PROBLEM SET 3
Physics 215C- Quantum Mechanics, SPRING 2008

(Due Wednesday, April 30.)

1. (Shankar Exercise 19.3.2) Show that if \( V(r) = -V_0 \theta(r_0 - r) \),

\[
\frac{d\sigma}{d\Omega} = 4r_0^2 \left( \frac{\mu V_0 r_0^2}{\hbar^2} \right)^2 \frac{(\sin qr_0 - qr_0 \cos qr_0)^2}{(qr_0)^6}.
\]

Show that as \( kr_0 \to \infty \) the scattering becomes isotropic and,

\[
\sigma \approx \frac{16\pi r_0^2}{9} \left( \frac{\mu V_0 r_0^2}{\hbar^2} \right)^2.
\]

(Here and in problem 2, recall that for elastic scattering the magnitude of the incoming and outgoing momenta \( k \) is related to the magnitude of the momentum exchanged \( q \) by \( q^2 = 2k^2(1 - \cos \theta) \).)

2. (Shankar 19.3.3) Show that for the Gaussian potential, \( V(r) = V_0 e^{-r^2/r_0^2} \),

\[
\frac{d\sigma}{d\Omega} = \frac{\pi r_0^2}{4} \left( \frac{\mu V_0 r_0^2}{\hbar^2} \right)^2 e^{-q^2r^2/2}
\]

\[
\sigma = \frac{\pi^2}{2k^2} \left( \frac{\mu V_0 r_0^2}{\hbar^2} \right)^2 (1 - e^{-2k^2r_0^2}).
\]

Hint: Since \( q^2 = 2k^2(1 - \cos \theta) \), we have \( d(\cos \theta) = -d(q^2)/2k^2 \).