

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 μ Ci.

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 μ Ci.

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.

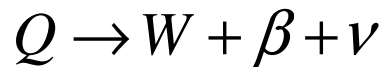
10. Smoke detectors contain Americium-241, which undergoes α decay. The activity rate in a typical smoke detector is roughly

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 .



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.