PHY6938 Mechanics Fall 98 January 21, 2000

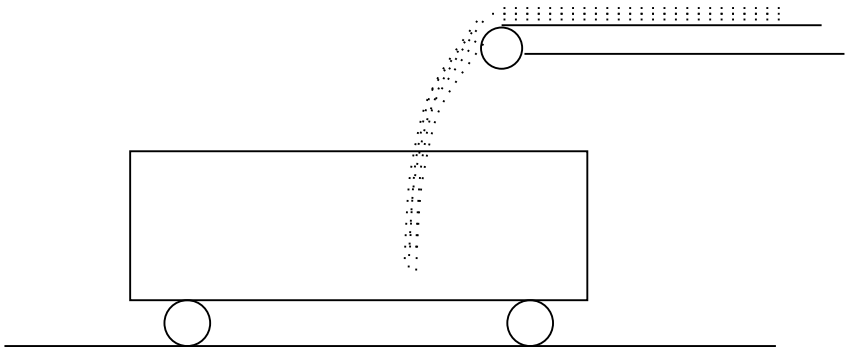
1. The asteroid Toro was discovered in 1964. Its radius is about 5 km.

a) Assuming the density of Toro is the same as that of Earth, find its total mass and the acceleration due to gravity at its surface.

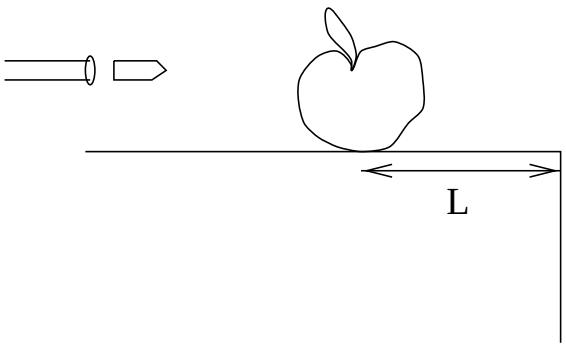
b) Suppose a body is to be placed in a circular orbit around Toro, with radius just slightly larger than the asteroid's radius. What is the speed of the body?

c) If a rock is thrown into a circular orbit around Toro at a height 200 m above the surface, what is its period of revolution?

2. A conveyor unloads sand with a horizontal velocity of v_0 into a cart at rest on a level track with a mass rate of m_0 per unit time. The top of the conveyor is a height h above the floor of the cart. Determine the force that the sand applies to the cart at time $t > 0$. Ignore the height of the sand pile.



3. An apple of mass M is placed on a table. Let the coefficient of kinetic friction between the apple and the table be μ_k. A gun is fired at the apple, and a bullet of mass m and initial velocity v_0 hits the apple, and eventually ends up stuck in it.



a) What is the initial velocity of the apple?

b) After what time will the apple stop (if it placed far from the edge of the table)?

c) If the apple is initially placed at a distance L from the edge of the table, what is the minimum velocity $v_{\min}$ of the bullet, such that the apple falls from the table?

d) If a second apple is initially placed exactly half-way between the first apple and the end of the table (a distance $L/2$ from both), describe what will happen to the two apples following the bullet impact. Assume that $v_0 > v_{\min}$, and that both apples have the same mass M.

4a) A cylindrically shaped log is placed in water. The log is 15.0 cm in diameter and 1.0 m long, and is placed in the water oriented with its length along the surface. Additionally, a 1.0 m long uniform rod with a mass of 2.5 kg is placed along the top of the log. With this rod in place, the log settles at an equilibrium position floating in the water with exactly 7.5 cm (half its diameter) exposed above the surface, and 7.5 cm below the surface. What is the density of the log?

b) Consider the exact same situation as described above, except that instead of the log being placed into water, it is now placed in a mixture of alcohol and water. The mixture is 18.0 percent (by weight) alcohol and 82.0 percent water. What would the density of the log now need to be in order to make it float as described in part a)??