1. (a) Show that in an elastic scattering, the angle of recoil of the target particle relative to the incident direction of the scattered particle is \( \Phi = \frac{1}{2}(\pi - \Theta) \).

(b) It is observed that in elastic scattering the scattering cross section is isotropic in terms of \( \Theta \). What are the corresponding probability distributions for the scattered energy of the incident particle, \( E_1 \), and for the recoil energy of the target particle, \( E_2 \)?

2. Problem Goldstein 3-8 (Goldstein, 2nd edition, Problem 3-34)

3. Problem Goldstein 3-31 (Goldstein, 2nd edition, Problem 3-26)

4. Problem Goldstein 3-32 (Goldstein, 2nd edition, Problem 3-27)

5. Find the equilibrium position and the eigenfrequency for small oscillation for a particle of mass \( m \) subject to the following one-dimensional potentials:

   (a) \( V = V_0(1 - e^{-\alpha(x-a)})^2 \),

   (b) \( V = V_0(e^{-2\alpha x} - 2e^{-\alpha x}) \),

   (c) \( V = V_0 \cosh \alpha x \), and

   (d) \( V = V_0(1 - \cos \alpha x) \),

   where \( V_0, \alpha, \) and \( a \) are constants.

6. Three masses \( m, M, \) and \( m \) are suspended by weightless rigid rods of length \( a \) each as shown. The masses on the side are also connected to the mass \( M \) by weightless springs of spring constant \( k \) and unstretched length \( a \). The motion is limited in the plane as shown below.

   (a) Write down the Lagrangian in appropriate coordinates of your choice.

   (b) If the system is subject to small oscillations, find the eigenfrequencies of the normal modes.

   (c) Describe qualitatively each normal mode with a simple sketch.