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?_____ which type(s) of radiation are energy?_____

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)_______________

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?_____________

5. How many protons, neutrons, and electrons are in this isotope? ^{18}O p____ n____ e____
b. Is this the most common isotope of oxygen?_____

6. How many protons, neutrons, and electrons are in this isotope? ^{56}Fe p____ n____ e____
b. Is this the most common isotope of iron?_____

7. Determine the number of protons, neutrons, and electrons in each thing: $^{65}Cu^{+2}$ p____ n____ e____ $^{35}Cl^{-1}$ p____ n____ e____

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.

Part II: Alpha Decay:

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

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

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

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

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

Part III: Beta decay

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

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

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

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

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?________________
b. Which type of reaction involves 10^6 to 10^7 times more energy (per gram) than the other type?______________
c. Combustion and single replacements are examples of this type of reaction:____________________
d, In which type can the atom increase or decrease the number of protons or neutrons?__________________
e. Which type is balanced by making sure that the same number of each type of atom is on each side of the equation?______________
f. Which type involves changes in the nucleus of the atom?____________________
g. Which type could involve an electron from an orbital leaving the atom?______________
h. Which type could involve an electron leaving the nucleus of the atom?______________________
i. Fission and fusion are examples of this type of reaction.______________________
j. Oxidation (loss of electrons) and reduction (gain of electrons) take place in this type of reaction.______________
k. Which type is sometimes called a "transmutation"?__________________________
("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}Pu ----------> α + ____________

2. ^{239}Pu ----------> β + ____________

3. ^{222}Rn ----------> ^{218}Po + ____________

4. ^{40}K ----------> ____________ + Ca

5. ^{235}U ----------> ____________ + α

6. ____________ ----------> α + ^{210}Tl

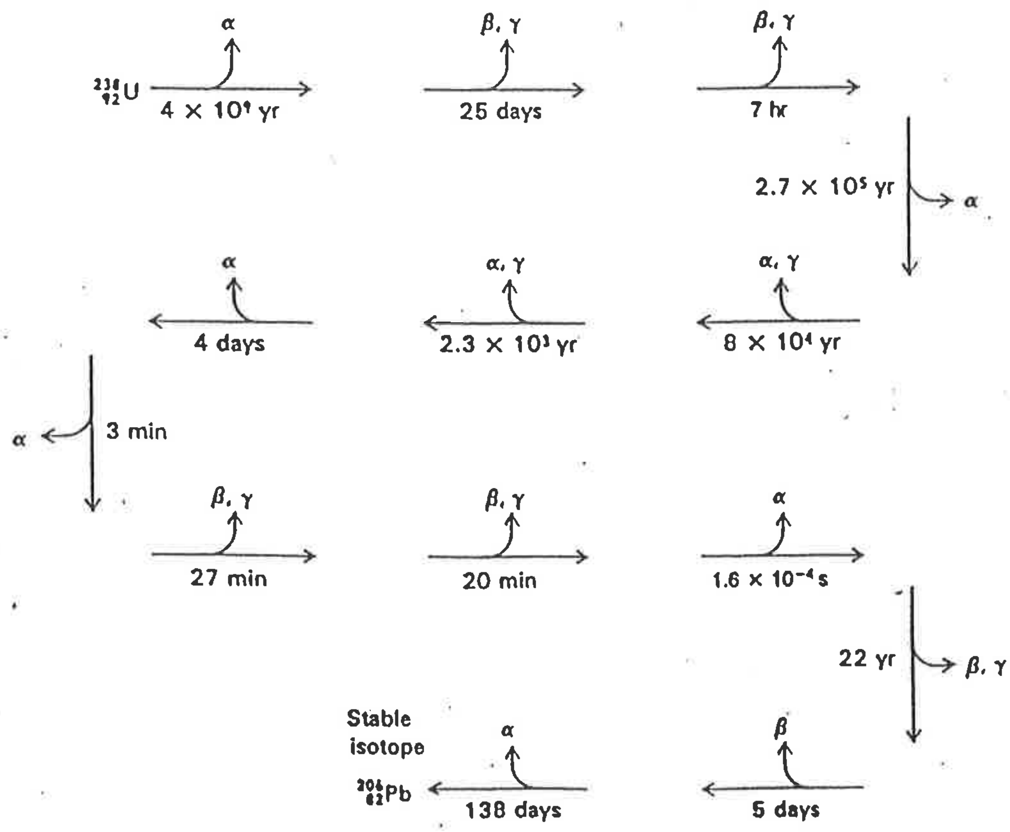
7. ____________ ----------> β + ^{27}P

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. ________ and ________

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

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

a. What is meant by half-life?

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.

Estimate Your Personal Radiation Dose

Radiation is measured in terms of millirems (mrems). The average annual dose per person from all sources is about 360 mrems per year, but it is not uncommon for any of us to receive far more than that in a given year (largely due to medical procedures we may have had done). International standards allow up to 5000 mrems per year exposure for those who work with and around radioactive material.

Factors	Common sources of radiation	Your annual dose (mrems)
Where you live	**Cosmic radiation** (from outer space) Exposure depends on your elevation. Amounts are in millirems per year. At sea level ....26 mrem; 0–1000 ft ....28; 1000–2000 ....31; 2000–3000 .... 35; 3000–4000 ....41; 4000–5000 ft ....47 mrem; 5000–6000 ....52; 6000–7000 ....66; 7000–8000 ....79; 8000–9000 96	_____ mrem
	Terrestrial (from the ground) If you live in a state that borders the Gulf or Atlantic coasts, add 16 mrem. If you live in the Colorado Plateau (around Denver), add 63 mrem. If you live anywhere else in the continental United States, add 30 mrem.	_____ mrem
	House construction If you live in a stone, adobe, brick or concrete building, add 7 mrem.	_____ mrem
	Power plants If you live within 50 miles of a nuclear power plant, add 0.009 mrem. If you live within 50 miles of a coal-fired power plant, add 0.03 mrem.	_____mrem
Food, Water, Air	**Internal radiation** (based on average values) From food (Carbon-14 and Potassium-40) and from water (radon dissolved in water)	40 mrem
	From air (radon)	200 mrem
How you live	Weapons test fallout (less than 1) — 1 mrem	1 mrem
	Travel by jet plane — 0.5 mrem per hour in the air	_____ mrem
	If you have porcelain crowns or false teeth — 0.07 mrem	_____ mrem
	If you wear a luminous wristwatch — 0.06 mrem	_____ mrem
	If you go through security inspection at airport (each time) — 0.002 mrem	_____ mrem
	If you watch TV — 1 mrem	_____ mrem
	If you use a video display (computer screen) — 1 mrem	_____ mrem
	If you have a smoke detector — 0.008 mrem	_____ mrem
	If you use a gas camping lantern — 0.2 mrem	_____ mrem
	If you wear a plutonium-powered pacemaker — 100 mrem	_____ mrem
Medical Tests	**Medical diagnostic tests** *Number of millirems per procedure* X-Rays: Extremity (arm, hand, foot, or leg) ......1 Dental ......1 Chest ......6 Pelvis/hip ......65 Skull/neck ......20 Barium enema ......405 Upper GI ......245 CAT Scan (head and body) ....110 Nuclear Medicine (e.g., thyroid scan) 14	_____ mrem
	Your Estimated Annual Radiation Dose	_____ mrem