1) Find the curl, $\nabla \times$ F, for the following forces: (a) F = kr; (b) F = (Ax, By^2, Cz^3); (c) F = (Ay^2, Bx, Cz), where A, B, C and k are constants.

2) Verify that the gravitational force $-GMm\mathbf{r}/r^2$ on a point mass m at *r*, due to a fixed point mass M at the origin, is conservative and calculate the corresponding potential energy.

3) A mass m is in uniform gravitational field, which exerts the usual force F = mg vertically down, but with g varying with time, g = g(t). Choosing axes with y measured vertically up and defining U = mgy as usual, show that F = $-\nabla$ U as usual, but, by differentiating $E = (1/2)mv^2 + U$ with respect to t, show that E is not conserved.

4) Verify the three equations: $x = r \sin\theta \cos\phi$, $y = r \sin\theta \sin\phi$, and $z = r\cos\theta$ that give x, y, z in terms of the spherical polar coordinates r, θ, ϕ. (b) Find expressions r, θ, ϕ in terms of x, y, z.

5) Consider a head-on elastic collision between two particles. Prove that the relative velocity after the collision is equal and opposite to that before. That is, $v_1 - v_2 = -(v'_1 - v'_2)$, where v_1 and v_2 are the initial velocities and v'_1 and v'_2 the corresponding final velocities.

6) A particle of mass m_1 and speed v_1 collides with a second particle of mass m_2 at rest. If the collision is perfectly inelastic, what fraction of the kinetic energy is lost in the collision? Comment on your answer for the cases that $m_1 << m_2$ and that $m_2 << m_1$.