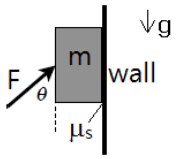
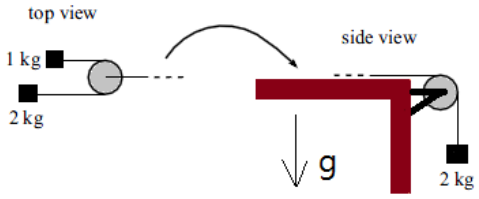
PHYSICS I — SPRING 2016

Homework Assignment #2 (Chs. 6-9) — **Due: 4:30 PM, April 6**

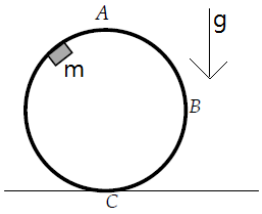
problem[1](10pts) A block of mass m is being held stationary against a vertical wall by pushing on it with the force F. The static friction coefficient between the block and the wall is $\mu_s < 1$. (a) Find the value of θ for which F is the smallest possible. (b) What is that smallest value, in terms of the given quantities?



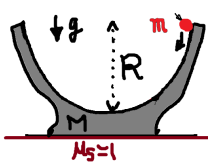
problem[2](10pts) Masses of 1kg and 2kg lie on a frictionless table, connected by a massless string which passes around a massless pulley. The pulley is connected to another mass of 2 kg, which hangs down over another massless pulley, as shown. Find the accelerations of all three masses after they are released from rest. Hint: Think carefully about the acceleration constraint.



problem[3](10pts) A block of mass m slides on the inside of a vertical frictionless circular track, moving clockwise. The radius of track is R. At point A the block has the minimum necessary speed. Find: (a) The normal force from the track at C. (b) The acceleration (magnitude and direction) of block at B. Express your answer in terms of the given quantities and g.



problem[4](10pts) A hemispherical bowl of mass M and inner radius R rests on a table. The inside surface of the bowl in frictionless, while the coefficient of friction between the bottom of the bowl and the table is $\mu_s = 1$. A particle of mass m (and negligible size) is released from rest at the top of the bowl and slides down into it. What is the largest value of m/M for which the bowl will never slide on the table?



problem[5](10pts) A block of mass m is located at the top of a frictionless wedge as shown. The wedge is fixed to a bus moving at a constant speed of u to the right. The block is released from rest and slides down the wedge. A student sitting on that bus calculates the speed of the block at the bottom of wedge by conservation of energy:

$$\frac{1}{2}mv^2 = mgH.$$

Therefore $v = \sqrt{2gH}$. A student "standing on the ground " again uses conservation of energy to find the speed of block when it reaches at the bottom of wedge:

$$\frac{1}{2}mw^2 = \frac{1}{2}mu^2 + mgH,$$

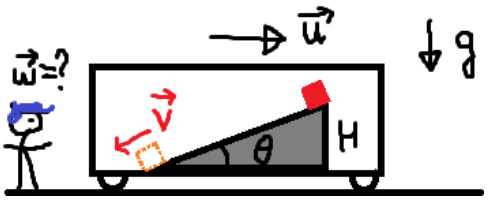
Therefore,

$$w = \sqrt{2gH + u^2}. \tag{1}$$

He now checks to see if this result agrees with the one he expected from $\vec{w} = \vec{u} + \vec{v}$:

$$w = \sqrt{(\vec{v} + \vec{u})^2} = \sqrt{v^2 + u^2 - 2vu\cos\theta} = \sqrt{2gH + u^2 - 2vu\cos\theta}. \tag{2}$$

He finds two different results (1) and (2). Determine which result is wrong, (1), (2) or both, and correct the error(s) in the above derivation(s).

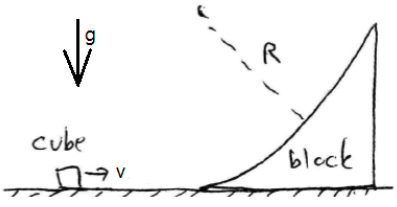


problem[6](10pts) Suppose that a force acts on a particle of mass m moving in a straight line. The position of the particle as a function of time is given by

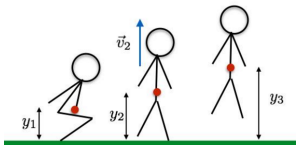
$$x(t) = 3.5t^3 - 2t^2 + t \quad \text{(m)},$$

where x in meters and t in seconds. Calculate the work done on the particle during the first 2 seconds.

problem[7] (10pts) A block of mass $m/2$ sits at rest on a frictionless table. The block has a frictionless circular surface of radius R. A small cube of mass m and speed v is incident upon the black. The cube slides up the block, reaches maximum height, and slides back down. (a) What is the maximum height h above the table, attained by the cube (assume v is small enough that $h << R$)? (b) What are the final speeds of the cube and the block when the cube is no longer on the block?

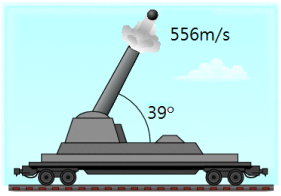


problem[8] (10pts) A person, of mass m, jumps vertically up off the ground. Suppose the person pushes off the ground with a constant force of magnitude F for a time interval Δt . What was the magnitude of the maximum displacement of the center of mass of the person? Express your answer in terms of given quantities and g.



problem[9] (10pts) Two identical balls of mass m are propelled at $t = 0$ from the same starting point. Ball A moves on a frictionless horizontal surface, starting with speed v_0. Ball B is thrown into the air with initial speed $2v_0$, at elevation angle 60° (neglect air drag). (a) What is the initial velocity (magnitude and direction) of the center of mass(CM)? (b) What is the acceleration (magnitude and direction) of the CM? (c) Sketch on the drawing the trajectories of the balls and of the CM, while ball B is in flight. Indicate on your sketch the location of the CM at the instant when ball B has its maximum height.

problem[10] (10pts) A 1400 kg cannon, which fires a 70 kg shell with a muzzle speed of 556 m/s, is set at an elevation of 39° above the horizontal. The cannon is mounted on frictionless rails, so that it recoils freely. (a) What is the speed of the shell with respect to the earth? (b) At what angle with the ground is the shell projected?



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