SCPY322 Nuclear and Particle Physics
Problem Set # 4 - Nuclear reaction cross section
Date: March 25, 2021. Due date: April 2, 2021 (put in my mail-box)

1. The screened Rutherford cross section is often used to describe the angular distribution of light charged particle having elastic scattering out of heavy nuclei. Its expression is

$$\frac{d\sigma}{d\Omega} = \frac{A}{(1-\cos\theta + a)^2}$$

, for A, a are dimensions of a target nucleus and projectile particle, respectively. The total cross section is known to be σ_0. Show that

   (a) (20 pt.)
$$A = \sigma_0 \frac{a(2+a)}{4\pi}$$

   (b) (20 pt.) If the forward ($\theta = 0$) intensity is 10^6 times greater than the backward ($\theta = \pi$) intensity, show that

$$A = \frac{2}{999}$$

   (c) (10 pt.) In the limit $a \to \infty$ show that the cross section is isotropic.

2. (50 pt.) In the $X(a,b)Y$ nuclear reaction, with the knwon Q and X is at rest, derive explicitly that

$$T_b^{1/2} = \frac{\sqrt{m_a m_b T_a}\cos\theta \pm \sqrt{m_a m_b T_a \cos^2\theta + (M_Y + m_b)[M_Y Q + (M_Y - m_a)T_a]}}{M_Y + m_b}$$

   (Some details appear in Krane's book.)