Name:_____ Date:_____

Radioactive Decay

1. For each of the following radioactive decays, determine the resultant element:
   a. A radioactive oxygen $^{15}O_8$ nucleus emits a positron and becomes

   b. A radon $^{220}Rn_{86}$ nucleus emits an alpha particle becomes a

   c. A potassium $^{40}K_{19}$ nucleus emits a B^- and becomes:

2. What does the ? represent in the following nuclear reactions:
   a. $^{2}H_1 + {}^{2}H_1 \rightarrow {}^{3}He_2 + ?$

   b. $^{6}Li_3 + ? \rightarrow {}^{7}Li_3$

3. During a particular kind of radioactive decay, a particle is emitted from the nucleus of an atom and the atom's atomic number increases by one. This decay necessarily involves the emission of _____ from the nucleus.

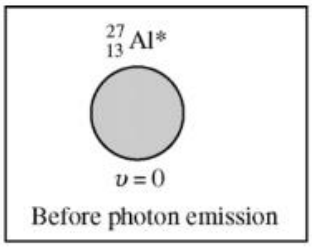
4. A nucleus of $^{235}U_{92}$ disintegrates to $^{207}Pb_{82}$ in about a billion years by emitting 7 alpha particles and how many beta particles?

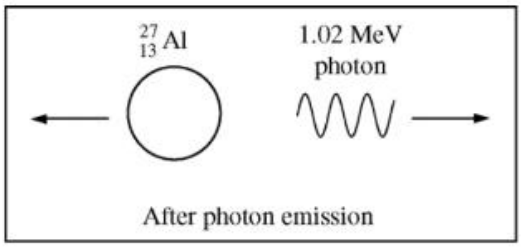
5. A new element, named Physonium (symbol Phys) is discovered to undergo double alpha decay and beta decay simultaneously. Amazingly, this causes the material to decay into an element called Awsomeonium (symbol Oo). What is the correct representation of the (Oo)?

$$^{2006}_{200}Phys \rightarrow {}^{4}_{2}\alpha + {}^{4}_{2}\alpha + {}^{0}_{-1}e + {}^{?}_{?}Oo$$

6. A proton collides with a nucleus of $^{14}_{7}N$. If this collision produces a nucleus of $^{11}_{6}C$ and one other particle. What is that particle?

7. A negative beta particle and a gamma ray are emitted during the radioactive decay of a nucleus of $^{214}_{82}Pb$. What is the resulting nucleus?





7. (10 points)

Following a nuclear reaction, a nucleus of aluminum is at rest in an excited state represented by $^{27}_{13}\text{Al}^*$, as shown above left. The excited nucleus returns to the ground state $^{27}_{13}\text{Al}$ by emitting a gamma ray photon of energy 1.02 MeV, as shown above right. The aluminum nucleus in the ground state has a mass of 4.48×10^{-26} kg. Assume nonrelativistic equations apply to the motion of the nucleus.

(a) Calculate the wavelength of the emitted photon in meters.

(b) Calculate the momentum of the emitted photon in kg•m/s.

(c) Calculate the speed of the recoiling nucleus in m/s.

(d) Calculate the kinetic energy of the recoiling nucleus in joules.

7. (10 points)

The momentum of a particular proton is 5.5×10^{-20} kg•m/s. Relativistic effects can be ignored throughout this question.

(a) Calculate the de Broglie wavelength of the proton.

(b) Calculate the kinetic energy of the proton.

The proton is directed toward a very distant stationary uranium nucleus, $^{235}_{92}\text{U}$. The proton reaches a distance D from the center of the nucleus and then reverses direction. Assume that the nucleus is heavy enough to remain stationary during the interaction.

(c) Calculate the value of D.

(d) After the proton has moved away, the $^{235}_{92}\text{U}$ nucleus spontaneously fissions into $^{148}_{57}\text{La}$ and $^{84}_{35}\text{Br}$, along with three neutrons. As a result, 2.5×10^{-11} J of energy is released. Indicate whether the mass of the $^{235}_{92}\text{U}$ nucleus is greater or less than the mass of the fission products.

____ Greater ____ Less

Calculate the mass difference.