Problem set 3 (due March 20)

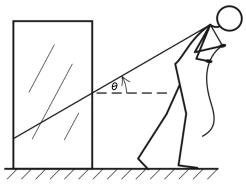
1. Consider a Ferris wheel with radius R rotating at a constant angular velocity w.

   (a) (1pt) Find the weight you experience at the top and at the bottom of the Ferris wheel.

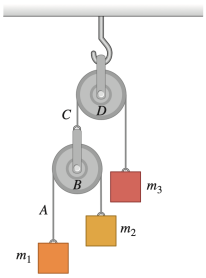
   (b) (1pt) Find the angular velocity for which you would feel weightless.

   (c) (0.5pt) To get some intuition for this number consider one of the largest Ferris wheels in the world, the Star of Nanchang (南昌之星) in Jiangxi province, which has a radius of $R = 80\,m$. Assuming your weight is $70\,kg$, what is the angular velocity and the period for which you would feel weightless? For comparison, the actual period of the Star of Nanchang is 30 minutes.

2. (2.5 pts) Suppose that you are pulling a box that is lying on a surface where the coefficient of kinetic friction is μ. Find the angle θ that minimizes the tension (and makes your job easier).



3. Consider the system illustrated in the figure below where the masses m_1, m_2, and m_3 are arbitrary. Let the system be released from rest. Assuming that the pulleys are frictionless and massless compute the following:

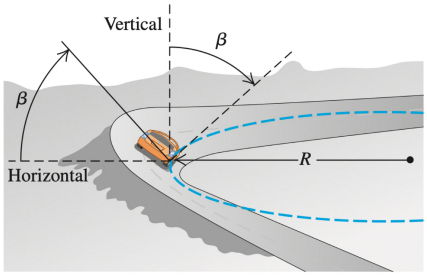


   (a) (1pt) Compute the acceleration of each of the blocks

   (b) (1pt) Compute the tension of rope A and rope C

   (c) (0.5pt) What happens to answers (a) and (b) when $m_1 = m_2 = m$ and $m_3 = 2m$? Is this the expected result?

4. Consider a car moving on a circular road of radius R that is inclined an angle β. The coefficient of static friction is denoted by μ.



(a) (1pt) Draw a diagram indicating the forces acting on the car and the direction of the acceleration. Find the maximum speed the car can be driven without sliding.

(b) (1pt) Consider the maximum speed in two limits: (i) a frictionless road with arbitrary β and (ii) a flat road with friction μ. What is the value of β in (i) necessary to reproduce the maximum speed in (ii)?

(c) (0.5pt) The coefficient of static friction between rubber and dry concrete is $\mu = 1$. Is the angle you found in part (b) reasonable in this case? When the concrete is wet the coefficient is reduced to $\mu = 0.3$. Is the answer reasonable in this case?