Tutorial : Detection of Radiation

1. Use Fig 7.2 of Krane to compute the ranges of (a) a 10 MeV α particle in gold; (b) a 5 MeV proton in beryllium; (c) a 1 MeV proton in water. Express your answer in cm.

2. Show that for a particle of mass M, charge z and non-relativistic energy E. the relation $E \times dE/dx = kMz^2$ holds approximately for some k. Deduce from this a possible experimental method for identifying charged particles.
   Hint : You will need a 2-D spectrum

3. A beam of X-rays is attenuated by a factor of 0.64 in passing through a 1cm slab of graphite. Calculate whether this is consistent with Thompson Scattering. No - req. PE effect

4. Calculate the energy gap between the photopeak and the high energy edge of the Compton distribution in a pulse height spectrum from a scintillator detecting gamma radiation from positron annihilation. [170 keV]

5. The immediate environment of a reactor contains a large flux of γ-rays with energies in the vicinity of 5-10 MeV. What thickness of lead is required to reduce the photon intensity by a factor of 10^{12} ?

6. An α-particle point source of 25μCi is placed in contact with one face of a large ionisation chamber. The source emits a single α-particle with an energy of 6.2 MeV. If the α-particles lose all their energy in the chamber, what is the current produced in the output of the chamber ?
   Assume 100% efficiency in charge collection.

7. The 662 keV photon in the decay of ^{137}Cs is observed by a NaI detector with an energy resolution (FWHM) of 53 keV. What will be the resolution for a measurement of the 1.836 MeV photon in the decay of ^{88}Y ?

8. In the decay of ^{88}Y, two photons are emitted with energies of 0.898 MeV (92% of decays) and 1.836 (100% of decays). Sketch the expected γ-ray spectrum for both a NaI and a HPGe detector.

9. Show the Poisson Distribution is the appropriate limit of the Binomial Distribution for the number of random events in an interval.

10. You have only one hour of time on a detection system, and you must determine the activities of the following sources to the greatest precision. How should you schedule the count if :(a) the net source counting rate is 5 times the background rate, (b) the net source counting rate is about equal to the background rate, (c) the net source counting rate is about one fifth of the background rate.

11. For the binomial, Poisson and Gaussian distributions, derive expressions for the variance σ.

12. Derive the expression for neutron moderation energy loss after one collision.

13. In an industrial manufacturing process the thickness of a metallic foil is regulated by observing the attenuation of a photon beam passing through the foil. The desired thickness is 0.1. mm, and for the chosen photon energy the attenuation is 50%. The detection efficiency without the foil in place is 1%. The thickness must be determined quit fast, in about 1s, and the tolerance is 5%. Calculate the necessary source strength.

14. Discuss as many aspects of the attached spectrum as you can.