Physics 235, Homework Set 08

Write the following text on the front cover of your homework assignment and sign it. If the text is missing, 20 points will be subtracted from your homework grade.

Honor Pledge for Graded Assignments
"I affirm that I have not given or received any unauthorized help on this assignment, and that this work is my own."

_____

_____

_____

Signature _____

1. The center of gravity of a system of particles is the point about which the external gravitational forces exert no net torque. For a uniform gravitational force, show that the center of gravity is identical to the center of mass for the system of particles.

2. A projectile is fired at an angle of 45° with initial kinetic energy E_0. At the top of its trajectory, the projectile explodes into two fragments (an additional energy E_0 is released during the explosion). One fragment of mass m_1 travels straight down. What is the velocity (specify both magnitude and direction) of the second fragment of mass m_2, and the velocity of the first?

3. A fixed force center scatters a particle of mass m according to the force law $F(r) = k/r^3$. If the initial velocity of the particle is u_0, show that the differential scattering cross section is

$$\sigma(\theta) = \frac{k\pi^2(\pi - \theta)}{mu_0{}^2\theta^2(2\pi - \theta)^2 \sin\theta}$$

4. The most energetic α-particles available to Ernest Rutherford and his colleagues for the famous Rutherford scattering experiment were 7.7 MeV. For the scattering of 7.7 MeV α-particles from ^{238}U (initially at rest) at a laboratory scattering angle of 90°, find the following:
    a. The recoil scattering angle of ^{238}U in the laboratory frame.
    b. The scattering angles of the α-particle and ^{238}U in the center-of-mass frame.
    c. The laboratory kinetic energy of the scattered α-particle and ^{238}U.
    d. The impact parameter b.
    e. The distance of closest approach r_{min}.
    f. The differential cross section at a laboratory scattering angle of 90°.
    g. The ratio of the probabilities of scattering at 90° to that of 5° in the laboratory frame.

5. A rocket in outer space, in a negligible gravitational field, starts from rest and accelerates uniformly with an acceleration a until it reaches its final speed v. The initial mass of the rocket is m_0. How much work does the rocket's engine do?