1 Problem Set 5 Solutions

1. (20pts) We start by using Rutherford's scattering formula,

$$\frac{d\sigma}{d\Omega} = \frac{b^2}{16sin^2\frac{\theta}{2}}$$

$$b = \frac{Z_1 Z_2 e^2}{E_\alpha} = \frac{Z_1 Z_2 e^2 \hbar c}{E_\alpha \hbar c}$$

$$= 43.9135fm$$

$$\Delta\Omega = \frac{\Delta A}{R^2} = \frac{1}{900}$$

$$CR = \Phi(\frac{d\sigma}{d\Omega}\Delta\Omega)n_{Au}d = 7.61\frac{cts}{min}$$

2. (10pts) Consider a head-on collision:

$$\frac{1}{2}mv^2 = E = \frac{Z_1 Z_2 e^2}{r}$$

$$r = \frac{Z_1 Z_2 e^2}{E} = 30.1fm$$

This gives us a distance for the closest approach for the given energy. Thus, for higher energies the nuclear forces would affect the scattering.

3. (20pts) The distance travelled through the aluminum is:

$$d = \frac{.0025\frac{g}{cm^2}}{2.69\frac{g}{cm^2}} = 0.000929cm$$

$$\sigma = \frac{P(interaction)}{dN}$$

where N is the number density of the aluminum.

$$P(interaction) = \frac{8}{10^6}$$

$$\sigma = 1.43E - 25cm^2$$

$$= .14b$$

4. (30pts) Please refer to the spring 2001 class notes for a thorough solution of the exact same problem.
5.(20pts)

$$\frac{1}{\lambda} = N_H \sigma = \frac{\rho N_A}{1g/mol}\sigma$$

$$\lambda = 0.042cm$$

We need the average number of collisions from 1eV to 1MeV,

$$ln(\frac{10^6}{1}) = 13.82$$

It takes 13.8 collisions to slow through this range. The total distance is then,

$$d = 13.8\lambda = 0.58cm$$