Chapter 11 Homework Key

4, 5, 16, 23, 29, 31, 43, 46, 51, 57

4. a. Half-life: The time it takes for half of a radioactive sample to disintegrate ($t_{½}$)
   b. Positron: Positive electron $^{0}_{-1}e$
   c. Background radiation: Radiation present in nature due to natural and artificial sources
   d. Radioisotope: A radioactive isotope of an element

5. (a) $^{4}_{2}\text{He}$, The nucleon number decreases by four, and the atomic number decreases by two.
   (b) $^{0}_{0}\gamma$, Neither the nucleon number nor the atomic number changes.
   (c) $^{1}_{1}\text{p}$, the nucleon and atomic number each decrease by 1.

16. Alpha particles do not have a lot of penetrating power, and you can easily protect yourself from alpha emitters. However, once they enter your body, you are no longer protected. They are large particles with lots of energy, so they easily cause damage to unprotected tissue.

23. a. $^{179}_{79}\text{Au} \rightarrow {}^{175}_{77}\text{Ir} + {}^{4}_{2}\text{He}$
    b. $^{12}_{6}\text{C} + {}^{2}_{1}\text{H} \rightarrow {}^{13}_{6}\text{C} + {}^{1}_{1}\text{H}$
    c. $^{154}_{62}\text{Sm} + {}^{1}_{0}\text{n} \rightarrow 2{}^{1}_{0}\text{n} + {}^{153}_{62}\text{Sm}$

29. $^{107}_{47}\text{Ag} + {}^{1}_{0}\text{n} \rightarrow {}^{108}_{47}\text{Ag}$ neutron absorption
    $^{108}_{47}\text{Ag} \rightarrow {}^{0}_{-1}\text{e} + {}^{108}_{48}\text{Cd}$ beta emission

31. Divide 2.00 μg in half until you get to 0.0625 μg = this series:
    2.00, 1.00, 0.50. 0.25, 0.125, 0.0625 = divided in half 5 times.
    Or $\frac{2.00}{2^n} = 0.0625$; solve for n: $2^n = 32$, nlog(2) = log(8),
    0.301n = 0.903, n = 5 half lives

    5 half-lives x $\frac{20{,}000\text{ y}}{1\text{ halflife}} = 100{,}000$ years

43. $^{48}_{20}\text{Ca} + {}^{247}_{197}\text{Bk} \rightarrow {}^{293}_{117}\text{Te} + 2{}^{1}_{0}\text{n}$ Two neutrons released
    $^{48}_{20}\text{Ca} + {}^{247}_{197}\text{Bk} \rightarrow {}^{294}_{117}\text{Te} + {}^{1}_{0}\text{n}$ One neutron released

46. An alpha particle; $^{241}_{95}\text{Am} \rightarrow {}^{237}_{93}\text{Np} + {}^{4}_{2}\text{He}$

51. a. $E = mc^2$; 1 g = 0.001 kg
    $E = (0.001\text{ kg})(3.00 \times 10^{8}\text{ m/s})^2 = 9 \times 10^{13}\text{ kg m}^2/\text{s}^2 = 9 \times 10^{13}\text{ J}$
    1 cal = 4.184 J; $9 \times 10^{13} J \frac{1\,cal}{4.184\,J} = 2.15 \times 10^{13}$ cal
    2.25×10^{13} cal = 2.15×10^{10} kcal

    b. $\frac{2.15 \times 10^{10}\text{ kcal}}{110\text{ kcal/bowl}} = 1.95 \times 10^{8}$ bowls = 195 million bowls!

57. Many apply: Power plants control the rate of the fission reaction, so it is slow, continuous, and controlled. Bombs' fission reaction rates are almost instantaneous; all the energy is released at once and is not controlled. Power plants use control rods to regulate the amount of neutrons and how much material is above the critical mass. Bombs have no control rods, and it is all brought above the critical mass at once. People can be nearby and live during the operation of a nuclear power plant; you need to be a long ways away during the operation of a nuclear bomb!