Practice Problems (Chapter 10): Nuclear Chemistry

1. Write the equation for the nuclear reaction described in each of the following processes:
   
   a. Americium-241 ($^{241}\text{Am}$) undergoes alpha decay (inside a smoke detector)
   
   b. Iodine-131 ($^{131}\text{I}$) undergoes normal beta decay (used in therapy for hyperthyroidism)
   
   c. Fluorine-18 ($^{18}\text{F}$) undergoes positron emission (one of the radionuclides used in PET scans)
   
   d. Technetium-99m ($^{99m}\text{Tc}$) undergoes gamma decay to form $^{99}\text{Tc}$ (a diagnostic radioactive tracer used to locate tumors, the “m” indicates a metastable excited nuclear state)
   
   e. Chromium-51 ($^{51}\text{Cr}$) undergoes electron capture (a diagnostic radioactive tracer used to study blood)

2. Sulfur-35 ($^{35}\text{S}$) is a naturally occurring radioactive isotope of sulfur that is produced in the upper atmosphere. What type of radioactive decay would you expect for this isotope, and why?

3. What type of radioactive decay would you expect for $^{238}\text{U}$, and why?
4. How many half-lives must pass before the amount of radioactive material remaining is less than 1% of the original amount?

Answer: Between _____ and _____ half-lives

5. If an object that was once living died 35,500 years ago, what is the exact percentage of the $^{14}$C remaining in the sample? (For $^{14}$C: $t_{1/2} = 5730$ yrs)

Answer: __________________________

6. All other factors being equal, circle the one that would be more hazardous for each of the following:

   a. A gamma emitter…
      
      3 ft away
      9 ft away

   b. An ingested…
      
      alpha emitter
      beta emitter

   c. A nuclide with a half-life of…
      
      2 hours
      2 minutes

   d. A(n)…

      alpha emitter
      gamma emitter
      behind
      behind
      1 mm of paper
      1 mm of lead