

Physics 56400 Assignment #1 – Due September 3th

1. We can measure the number of protons that hit an aluminum target by counting the decay rates of radioactive isotopes that are produced by the interactions the protons with the aluminum nuclei. Both Na-22 and Be-7 isotopes are useful for this purpose. The cross section for producing Na-22 from an 800 MeV proton beam on an aluminum target is 15 mb, while the cross section for producing Be-7 is 6.4 mb.
 - (a) Both isotopes decay by emitting gamma rays. If a gamma ray detector has a circular acceptance with a radius of 3 cm and is located 23 cm away from a point-like source, calculate the fraction of isotropically emitted gamma rays that will hit the detector.
 - (b) Look up the decay diagrams for Na-22 and Be-7. What are the energies of the gamma rays emitted in these transitions? What are the branching fractions for Na-22 and Be-7 to decay by gamma emission?
 - (c) Suppose an irradiated aluminum sample with a mass of 0.02 grams that is 0.025 mm thick had a decay rate measured using the apparatus described in (a) that was 1.79 counts per second. If the sample was analyzed 266 days after it was irradiated with an 800 MeV proton beam, what was the samples total activity just after the irradiation was completed?
 - (d) How many protons were incident on the aluminum target?
 - (e) What is the expected counting rate for the Be-7 isotope if it was also analyzed 266 days after the aluminum sample was irradiated?