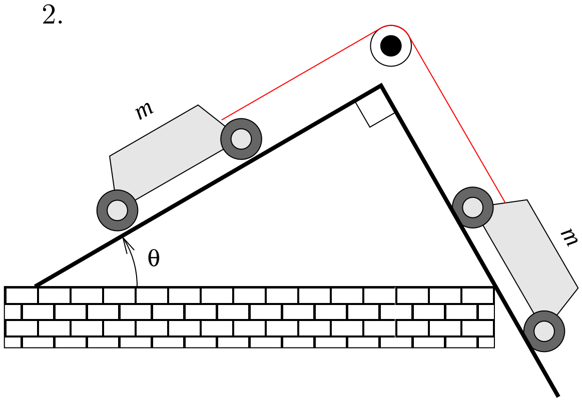
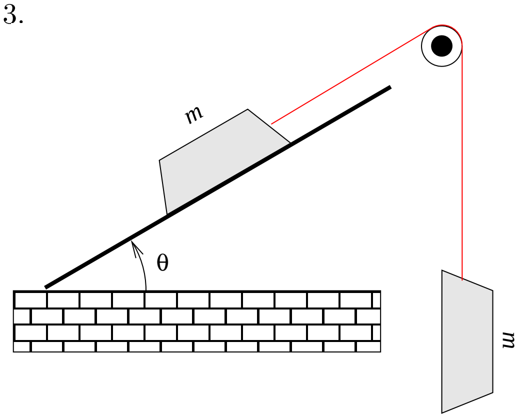
**PHY 201 Homework 5**
**Due Wednesday, October 2 in SE 227 at 2:00 PM.**
The first midterm will be on October 9 and will be based on the first five homeworks. There will be a physics tea on Monday, September 30, between 8 and 10 pm at 3510 5th Ave.

1. In an earlier homework, we discussed the Top Fuel world record run by Clay Mullican. Using his average acceleration, what was the coefficient of friction of his tires against the track? Would this be kinetic friction or static friction? Explain.

2. 


Your lab instructor decides that the class is not working hard enough. So he constructs the following arrangement of two ramps, which are perpendicular to each other, and a friction-less pulley. Two cars, each mass $m$, are placed on the ramps. They are are joined by a string and move with negligible friction.

   (a) Draw a force diagram for each car.
   (b) Find the acceleration of the cars as a function of $\theta$.
   (c) For what value of theta is there no acceleration?

3. 


The lab instructor takes the wheels off the cars and removes one of the ramps. After some experimentation, the students find that the block just starts sliding when $\theta = 30°$.

   (a) Draw a nice force diagram for each block.
   (b) What is the coefficient of static friction of the block against the ramp?
   (c) Does the block slide for $\theta > 30°$ or for $\theta < 30°$? Explain.

4. In physics, a lot of important concepts are based on series expansions. Hooke's law is just one example. Compute the first three non-zero terms of the Taylor (or MacLaurin) series for each of the following functions:

   (a) $f(x) = \sin(kx)$ about $x = 0$,
   (b) $f(x) = \sin(x)$ about $x = \pi/2$,
   (c) $f(x) = ax^2$ about $x = x_0$, and
   (d) $f(z) = 1 - \cos(z)$ about $z = 0$.

   Show your work.

5. I have a rather peculiar rubber band whose force as a function of stretch $z$ is

$$F(z) = -\left(100\,\frac{\mathrm{N}}{\mathrm{m}^2}\right) z^2 \,.$$

(a) I hang a 100 g mass from the rubber band. What is the equilibrium position of the mass?

(b) Show that, for small oscillations about this equilibrium position, the spring constant is $k = 19.8\,\mathrm{N/m}$.

(c) What is $k$ if I use a 200 g mass instead?

Suggestion: introduce a variable for $100\,\frac{\mathrm{N}}{\mathrm{m}^2}$.