

Problem 1.

Calculate the geometric cross sections for ${}^4_2\text{He}$ nuclei striking H and ${}^{12}_6\text{C}$. Using these cross sections, determine the geometric cross section for ${}^4\text{He} + \text{CH}_2$.

Solution

$$\begin{aligned}\sigma &= \pi (R_1 + R_2)^2 \\ &= \pi (R_{{}^4\text{He}} + R_{{}^{12}\text{C}})^2 \\ R &= r_0 A^{1/3} \\ r_0 &= 1.4 * 10^{-13} \text{cm}\end{aligned}$$

First ${}^{12}\text{C}$:

$$\begin{aligned}\sigma_C &= \pi r_0^2 (4^{1/3} + 12^{1/3})^2 \\ \sigma_C &= 0.925b\end{aligned}$$

Next H:

$$\begin{aligned}\sigma_H &= \pi r_0^2 (4^{1/3} + 1^{1/3})^2 \\ \sigma_H &= 0.412b\end{aligned}$$

Finally we add them according to their number percentages:

$$\begin{aligned}\sigma_{\text{CH}_2} &= 2\sigma_H + \sigma_C \\ \sigma_{\text{CH}_2} &= 1.75b\end{aligned}$$

Problem 2.

Compare the differences in stopping power determined from the two equations below for protons at 10, 100, and 500 MeV in aluminum.

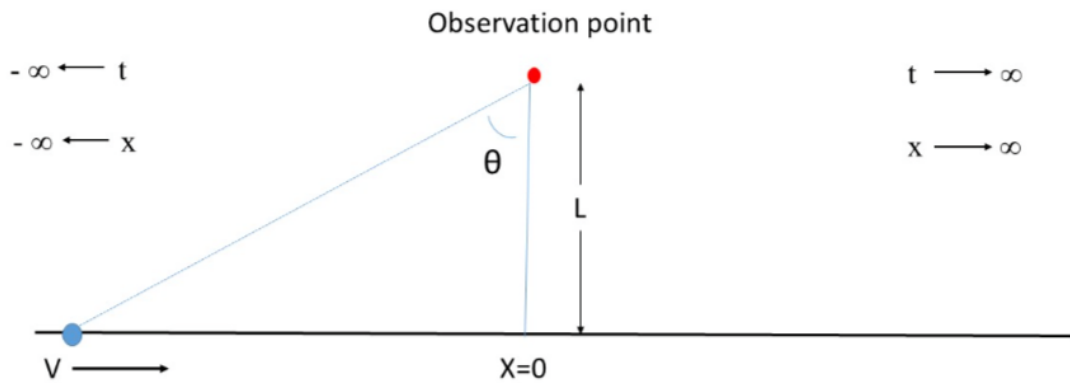
$$S_c = 4\pi r_0^2 m_e c^2 \left(\frac{z^2}{\beta^2} \right) \left(\frac{N_A \rho}{M_m} \right) Z \left(\ln \left(\frac{2m_e c^2 \gamma^2 \beta^2}{I} \right) - \beta^2 \right) \quad (1)$$

$$S_c = 4\pi r_0^2 m_e c^2 \left(\frac{z^2}{\beta^2} \right) \left(\frac{N_A \rho}{M_m} \right) Z \left(\ln \left(\frac{2m_e c^2 \gamma^2 \beta^2}{I} \right) \right) \quad (2)$$

Solution

Problem 3.

A point source of a radioisotope moves along a straight line past an observer (see diagram below). The distance of closest approach between the source and observer is equal to L . The dose rate at the distance of closest approach is known and has a value of \dot{D}_L . If the source moves with a velocity v , what is the total integrated dose at the observation point? Hint: see class notes on the derivation of the stopping power eqn.

**Solution**

Problem 4. Anderson 2.5

- (a) (Anderson 2.4) Calculate the rate of energy loss of a 2.5MeV proton in aluminum. Use Equations 2.26 and 2.27 with no shell corrections or density corrections. Use the I_a value from Table 2.3.
- (b) (Anderson 2.5) Amend the calculations of problem 4 by adding the shell correction and the effective charge correction.

Solution