Physics 310 - Assignment #4 - Due November 8^{th}

1. (Similar to *Fowles and Cassiday, 6.6*)
   (a) A geosynchronous orbit is one for which a satallite is always at a fixed position above the surface of the Earth. Calculate the radius of a geosynchronous orbit.
   (b) The Moon has an approximately circular orbit. If the Moon orbits the earth once every 29.53 days, caclulate the radius of the Lunar orbit.

2. (Similar to *Fowles and Cassiday, 6.19*)
   At a certain point in its elliptical orbit around the Earth, a satallite receives a small tangential impulse so that its velocity changes from v to $v + \delta v$. Find the resultant small changes in a, the semi-major axis.

3. A satallite is in a low altitude circular orbit of radius r_0. Calculate the increase in speed, Δv, required to change its orbit to an elliptical orbit with its apogee at the mean radius of the Lunar orbit, r_1. Calculate the fractional change in r_1 if there was a 1% error Δv.

4. (*Fowles and Cassiday, 7.6*)
   A ball is dropped from a height h onto a horizontal surface.
   (a) If the coefficient of restitution is ϵ, show that the total vertical distance the ball goes before the rebounds cease is $h(1 + \epsilon^2)/(1 - \epsilon^2)$.
   (b) Find the total length of time that the ball bounces.
   Ask if you need a hint.

5. A proton of mass m_p with initial velocity v_0 collides with a deuterium atom with mass $2m_p$ that was initially at rest.
   (a) Calculate the velocity of the centre-of-mass.
   (b) If the collision is elastic and the proton is scattered with an angle $\theta^* = 30^\circ$ in the centre-of-mass frame, calculate the scattering angles of the proton and the deuteron in the lab frame.

6. (*See* `http://www.darwinawards.com/darwin/darwin1995-04.html`)
   To arrive at Purdue in time to teach Physics 310, a physics professor attaches a rocket to his 1999 Corolla. If the mass of the rocket is 1/2 the mass of the car and it ejects mass at a constant rate with a relative velocity $V = 100$ m/s, what will be the final speed of the car?