Alpha decay occurs when there are too many protons in the nucleus
- An alpha particle is emitted
- An alpha particle is the nucleus of a helium atom without any electrons = $\mathbf{{}_{2}^{4}\alpha}$



Examples:

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha$$

$$^{240}_{94}Pu \rightarrow {}^{236}_{92}U + {}^{4}_{2}\alpha$$

$$^{236}_{90}Th \rightarrow {}^{232}_{88}Ra + {}^{4}_{2}\alpha$$

Using the examples to the left, answer the following questions:

o For each the examples, the element decays to two elements. What is produced in each of the nuclear reactions?

o Look at the original element and the element produced. What happens to the atomic number?

o Still looking at the original element and the element produced, what happens to the mass?

o In terms of protons and neutrons, what is going on when the original element undergoes alpha decay?

PRACTICE: Fill in the blank with the missing particle

$$^{100}_{56}Ba \rightarrow \_\_\_\_ + {}^{4}_{2}\alpha$$

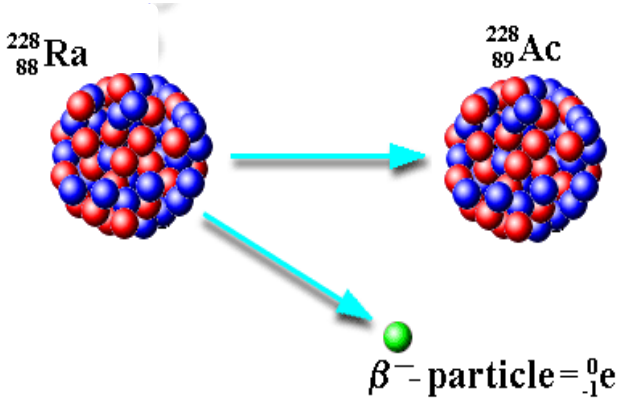
$$\_\_\_\_ \rightarrow {}^{230}_{90}Th + {}^{4}_{2}\alpha$$

$$^{110}_{53}I \rightarrow \_\_\_\_ + {}^{4}_{2}\alpha$$

$$\_\_\_\_ \rightarrow {}^{226}_{86}Rn + {}^{4}_{2}\alpha$$

Beta emission

- Beta decay occurs when there are too many neutrons in the nucleus
- A neutron converts into a proton and a *beta particle* is ejected from the nucleus
- An Beta particle is an electron = $_{-1}^{0}e$



Examples:

$$^{47}_{20}Ca \rightarrow {}^{47}_{21}Sc + {}^{0}_{-1}e$$

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

$$^{197}_{78}Pt \rightarrow {}^{197}_{79}Au + {}^{0}_{-1}e$$

Questions:

o For each the examples, the element decays to two elements. What is produced in each of the nuclear reactions?

o Look at the original element and the element produced. What happens to the atomic number?

o Still looking at the original element and the element produced, what happens to the mass?

o In terms of protons and neutrons, what is going on when the original element undergoes beta decay?

PRACTICE: Fill in the blank with the missing particle

$$^{131}_{53}I \rightarrow \_\_\_\_ + {}^{0}_{-1}e$$

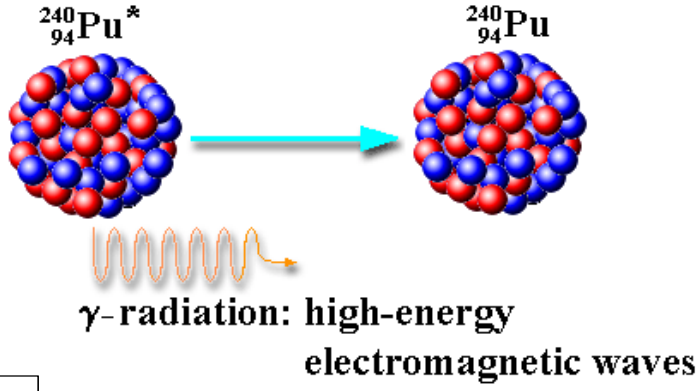
$$\_\_\_\_ \rightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e$$

$$^{6}_{2}He \rightarrow \_\_\_\_ + {}^{0}_{-1}e$$

$$\_\_\_\_ \rightarrow {}^{52}_{27}Co + {}^{0}_{-1}e$$

Gamma emission

- High energy electromagnetic waves
- Also known as gamma radiation, $^{0}_{0}\gamma$
- Emitted in all decay processes



Examples:

$$^{99}_{43}Tc^{*} \rightarrow {}^{99}_{43}Tc + {}^{0}_{0}\gamma$$

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + {}^{0}_{0}\gamma$$

$$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}\alpha + {}^{0}_{0}\gamma$$

Question:

o Look at all the nuclear reactions, does gamma decay change the mass or the atomic number?

Summary of Types of Nuclear Reactions

Radiation Type	Particle	Gain or Lose proton	Δ in atomic #	Δ in atomic mass
Alpha Emission	$^{4}_{2}\alpha$			
Beta Emission	$^{0}_{1}e$			
Gamma Emission	$^{0}_{0}\gamma$			

PRACTICE:

Identify the following as ALPHA, BETA, or GAMMA

1. $_{-1}^{0}e$ _____ 2. $_{2}^{4}\alpha$ _____ 3. $_{0}^{0}\gamma$ _____

4. Nuclear decay with NO mass and NO charge _____
5. Decay emitting an electron _____
6. Nuclear decay giving of a helium nucleus _____
7. Given off by all process of decay _____
8. Emitted when there are too many neutrons _____
9. Emitted when there are too many protons _____

Balance the following nuclear equations and determine the type of decays that occurs.

Chemical Equation	Type of decay
$_{11}^{22}Na \rightarrow {}_{-1}^{0}e +$ _____	
$_{84}^{209}Po \rightarrow {}_{2}^{4}He +$ _____	
$_{29}^{66}Cu \rightarrow {}_{-1}^{0}e + \gamma +$ _____	
$_{19}^{40}K \rightarrow {}_{20}^{40}Ca +$ _____	
$_{86}^{222}Rn \rightarrow {}_{84}^{218}Po +$ _____	

Write the chemical equation for each of the following nuclear decays.

1. Alpha decay of Astatine-209

2. Beta Decay of Potassium – 40

3. Beta Decay of beryllium-7

4. Alpha decay of Oxygen-19

5. Alpha decay of At-212

6. Hg-202 (β)

7. Beta decay of Hs-260

8. Fr-230 (α)