Key

WS 28.0 Nuclear Reactions and radiation Name:_____ p.____

Part I: Types of Nuclear Radiation.

In a nuclear reaction, the nucleus of an atom can release energy or particles, both of which are called radiation. Three types of radiation that can be released by a nuclear reaction are called alpha (α), beta (β) and gamma(γ), (there are other types as well, but we won't study them in this class). Each of these three types of radiation has a different mass and charge. Each type can cause cancer, though there are many positive uses of radiation.

1. Fill out this table

Type of radiation	Symbol(s)	What is it?	mass	charge	penetrating power
_____	α or He	_____	____	____	_____
_____	β or e	_____	____	____	_____
_____	γ	_____	____	____	_____

2. In the above chart, which type(s) of radiation are matter? α, β
which type(s) of radiation are energy? γ

3. Which type of radiation (alpha, beta, or gamma) did Rutherford use in the gold foil experiment? (Hint, this particle was repelled by the gold nucleus) alpha

4. Which type of radiation did Thomson name? Hint, it was the particle in the Cathode Ray Tube and Thomson discovered that it was much lighter than the rest of the atom? Beta

5. How many protons, neutrons, and electrons are in this isotope? ^{18}O p 8 n 10 e 8
b. Is this the most common isotope of oxygen? no

6. How many protons, neutrons, and electrons are in this isotope? ^{56}Fe p 26 n 30 e 26
b. Is this the most common isotope of iron? yes

7. Determine the number of protons, neutrons, and electrons in each thing: $^{65}Cu^{+2}$ p 29 n 36 e 27 $^{35}Cl^{-1}$ p 17 n 18 e 18

8. "Penetrating Power" has to do with how much material the radiation can go through before it is stopped. Explain why alpha particles have the lowest penetrating power.

alphas are the largest and have the most charge, so they are the most likely to run into/interact with things and get stopped/absorbed.

Part II: Alpha Decay:

1. Write an equation for the alpha decay of Uranium-238.

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

2. Write an equation for the lead-210 undergoing alpha emission.

$$^{210}_{82}Pb \longrightarrow {}^{206}_{80}Hg + {}^{4}_{2}\alpha$$

3. Write an equation for the alpha decay of Rf-261 (Rutherfordium is element #104)

$$^{261}_{104}Rf \longrightarrow {}^{4}_{2}\alpha + {}^{257}_{102}No$$

4. An element alpha decays to PRODUCE the isotope Pb-206. Write the equation for this.

$$^{210}_{84}Po \longrightarrow {}^{4}_{2}\alpha + {}^{206}_{82}Pb$$

5. Make a generalization as to what new element will form if an element undergoes alpha decay.

The new element will have 2 fewer protons than the original element (and a mass of 4 fewer amu)

Part III: Beta decay

1. Write an equation for the beta decay of Bismuth-211.

$^{211}_{83}Bi \rightarrow {}^{0}_{-1}\beta + {}^{211}_{84}Po$ $\quad ({}^{1}_{0}n \rightarrow {}^{0}_{-1}\beta + {}^{1}_{1}p)$

(83 protons, 128 neutrons) (84 protons, 127 neutrons)

2. Write an equation Neptunium-239 undergoing beta emission.

$^{239}_{93}Np \rightarrow {}^{0}_{-1}\beta + {}^{239}_{94}Pu$

3. An element undergoes beta emission TO PRODUCE a Nitrogen-14 atom. Write an equation for this.

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

4. Make a generalization about the identity of the element that forms in beta decay.

you form the element with one more proton than the original element. (but the same mass number, since it has 1 less neutron)

5. Nuclear reactions, like alpha and beta decay, are quite different from chemical reactions. Answer the questions below: Fill in the blanks with nuclear or chemical.

a. Which type of reaction often involves forming a different element? nuclear
b. Which type of reaction involves 10^6 to 10^7 times more energy (per gram) than the other type? nuclear
c. Combustion and single replacements are examples of this type of reaction: chemical
d. In which type can the atom increase or decrease the number of protons or neutrons? nuclear
e. Which type is balanced by making sure that the same number of each type of atom is on each side of the equation? chemical
f. Which type involves changes in the nucleus of the atom? nuclear
g. Which type could involve an electron from an orbital leaving the atom? chemical
h. Which type could involve an electron leaving the nucleus of the atom? nuclear (if beta decay!)
i. Fission and fusion are examples of this type of reaction. nuclear
j. Oxidation (loss of electrons) and reduction (gain of electrons) take place in this type of reaction. chemical
k. Which type is sometimes called a "transmutation"? nuclear

("Transmutation" is the word to describe what happens when one element turns into another. Alchemists thought they could achieve transmutation of lead into gold!)

Part IV. Mixed Exercises. (Fill in the Blanks)

NOTE: Every particle in these equations needs a mass number (top) and a charge number (bottom). Add these numbers in where they are missing.

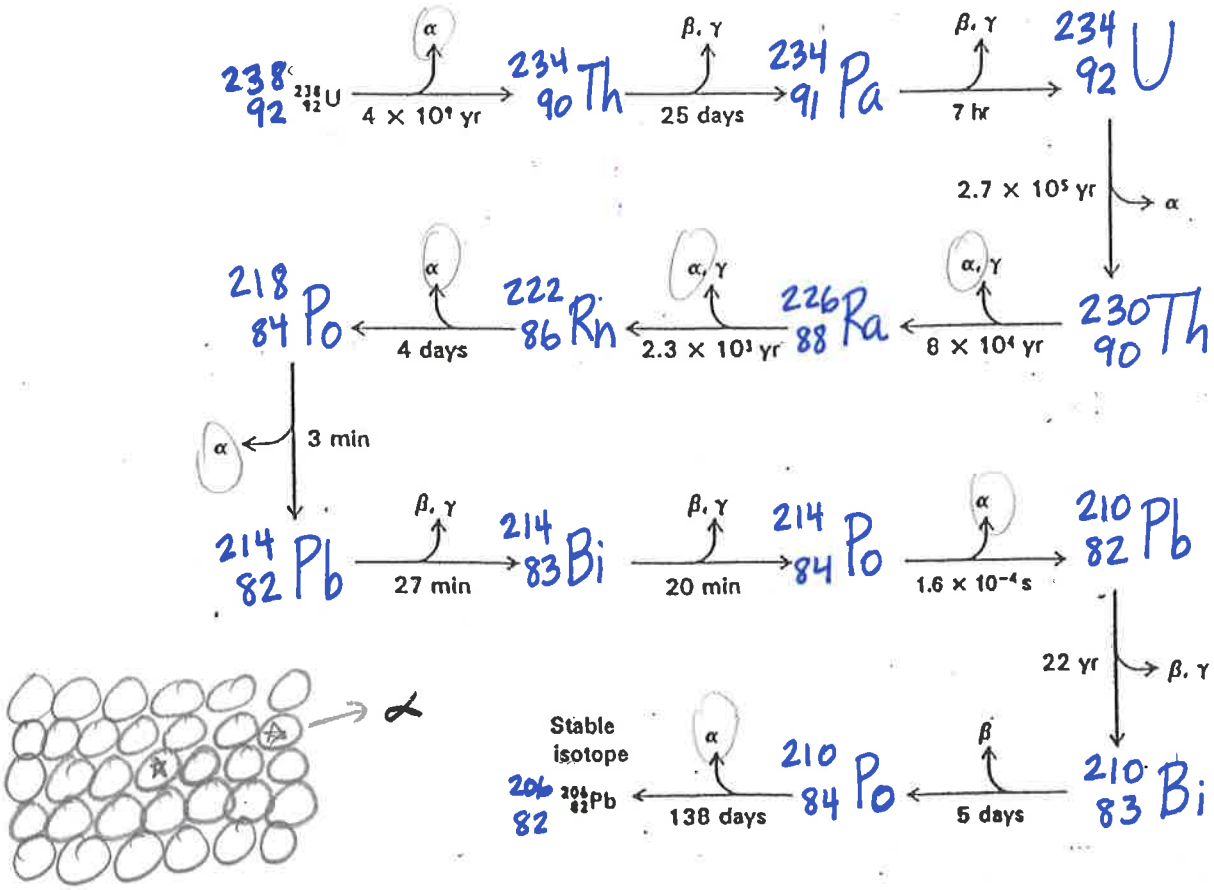
1. $^{239}_{94}Pu$ ----------> $^{4}_{2}\alpha$ + $^{235}_{92}U$
2. $^{239}_{94}Pu$ ----------> $^{0}_{-1}\beta$ + $^{239}_{95}Am$
3. $^{222}_{86}Rn$ ----------> $^{218}_{84}Po$ + $^{4}_{2}\alpha$
4. $^{40}_{19}K$ ----------> $^{0}_{-1}\beta$ + $^{40}_{20}Ca$
5. $^{235}_{92}U$ ----------> $^{231}_{90}Th$ + $^{4}_{2}\alpha$
6. $^{214}_{83}Bi$ ----------> $^{4}_{2}\alpha$ + $^{210}_{81}Tl$
7. $^{27}_{14}Si$ ----------> $^{0}_{-1}\beta$ + $^{27}_{15}P$

BRING YOUR **FANCY PERIODIC TABLE** AND **CALCULATOR** TO CLASS TOMORROW!!!

Part V. Radioactive Decay Series!

Ernest Rutherford received the Nobel Prize in chemistry in 1908 (3 years before he discovered the nucleus!) for figuring out the following radioactive decay series. The prize was awarded "For his investigations into the disintegration of the elements, and the chemistry of radioactive substances," At his acceptance speech he presented the results of a new experiment, in which he proved that alpha particles were helium ions.

1. Fill in each isotope symbol in the series. Include the top and bottom numbers!



2a. List two noble gases that are typically found mixed in with samples of uranium. He and Rn

b. Which one of the gases listed in (a) can cause lung cancer? Rn

3. The times shown in the above chart are the half-lives of the radioactive isotopes.

a. What is meant by half-life? The amount of time required for half the radioactive atoms in a sample to undergo radioactive decay.

$t_{1/2}$

b. Which radioactive isotope would be more dangerous to hold in your hand – one with a very long half-life, or one with a very short half-life? Explain.

The one w/ short half-life is more dangerous, because it will emit more alphas/more betas per unit time.