Physics 1135 Homework #15: Universal gravitational force

1. a) Uranus has a mass of 8.68×10^{25} kg and a radius of 2.33×10^{7}m. Find the free-fall acceleration on the surface of Uranus.
b) Jupiter's moon Io has a mass of 8.9×10^{22}kg. It is orbiting Jupiter at a distance 4.22×10^{8}m and has an orbital period of 1.77 Earth days. Find the mass of Jupiter.

2. The center of a moon of mass *m* is a distance *D* from the center of a planet of mass *M.* At some distance *x* from the center of the planet, along a line connecting the centers of planet and moon, the net force on an object will be zero.
a) Derive an expression for *x* in terms of m, M, and D.

b) If the net force is zero a distance ⅔D from the planet, what is the ratio R of the mass of the planet to the mass of the moon, M/m?

3. A geosynchronous satellite moves in a circular orbit around the Earth and completes one circle in the same time *T* during which the Earth completes one revolution around its own axis. The satellite has mass *m* and the Earth has mass *M* and radius *R*. In order to be geosynchronous, the satellite must be at a certain height *h* above the Earth's surface.
Derive an expression for *h* in terms of *m*, *M*, *R*, *T* and constants and find a numerical value. Earth's mass and radius can be found in your textbook.

4. **Binary Star**. Two identical stars of mass *M* orbit around the center of a circle with radius *R*. The stars are always on opposite sides of the circle as shown.

Derive expressions for the orbital speed and the orbital period of each star.