Radioactivity: Effect of Absorbers*

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Natural radioactivity usually results from nuclear reactions. In radioactivity, some heavier nuclei spontaneously transform into different nuclides. This results in emission of one or more kinds of radiations such as alpha, beta and gamma rays. Out of these gamma rays are short wavelength electromagnetic waves, hence uncharged and highly penetrating inside matter. The purpose of this task is to find the penetration of γ rays through lead or aluminum sheets. We will be using Co-60 as the γ ray source. The schematic is shown in Figure 1.

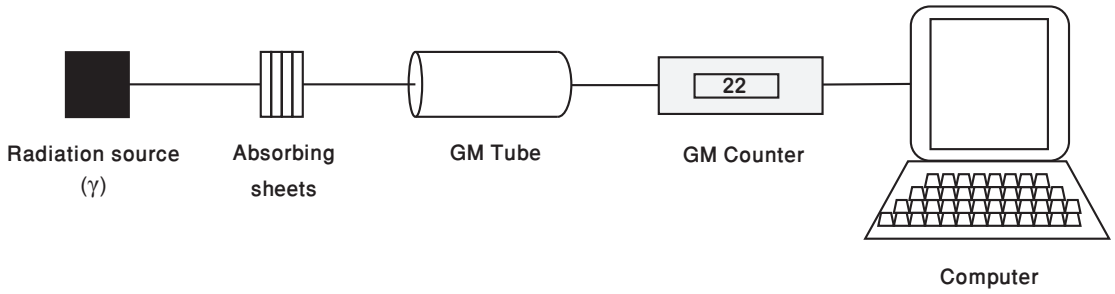

Figure 1: Schematic for the task

The detector is a Geiger-Muller (GM) tube and decays are picked up by the tube and counted by a counter. The supplied software Geiger shows the counts. Save the data and build a histogram of counts/time interval. From the histogram, estimate the mean and the standard deviation. Repeat for different number of absorbing sheets.

Absorption of the radiation can be described by an exponential law, which is given by,

$$I = I_o e^{-\mu x}, \tag{1}$$

where I is the intensity in presence of absorbing sheets, I_o is the intensity without absorbing sheets, μ is the absorption coefficient or attenuation coefficient and x is the thickness of the absorbing sheet. Keep in mind that the electron density is approximately proportional to

the density of the material and the absorption coefficient μ depends strongly on the density of the substance. For this reason, it is convenient to define a mass attenuation coefficient by dividing μ by the density ρ of the material. So, above equation can be written as,

$$I = I_o e^{-\mu x} = I_o e^{\frac{-\mu}{\rho}\rho x} \quad (2)$$

$$I = I_o e^{-\mu' z} \quad (3)$$

where, $z \equiv \rho x$ and $\mu' = \frac{\mu}{\rho}$

The units of μ' are commonly given in cm^2/g. The densities of lead and aluminum are 11.34 g/cm^3 and 2.70 g/cm^3 respectively. Determine the attenuation coefficient and the associated uncertainties in your data. You will be assessed for the linearization of plots, merit of plotting, extracting and representing uncertainties.