1. An isolated system consists of three particles of mass $m_1$, $m_2$, and $m_3$ that interact with pairwise forces.
   a. What is the net force (sum of all of the forces) on this system?
   b. What quantities are conserved?
   c. If $m_1 = m_2 = m_3/2$ and $v_1 = v_2$ find $v_3$?

2. The position of a particle in a damped harmonic oscillator satisfies the differential equation
   \[ \frac{d^2x}{dt^2} + 2\gamma x + \omega_0^2 x = 0 \]
   where $\omega_0 > \gamma > 0$. Independent solutions are
   \[ x(t) = e^{-\gamma t} e^{\pm i\omega t} \quad \omega^2 = \omega_0^2 - \gamma^2. \]
   a. Find the solution of this problem satisfying $x(0) = 0$ and $v(0) = v$ where $v(0)$ is the initial velocity.
   b. Show that this solution is real for all time.
   c. How long does it take for the maximum amplitude of the oscillations to be half of its original value?
   d. Assume that this system is initially at rest at $x(0) = 0$ and it is struck by a hammer with force per unit mass $F/m$ that is applied for a short period of time $\Delta t$. Find $x(t)$ for $t > 0$.

3. Consider the two forces:
   \[ F_1 = \hat{i}(3x^2 + 2y^2 + 4xy) + \hat{j}(4xy + 2x^2) \]
   \[ F_2 = \hat{i}(3x^2 + 2y^2 + 2xy) + \hat{j}(4xy - 2y^2) \]
   a. Determine if either of these forces are conservative?
   b. For the conservative force(s) find the potential that leads to the force(s).
   c. If a particle of mass $m$ is acted on by the conservative force above, write an expression for the conserved quantity?

4. A particle of mass $m$ moves under the influence of a force with potential
   \[ V(x) = ax^2 + \frac{b}{x^2} \]
   a. Find the force on the particle.
   b. Find any equilibrium point(s).
   c. Determine which equilibrium point(s) are stable.
   d. What are the angular frequencies of the small oscillations about the stable equilibrium point(s).