Assignment 4; Phys 185 Name _____

1. (30 points) You have a bucket tethered to a rope, and you swing the rope such that the bucket rotates in a vertical circle with radius r. There is a small ball with mass m in the bucket. What is the minimum v at the top of the circle that you must have in order for the ball not to fall out of the bucket during rotation?

2. (30 points) The diagrams below show a binary star system. The white star is more massive than the one shown as a black circle, but not hugely more massive. The stars revolve in circular orbits around their common center of mass. On diagram (a), draw and label the velocity and acceleration vectors for each star. On (b), show the forces on each star. Assume that the stars are in deep space and we can ignore the effects of the rest of the universe on either star. Draw the sizes of your arrows such that I can tell whether v, a, and F for each star is larger, smaller, or equal to the other.

(a)

(b)

Explain your reasoning:

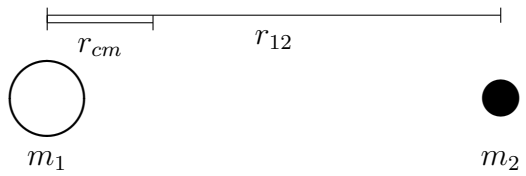
3. (40 points) Astronomers observe a planet that has a small moon with a circular orbit. Call the planet's mass M and the moon's mass m; from the orbit, astronomers can also tell that $m \ll M$. Astronomers can also observe r, the distance between the planet and the moon, and T, the period of the moon's orbit around the planet. They also know that gravity is the only significant force between the moon and the planet.

(a) Given all the above information, can the astronomers determine M? If so, find an equation for M.

(b) Given all the above information, can the astronomers determine m? If so, find an equation for m.

Extra Problems (not graded)

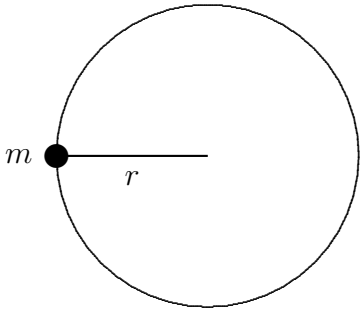
4. (0 points) The diagram below shows a binary star system. The white star has mass m_1, the black star mass m_2. The distance between the centers of stars is r_{12}. The only force on each star is the gravity from the other star. You look up the center of mass for two bodies and find that the center of mass is located at a distance $r_{cm} = \frac{m_2}{m_1+m_2} r_{12}$ from the center of the white star.



(a) Find equations for a_1, a_2, v_1, v_2—the magnitudes of the accelerations of each star and the speeds of each star, in terms of m_1, m_2, r_{12}, and appropriate physical constants.

(b) To confirm your results, show that the period of the stars—the time it takes for each to make one full circle—is the same.

5. (0 points) You have a mass attached to a string, and you set the mass in motion such that it goes in a vertical circle (in the xy-plane, so it keeps changing height).



(a) Explain why the circular motion of the mass cannot be *uniform* circular motion.

(b) At what point on the circle is the tension in the string the largest? Why?

(c) Find an equation for $T_{\max}$, the largest tension in the string during the rotation. $T_{\max}$ might depend on m (the mass of your mass), r (the radius of the circle), g (the acceleration due to gravity), v (the speed of your mass at the point where the tension was largest), and k (the spring constant).