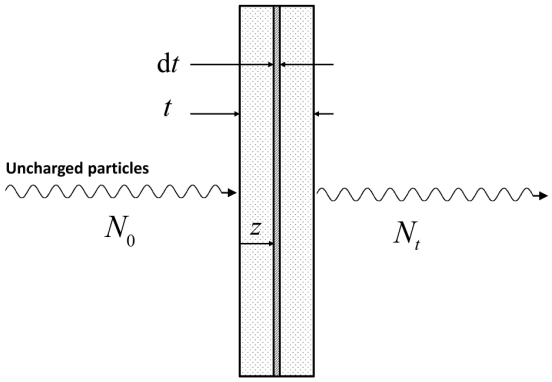
NERS555: Introduction to Radiological Physics and Radiation Dosimetry
Assignment 3: **More Radiometric Calculations** Fall 2018

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Due: Thursday, October 18, 2018 before class ($t \leq 14{:}30$) pm
You may bring it to class, or slip it under my office door at anytime beforehand.
There are many questions on this assignment, with the weight of each indicated below.

Justify all your answers.

1. **[10%]** A broad plane-parallel beam of electrons is perpendicularly incident upon a thin foil that scatters the electrons through an average angle of 20°, stopping none of them.
   (a) What is the ratio of the fluence of primary electrons just behind the foil to that with the foil removed?
   (b) What is the ratio of the number of electrons per cm^2 passing through a plane just behind (and parallel to) the foil to that with the foil removed?
2. **[10%]** The fluence rate decreases with increasing distance from a point source of γ-rays as the inverse square of the distance). The electric field strength of the electric field surrounding a point electric charge does likewise. At a point midway between two identical charges the electric field is zero.
   (a) What is the fluence rate midway between two identical sources?
   (b) What is the essential difference between the two cases?
3. **[10%]** A point source of ^{60}Co γ-rays emits equal numbers of photons of 1.17 MeV and 1.33 MeV, giving a fluence rate of 5.7×10^9 photons cm^{-2} s^{-1} at a specified location. What is the energy fluence rate there, expressed
   (a) in erg cm^{-2} s^{-1}
   (b) in J m^{-2} min^{-1}
4. **[10%]** In the previous exercise, what is the energy fluence of 1.17 MeV photons during 24 hours,
   (a) in erg cm^{-2}
   (b) in J m^{-2}
5. **[20%]** A point source isotropically emitting 10^8 fast neutrons per second falls out of its shield onto a railroad platform 3 m horizontally from the track. A train goes by at 60 km/h. Ignoring scattering and attenuation, what is the fluence of neutrons that would strike a passenger at the same height above the track as the source?
6. **[10%]** An x-ray field at a $\vec{x}$ contains 7.5×10^8 photons m^{-2} s^{-1} keV^{-1}, with energies uniformly distributed from 10 keV to 100 keV.
   (a) What is the photon fluence rate at $\vec{x}$?
   (b) What would be the photon fluence in one hour?
   (c) What is the corresponding energy fluence, in J m^{-2} and erg cm^{-2}?

7. **[10%]** Let $\Sigma_1 = 0.02$ cm^{-1} and $\Sigma_2 = 0.04$ cm^{-1} be the partial linear attenuation coefficients in the slab shown in the figure below.



Let $t = 5$ cm, and $N_0 = 10^6$ particles. How many particles N_t are transmitted on average, and how many are absorbed, on average, by each process in the slab? Extra credit for estimating error bars.

8. **[10%]** A plane-parallel monoenergetic beam of 10^{12} uncharged particles per second is incident perpendicularly on a layer of material 0.02 m thick, having a density $\rho = 11.3 \times 10^3$ kg m^{-3}. For values of the mass attenuation coefficient $\mu = 1 \times 10^{-3}, 3 \times 10^{-4}$, and 1×10^{-4} m^2 kg^{-1}, calculate the average number of primary particles transmitted in 1 minute. Compare in each case with the approximation $exp(-\Sigma t) \approx 1 - \Sigma t$ and give percentage errors.

9. **[10%]** What is the mean free path in each case in the above question?