Physics 1210
Homework 11 Written-out Problems

1.
Satellites like the Hubble Space Telescope (11,000.0 kg) orbit about 200.000 km above the surface of the Earth in circular orbits. Tiny amounts of air drag from the upper atmosphere there cause satellites to slowly undergo orbital decay. Due to this, eventually the Hubble Space Telescope's orbit will be 150.000 km above the surface of the Earth and still circular.

A) Find the speed of the satellite in its initial orbit as well as the speed of the eventual orbit.
B) Show whether the satellite has gained or lost energy (consider kinetic and potential energy).
C) Does the change in total energy make sense given the air resistance (frictional) force causing the change?

2.
In the future you are a citizen on a massive space station. The space station is shaped like a long tube of mass M and length 2L as shown below. You decide to go out on a space-walk to take a picture of the station to send back home some distance D above the center of the station. While you float there, you wonder if you should be worried about the gravitational force between you and the station and decide to compute it.

A) First express the gravitational force as an integral of the force between you and each infinitesimal mass element, dm and the distance to those mass elements.

B) Now express your equation in terms of just lengths utilizing dm = λ dx where the linear mass density λ is M/2L and dx is an infinitesimal length element along the station. In addition express the distance to these length elements in terms of D and the elements' location along the ship (x). The vertical elements of these forces cancel so add a trig term to only obtain the horizontal component of the force at any dx.

C) Then utilize $\int \frac{dx}{\left(\sqrt{x^2+D^2}\right)^3} = \frac{x}{D^2\sqrt{x^2+D^2}}$ to perform the integration and find a final expression for the net gravitational force. Are the units on your final value in Newtons?