DAY 27

1. Find the activity of .1 gram of Hydrogen-3 (Tritium) in Curies.

2. A 100 g sample of element X is found to have an activity of 10 Curies. An atom of element X has a mass of 100 u. Calculate the half-life of element X.

3. A sample of an α-emitter has an activity of 10 mCi. Find the α flux rate at a distance of 10 cm, 20 cm, and 1 m from the sample. The sample radiates isotropically.

4. Look up the decay mode of Polonium-210 and write down the nuclear reaction equation for its decay. Look up the half-life of Po-210 and its mass. Determine the activity of 1 g of pure Po-210 in Bq and Ci. Determine the flux rate a distance of 10 cm and 20 cm from the 1 g sample of Po-210 for all particles emitted by the Po-210.

5. A sample of isotope with an activity of 100 milliCuries has a half-life of 5 days. What will the activity of the sample be after 30 days?

6. For a test, a bronze bearing is doped with Copper-64. The bearing has an activity of 50 μCi.

   The bearing is run through a 24-hour "torture test". The oil that lubricated the bearing is drained out and its activity measured. The activity of the oil is measured to be 0.0625 μCi.

   How much of the bearing was worn away? Give your answer as a percent of the bearing's original mass.

   HINT = μ is micro (10^{-6}). You'll need to know the half-life of Cu-64.

7. A loudspeaker puts out 50 W of sound power. Calculate the sound intensity in W/m^2 at a distance of 10 m from the speaker.

8. A certain decay produces a mass defect of 0.0001 u. Calculate the energy released (in J). If a sample of material is producing an activity of a billion decays per second, calculate the power output of the sample. Calculate the intensity at a distance of 25 cm from the sample.

9. Calculate the mass defect in the decay of the following nuclei:

   Cobalt-60
   Americium-241
   Radon-222

   In each of these, calculate the energy released in the decay.

10. Smoke detectors contain Americium-241, which undergoes α decay. The activity rate in a typical smoke detector is roughly

35,000 Bq. Calculate the power output of the smoke detector.

11. How many grams of Cobalt-60 would be required to put out the power of a small room heater (1500 W)?

12. Protons and neutrons (both nucleons) are assembled together to create nuclei. Sticking 6 protons and 6 neutrons together creates a nucleus of Carbon-12. Sticking 26 protons and 30 neutrons together creates a nucleus of Iron-56. Sticking 146 neutrons and 92 protons together creates a nucleus of Uranium-238.

a) Calculate the mass defect in each case.

b) Calculate the energy released (known as binding energy) in each case.

c)Calculate the binding energy per nucleon in each case.

Iron-56 releases more energy per nucleon than any other nucleus when put together, and requires more energy per nucleon to break it apart than any other nucleus.

13. **PHY 232 Only**

Suppose that parent isotope Q β decays into daughter isotope W with a decay constant of λ.

$$Q \rightarrow W + \beta + \nu$$

We already know that if we have N_0 nuclei of the parent (Q) the number of nuclei of Q at time t decays away to N = 0 via the equation $N_Q = N_0\, e^{-\lambda t}$. So what happens to the daughter (W)? W must start with N = 0 and increase towards N = N_0 as time passes.

Show that the number of W nuclei is given by the equation $N_W = N_0(1- e^{-\lambda t})$.

Sketch a graph of the number of Q's and the number of W's vs. time (rough sketch only).

Show that the "increase Rate" of W is given by R = $+\lambda N$ as opposed to R = $-\lambda N$. Use the calculus definition of R to do this, not just discussion.