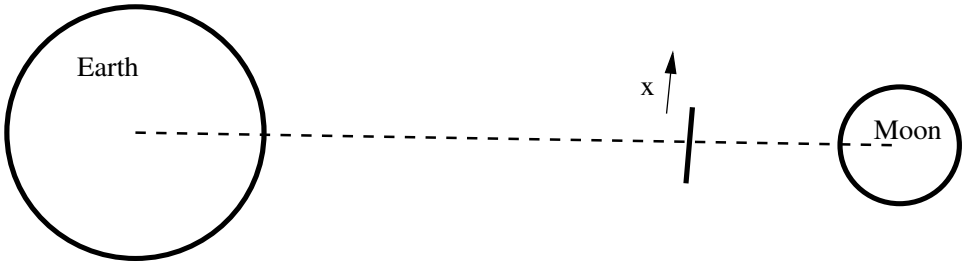
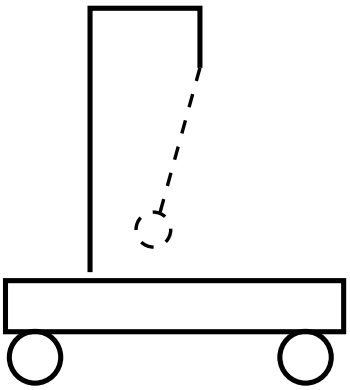
Physics 10310 — General Physics I

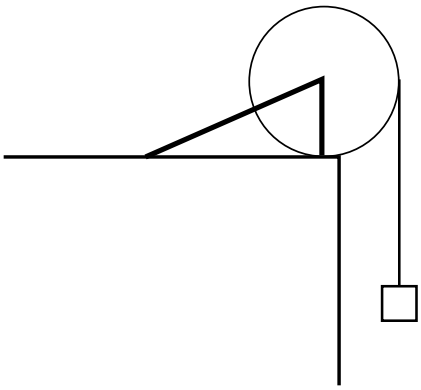
Final Exam – Fall 2009
There are 7 problems. Please do all problems. Please show all work.



1. **Suppose that an object is placed at the point at which the gravitational attraction of the Moon is just canceled by that of Earth. Further suppose that the object is displaced a small distance x along a line perpendicular to the line connecting the centers of the Earth and Moon. What are the magnitude and direction of the net force on the object as a function of x? You can use the approximation that** $(r^2+x^2)^n = r^{2n}(1+\frac{nx^2}{r^2}+...)$ **which is valid for** $x^2/r^2 << 1$**.**
Hints: You only need to work to first order in x/r**. Take** M_E **and** M_M **for the masses of the Earth and Moon respectively.**



2. **A simple pendulum of mass 0.5 kg and length 0.65 meters is attached to a cart of mass 1 kg. The mass of the pendulum support is negligible. The cart can roll freely on a horizontal surface. at t=0 the pendulum bob is released from rest when the string makes an angle of 10° with the vertical. Assume the motion of the cart relative to the ground is simple harmonic motion. Determine the amplitude of the motion of the cart. Why would you expect the cart to move in simple harmonic motion?**
Hints: The standard formula for the motion of a pendulum is relative to its pivot point.



3. **A massless rope is wrapped around a hollow cylinder of radius 12 cm whose central axis is fixed in a horizontal position. A mass of 4.0 kg hangs from the rope and starting from rest moves 180 cm in 2.0 seconds. What is the mass of the cylinder?**

4. **A sailor on top of a mast 26 m high drops a hammer. The ship is rolling with a maximum angle away from the vertical of 15°. At the moment the hammer is dropped the mast is exactly vertical while the top of the mast is moving laterally at a speed of 3.6 m/s. Will the hammer fall into the sea or onto the deck? The mast is in the center of a 19 m wide deck.**

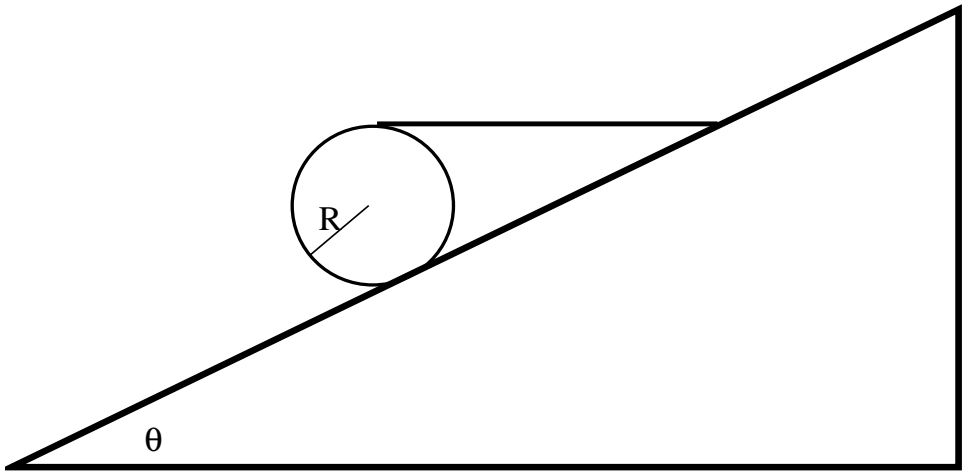
5. **The velocity of an object is given as a function of time by** $v = (4m/s^4)t^3 - (1m/s^2)t$ **where**

v is measured in meters per second and t is measured in seconds. How far did the object move in the period from 0.5 to 1.5 seconds? Find the average velocity in this period and compare it to the maximum and minimum values of the velocity in the same period. *Note you are given the formula for the velocity not the displacement.*

6. **A track consists of a descending ramp, a straight track and an ascending ramp. The smooth (frictionless) ramps both make an angle of 20° with the horizontal. The coefficient of kinetic friction on the horizontal surface is μ_k =0.18. An object starts sliding from rest at a height of 1.3 meters on the descending ramp. It slides down the ramp and across the horizontal track and up the ascending ramp. It achieves a vertical height of 0.55 meters before it momentarily comes to rest.**
   a) How long is the horizontal part of the

track?

b) The object slides back down from the 0.55 meter height. How far along the horizontal track does it slide?



7. A hollow cylinder of mass M and radius R rests on an inclined plane. It is held in place by a horizontal string that is attached to the upper edge of the cylinder. If the angle that the plane makes with the horizontal is θ and the coefficient of static friction between the cylinder and the inclined plane is μ_s. What is the smallest value of μ_s that will maintain this position as an equilibrium position. In an equilibrium position there are no net forces and no net torques.

Hints: The normal force is chosen to get the sum of all forces in that direction to be zero. It is not $mg\cos(\theta)$.