# Lab #4: Estimate of g

Lab due Tuesday, October 3, 2006!

Purpose: To estimate the acceleration of gravity

Equipment: 500g weights, Scale, 500g PASCO carts and frictionless track, ultrasonic motion sensor, Multi-Purpose Laboratory interface.

Theory:

1. Consider the ramp shown below. A Cart is placed on the ramp. It has a certain mass, M which will be variable in this experiment. Assuming no friction, determine the acceleration of the cart in terms of the height(h), length(L), and the acceleration due to gravity(g) as shown below.
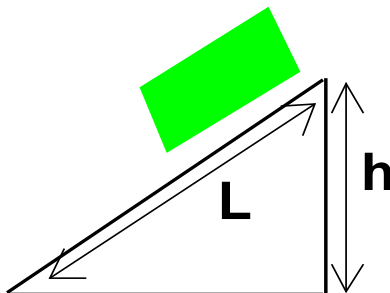
2. Next assume that there is a constant friction friction force F_{fr} on the cart, stemming from friction in the rotation of the wheels. Determine the acceleration of the cart in terms of M, F_{fr}, h and L. You should find that the acceleration down the ramp is:

$$a = g\,\frac{h}{L} - \frac{F_{fr}}{M} \tag{1}$$

3. As the mass becomes larger and larger, argue that the constant friction force becomes less and less significant. Clearly if we graph acceleration vs. $\frac{1}{M}$ we expect a line.

   – The intercept is:

   – The slope is:

Experiment: The goal of this experiment is to estimate g and to understand the limitation of the physics presented in the course.

1. First we construct a ramp with a known h and a known L.

   - First level the track by placing a cart on the PASCO frictionless track with at least one of the 500g weights and adjusting the feet until the cart does not move.

   - Now raise one end a known distance. To do this, we note that a typical #7 screw has 20 turns per inch, i.e.if you make twenty rotations you go up one inch. Turn the "feet" on one end by full rotations say 15 times so that the cart is no longer level. You may wish to borrow a piece of chalk to mark one spot on the foot so you know how many rotations you have made.

   - You can also measure the distance between the feet L. You have now constructed the a ramp with a known h and L. Record these values.

$$h = \tag{2a}$$

$$L = \tag{2b}$$

2. Weigh the mass of the frictionless cart.

3. Start the cart down the ramp. Let the computer measure the position and velocity as a function of time. Fit the velocity data with a line in a certain reliable region to determine the acceleration of the cart. Make a printout of your velocity vs. time graph and the fit and include it in your report.

4. Add another 500g weight to the cart and determine the acceleration of the cart as in step #3. Add one more 500g weight to cart and again determine the acceleration of the cart as in step #3. Do this one more time.

5. Using the Graphical Analysis program make a graph of acceleration vs. mass for the four masses used in this experiment. Fit your results with a line.

6. Use the intercept of this fit together with Eq. (1) and the values in Eq. (2) to determine g the acceleration due to gravity

   Note: It is important for this lab that the wheels have negligible mass compared to cart for reasons that will be clear later in the course.