1. Calculate the differential cross section (in terms of the transition operator matrix elements) for two-body scattering in the laboratory frame where particle 1 of mass $m_1$ is initially at rest, particle 2 of mass $m_2$ is initially moving with momentum $p = p_2$ and the angular distribution of particle 2 is measured. (hint - you need to find the initial relative velocity in this frame and integrate over all variables that are not measured.

2. Assume that an electron scatters off of a potential due to a spherically symmetric electric charge density, $-e\rho(r)$. Find the scattering amplitude and differential cross section in the Born approximation. Show how these are related to the Fourier of this charge distribution.

3. Consider a three-dimensional scattering problem for two particles of mass $m$ scattering with a potential $\langle P', k'|V|P, k \rangle = -\lambda \delta(P' - P) \frac{1}{a^2 + k'^2} \frac{1}{a^2 + k^2}$

Solve the Lippmann Schwinger equation exactly to find

$$\langle k'|T\left(\frac{k^2}{2\mu} + i\epsilon\right)|k \rangle$$

4. For the potential of problem 3 find the scattering amplitude $F(k', k)$ and the differential cross section in the center of mass frame.

5. For the potential of problem 3 calculate the total cross section using the optical theorem.

6. For the potential of problem 3 the Born approximation can be obtained from the exact solution by keeping only the term in the scattering amplitude that is linear in the coupling constant $\lambda$. Compute the differential cross section in the Born approximation and compare the result to the exact cross section.