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ChemCatalyst:

Q: What patterns do you notice in the fusion rxns?

Q: Do you think gold can be created on Earth by a fusion rxn?

Notes:

- What is nuclear chemistry?
  - The study of changes to the nucleus
  - Types of nuclear changes:
    1. Fission: splitting apart of a nucleus into two smaller nuclei
    2. Fusion: joining of 2 nuclei to form a larger nucleus
    3. Radioactive decay: spontaneous process by which an atom emits radiation or a particle from its nucleus to become more stable.
       Ex: alpha decay, beta decay, gamma decay

- What do all nuclear charges have in common?
  - ALL types of nuclear changes give off a tremendous amount of energy!!

- How do I protect myself?
  - Alpha decay is blocked by a piece of paper
  - Beta decay is blocked by foil
  - Gamma decay is partially blocked by lead or concrete

LESSON 16

CLASSWORK

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Old Gold

Formation of Elements

Name _____

Date _____ Period _____

Purpose

To practice interpreting nuclear equations and to predict the products of specific nuclear reactions.

Part 1: Nuclear Equations

Use a periodic table and the isotope chart from Lesson 14.

1. Fill in this table.

Nuclear equation	Change in atomic number	Change in number of protons	Change in number of neutrons	Change in mass number	Type of nuclear change
a $^{226}_{88}\text{Ra} \longrightarrow {}^{4}_{2}\text{He} + {}^{222}_{86}\text{Rn}$					alpha decay
b $^{214}_{84}\text{Po} \longrightarrow {}^{4}_{2}\text{He} + {}^{210}_{82}\text{Pb}$					
c $^{17}_{8}\text{O} + {}^{14}_{7}\text{N} \longrightarrow {}^{31}_{15}\text{P}$					
d $^{47}_{20}\text{Ca} \longrightarrow {}^{0}_{-1}\text{e}^{-} + {}^{47}_{21}\text{Sc}$					
e $^{148}_{64}\text{Gd} \longrightarrow {}^{4}_{2}\text{He} + {}^{144}_{62}\text{Sm}$				−4	
f $^{8}_{4}\text{Be} + {}^{4}_{2}\text{He} \longrightarrow {}^{12}_{6}\text{C}$		+2			
g $^{14}_{6}\text{C} \longrightarrow {}^{0}_{-1}\text{e}^{-} + {}^{14}_{7}\text{N}$	+1				beta decay

2. Based on the equations, how do you know which nuclear changes are fusion?

3. When an alpha particle is lost from an atom, where on the periodic table would you find the product of the nuclear reaction?

4. Explain how you figured out how many neutrons an isotope has.

5. Fill in the missing parts of these nuclear reactions:

a. _____ $\longrightarrow \beta + {}^{40}_{20}\text{Ca}$

b. _____ $\longrightarrow {}^{4}_{2}\text{He} + {}^{226}_{88}\text{Rn}$

c. $^{35}_{14}\text{Si} \longrightarrow {}^{0}_{-1}\text{e}^{-} +$ _____

d. $^{238}_{92}\text{U} \longrightarrow \alpha +$ _____

e. $^{110}_{53}\text{I} \longrightarrow$ _____ $+ {}^{106}_{51}\text{Sb}$

f. $^{140}_{56}\text{Ba} \longrightarrow$ _____ $+ {}^{140}_{57}\text{La}$

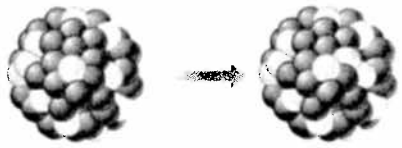
6. If a francium atom, element 87, undergoes beta decay, what type of atom will be produced?

Part 2: Making Gold By Radioactive Decay

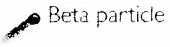
7. Examine the possibility of making gold atoms by alpha or beta decay as shown in these two illustrations. Place the appropriate starting isotope in each equation.

Alpha decay:

$$\_\_\_\_\_ \longrightarrow {}^{197}_{79}\mathrm{Au} + \alpha$$



Beta decay:



$$\_\_\_\_\_ \longrightarrow {}^{197}_{79}\mathrm{Au} + \beta$$

8. Referring to question 7, find the two starting isotopes in the equations on the isotope chart. Are they found in nature?

9. **Making Sense** Why do you think the alchemists were not successful in making gold from other metals?

10. **If You Finish Early** Write the nuclear equation representing the alpha decay of element 85, astatine.

Making Sense Notes:

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- How are nuclear processes written?
  - As nuclear equations:

    Ex: technetium-100 undergoing alpha decay

    $$^{100}_{43}T \rightarrow ^{96}_{41}Nb + ^{4}_{2}He$$

    Ex: carbon-14 undergoing beta decay

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

    *nuclear equations must be balanced both in mass (upper #) & atomic # (lower #)

- What are the types of nuclear processes (rxns)?

1. Alpha decay (α)
   - Nucleus of an atom releases a He nucleus (2p & 2n = $^{4}_{2}He$)
   - The element is transformed into a <u>new</u> element with a smaller nucleus (go backward 2 spaces on the P.T.)
   - Gamma rays (high energy radiation) is also released
   - Ex: $^{238}_{92}U \rightarrow \alpha + ^{234}_{90}Th$
2. Beta decay (β)
   - A neutron inside the nucleus splits into an electron & a proton ($n \rightarrow p + e^-$)
   - The nucleus then releases the electron at a high speed (b/c electrons don't belong in the nucleus!)
   - The new element has the same mass as the old one, but different atomic # (go forward one space on the P.T.)
   - Gamma rays are also released
   - Ex: $^{140}_{56}Ba \rightarrow \beta + ^{234}_{90}Th$

3. Nuclear Fusion
   - Joining together of nuclei
   - Requires lots of energy
   - Ex: $^{52}_{24}Cr + {}^{4}_{2}He \rightarrow {}^{56}_{26}Fe$
4. Nuclear Fission
   - a nucleus breaking up into smaller nuclei
   - releases lots of energy
   - Ex:

$$^{235}_{92}U \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + {}^{1}_{0}n + {}^{1}_{0}n$$