Comments on Homework Set #5 & #6

1. Draw potential information (2 graphs)

1) Real Part - Nuclear, Coulomb, Nuclear+Coulomb, E_{cm}
2) Extract the maximum height of the Coulomb barrier.
3) Extract the radial distance at the maximum height.
4) Imaginary Part - 3 W's

2. Write down characteristics of the scattering

1) Target mass $m_2 = A_2 m_{amu}$,
   Projectile mass $m_1 = A_1 m_{amu}$,
   Reduced mass $\mu = A_1 A_2/(A_1 + A_2)$
2) Energy E_{lab}, E_{cm}
3) Relative velocity ($v/c = \sqrt{E_{lab}/469A_1}$, E_{lab} in MeV.)
4) Wave number ($k = \mu v/\hbar$), Wave length ($\lambda = 2\pi/k$)
5) Target charge (Z_2), Projectile charge (Z_1),
6) Sommerfeld parameter, $\eta = Z_1 Z_2 e^2/\hbar v$
7) The closest distance in head-on collision,
   $a = Z_1 Z_2 e^2/2E_{cm}$
8) The proximity radius of two nuclei,
   $R_0 = r_0(A_1^{1/3} + A_2^{1/3})$

3. Coulomb Barrier.

The angular momentum corresponding to the impact parameter b is given

$$\ell = kb$$

The closest distance on the Rutherford orbit with a scattering angle θ,

$$D = a(1 + \csc(\theta/2)) = \eta/k(1 + \sqrt{1 + (\ell/\eta)^2})$$

The interaction radius is defined as

$$R_N = r_N(A_1^{1/3} + A_2^{1/3})$$

where r_N is known to be 1.68 fm from the experiments. The critical scattering angle θ_c and the critical angular momentum ℓ_c when $D = R_N$ become

$$\begin{aligned} \sin(\theta_c/2) &= \frac{a}{R_N - a} \\ b_c &= R_N\sqrt{1 - 2a/R_N} \\ \ell_c &= kb_c = kR_N(1 - 2\eta/kR_N) \end{aligned}$$

The height of the Coulomb barrier is

$$E_B = Z_1 Z_2 e^2/R_N$$

Compare these values, R_N and E_B, with ones obtained 1-2) and 1-3).

4. Strong Absorption Radius

1) Find out the following angular momenta

$$\begin{aligned} \bar{\ell} &= \sum \ell\sigma_\ell / \sum \sigma_\ell \\ \sqrt{\bar{\ell}^2} &= \sqrt{\sum \ell^2\sigma_\ell / \sum \sigma_\ell} \\ T_{\ell_{sa}} &= 0.5 \end{aligned}$$

2) Obtain the strong absorption radius $R_{sa} = \ell_{sa}/k$
3) Compare this value with R_W.