The average logarithmic energy decrease per collision, ζ, is 0.158 for carbon (A=12). For hydrogen, $\zeta = 1$ = average $\log_e E/E'$ so that E'/E is, on the average, 1/e. To reduce a 1-Mev neutron to 0.025 ev (thermal energies) by collisions with hydrogen, one would require ν collisions with:

$$\nu = \frac{\log_e(E/E')}{\log_e(E/E')_{av}} = \frac{\log_e(10^6/0.025)}{\zeta} = \log_e 4 \cdot 10^7 = 17.5$$

For carbon, since ζ is 0.158, about 17.5/0.158 or 110 collisions would be required.

6.2 NEUTRON DISTRIBUTION FROM POINT SOURCE - EXPERIMENTAL METHODS

Knowledge of the nature of the process of slowing down of neutrons by collisions is essential in the treatment of most problems in which neutron fluxes are introduced into media. Perhaps the simplest question to be answered is: "Given a point source of monoenergetic neutrons, what is the steady state spatial distribution as a function of energy?" The answer will be basic, since any source distribution can be considered a superposition of point sources.

Suppose there is a radium-beryllium neutron source in a large tank of water. For hydrogen the scattering cross section is particularly large at low energies so that a 1-Mev neutron will do most of its traveling between the first few collisions, as shown qualitatively in Figure 32. The distribution of neutrons from the source in water can be investigated by using detectors sensitive to different energy neutrons. Materials such as indium, rhodium, or iodine, each of which has a strong resonance for one particular neutron energy, can be used as detectors for that energy, provided that the neutron absorption corresponding to the resonance level results in the production of radioactivity. Figure 33 sketches the cross section versus energy curve for indium. The reference given with the figure contains further details and bibliographies on activation of such materials. When possible, the detectors are made into foils. Elimination of the effects of thermal neutrons (since most of the detectors, in addition to being responsive to particular resonance energy neutrons, are generally responsive to thermal neutrons as well) is accomplished by surrounding the detector with cadmium. The effect of cadmium may be seen by inspection of its cross section versus energy curve, the broken line of Figure 33.

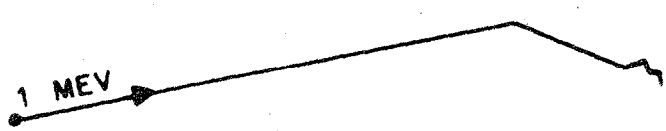

Figure 32. Mean free path decreases as energy does in hydrogenous materials.

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