_____ 1. Which particle is emitted from a hydrogen-3 nucleus when it undergoes radioactive decay?
   (1) α+   (2) β–   (3) β+   (4) γ

_____ 2. What is the half-life of a radioisotope if 25.0 grams of an original 200.-gram sample of the isotope remains unchanged after 11.46 days?
   (1) 2.87 d   (2) 3.82 d   (3) 11.46 d   (4) 34.38 d

_____ 3. Which particle has the greatest mass?
   (1) an alpha particle   (2) a beta particle   (3) a neutron   (4) a positron

_____ 4. A beta particle may be spontaneously emitted from
   (1) a ground-state electron   (3) an excited electron
   (2) a stable nucleus   (4) an unstable nucleus

_____ 5. The nucleus of a radium-226 atom is unstable, which causes the nucleus to spontaneously
   (1) absorb electrons   (2) absorb protons   (3) decay   (4) oxidize

_____ 6. An original sample of the radioisotope fluorine-21 had a mass of 80.0 milligrams. Only 20.0 miligrams of this original sample remain unchanged after 8.32 seconds. What is the half-life of fluorine-21?
   (1) 1.04 s   (2) 2.08 s   (3) 4.16 s   (4) 8.32 s

_____ 7. Given the balanced equation representing a nuclear reaction:
   $^{235}_{92}U + {}^1_0n \rightarrow {}^{142}_{56}Ba + {}^{91}_{36}Kr + 3X + energy$
   Which particle is represented by X?
   (1) $^0_{-1}e$ (2) ^1_1H (3) ^4_2He (4) ^1_0n

_____ 8. A proton has a charge that is opposite the charge of
   (1) an alpha particle   (2) a neutron   (3) an electron   (4) a positron

_____ 9. An original sample of K-40 has a mass of 25.00 grams. After 3.9×10^9 years, 3.125 grams of the original sample remains unchanged. What is the half-life of K-40?
   (1) 1.3×10^9 y   (2) 2.6×10^9 y   (3) 3.9×10^9 y   (4) 1.2×10^{10} y

_____ 10. Which list of nuclear emissions is arranged in order from the *least* penetrating power to the greatest penetrating power?
   (1) alpha particle, beta particle, gamma ray
   (2) alpha particle, gamma ray, beta particle
   (3) gamma ray, beta particle, alpha particle
   (4) beta particle, alpha particle, gamma ray

_____ 11. Which two radioisotopes have the same decay mode?
   (1) ^{37}Ca and ^{53}Fe   (3) ^{37}K and ^{42}K
   (2) ^{220}Fr and ^{60}Co   (4) ^{99}Tc and ^{19}Ne

_____ 12. Which nuclear emission has the greatest penetrating power?
   (1) alpha particle   (2) beta particle   (3) gamma radiation   (4) positron

_____ 13. What is the decay mode of ^{37}K?

    (1) α   (2) β−   (3) β+   (4) γ

_____ 14. What is the mass number of an alpha particle?

    (1) 1   (2) 2   (3) 0   (4) 4

_____ 15. Which list of radioisotopes contains an alpha emitter, a beta emitter, and a positron emitter?

    (1) C-14, N-16, P-32   (3) Kr-85, Ne-19, Rn-222
    (2) Cs-137, Fr-220, Tc-99   (4) Pu-239, Th-232, U-238

_____ 16. Which nuclear decay emission consists of energy, only?

    (1) alpha particle   (3) gamma radiation
    (2) beta particle   (4) positron

_____ 17. Given the nuclear equation: $^{253}_{99}\text{Es} + X \rightarrow {}^{1}_{0}\text{n} + {}^{256}_{101}\text{Md}$

Which particle is represented by X?

    (1) $^{4}_{2}\text{He}$ (2) $^{0}_{-1}\text{e}$ (3) $^{1}_{0}\text{n}$ (4) $^{0}_{+1}\text{e}$

_____18. Which group of nuclear emissions is listed in order of increasing charge?

    (1) alpha particle, beta particle, gamma radiation
    (2) gamma radiation, alpha particle, beta particle
    (3) positron, alpha particle, neutron
    (4) neutron, positron, alpha particle

_____ 19. Which notation of a radioisotope is correctly paired with the notation of its emission particle?

    (1) ^{37}Ca and $^{4}_{2}\text{He}$ (2) ^{235}U and $^{0}_{+1}\text{e}$ (3) ^{16}N and $^{1}_{1}\text{p}$ (4) ^{3}H and $^{0}_{-1}\text{e}$

_____ 20. Positrons are spontaneously emitted from the nuclei of

    (1) potassium-37   (2) radium-226   (3) nitrogen-16   (4) thorium-232

_____ 21. Which isotope will spontaneously decay and emit particles with a charge of +2?

    (1) ^{53}Fe (2) ^{137}Cs (3) ^{198}Au (4) ^{220}Fr

_____ 22. Which equation represents positron decay?

    (1) $^{87}_{37}\text{Rb} \rightarrow {}^{0}_{-1}\text{e} + {}^{87}_{38}\text{Sr}$ (2) $^{227}_{92}\text{U} \rightarrow {}^{223}_{90}\text{Th} + {}^{4}_{2}\text{He}$
    (3) $^{27}_{13}\text{Al} + {}^{4}_{2}\text{He} \rightarrow {}^{30}_{15}\text{P} + {}^{1}_{0}\text{n}$ (4) $^{11}_{6}\text{C} \rightarrow {}^{0}_{+1}\text{e} + {}^{11}_{5}\text{B}$

_____ 23. Which statement best describes gamma radiation?

    (1) It has a mass of 1 and a charge of 1.   (3) It has a mass of 0 and a charge of 0.
    (2) It has a mass of 0 and a charge of −1.   (4) It has a mass of 4 and a charge of +2.

_____ 24. The nucleus of an atom of cobalt-58 contains

    (1) 27 protons and 31 neutrons   (3) 59 protons and 60 neutrons
    (2) 27 protons and 32 neutrons   (4) 60 protons and 60 neutrons

_____ 25. The stability of an isotope is based on its

    (1) number of neutrons, only   (3) ratio of neutrons to protons
    (2) number of protons, only   (4) ratio of electrons to protons

26. Complete the following nuclear reactions, and label if they are <u>natural</u> or <u>artificial</u> <u>transmutation</u>.

a. $_{28}Ni^{64} + _{83}Bi^{209} \rightarrow _{111}Rg^{272} +$ ☐   type: _____

b. $_{88}Ra^{226} \rightarrow$ ☐ $+ _{2}\alpha^{4}$ type: _____

c. $_{4}Be^{9} +$ ☐ $\rightarrow _{3}Li^{6} + _{2}He^{4}$ type: _____
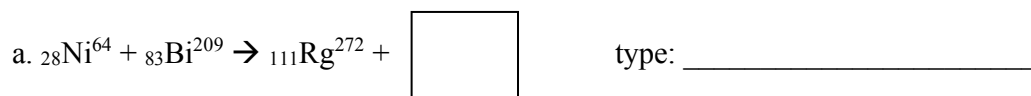
27. Uranium-238, a solid, is a naturally radioactive element found in the earth's crust. As it decays, one of the products is Radon-222, which is a gas and is very radioactive.
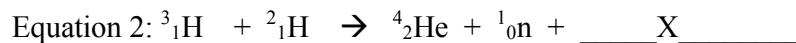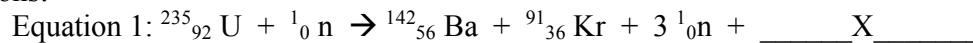
a. Using Reference Table N, write the equation for the decay of $_{86}Rn^{222}$.

_____

b. How many grams of a 10.0 gram sample of Rn-222 would remain after 11.469 days?

28. Determine the fraction of an original sample of K-42 that remains unchanged after 24.72 hours.

29. Given the nuclear equations:

Equation 1: $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3\ ^{1}_{0}n +$ _____X_____

Equation 2: $^{3}_{1}H + ^{2}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n +$ _____X_____

a. Name the nuclear reaction represented by equation 1:_____

b. Name the nuclear reaction represented by equation 2:_____

c. What does the "X" represent for both of these nuclear equations? _____

d. Which equation is the nuclear reaction of the sun? _____

e. Which equation is the nuclear reaction used in power plants? _____