Acceleration Down a Ramp
(Measuring g)

Introduction:
During the early part of the seventeenth century, Galileo experimentally examined the concept of acceleration. One of his goals was to learn more about freely falling objects. Unfortunately, his timing devices were not precise enough to allow him to study free fall directly. Therefore, he decided to limit the acceleration by using fluids, inclined planes, and pendulums. In addition, Galileo was able to determine that the mass of the "falling" object did not alter the acceleration of the falling object. That surprising fact is well understood today. In this lab exercise, you will measure the acceleration of a "frictionless" cart down a ramp. Using right triangle relationships, you will use your data to calculate the motion on a vertical "ramp" that is, the acceleration of an object in free fall. You will use time and distance data to calculate the acceleration of the object and thus determine g. A motion detector is also used to determine the acceleration down the ramp directly.

Relating g to the measured (ramp) acceleration:
From the diagram to the right we can determine that the acceleration down the ramp is the acceleration due to gravity (g) times the sin(θ) the angle of the ramp with respect to the horizontal. To arrive at this result, realize that g points straight down and is represented by the vector downward from the object on the ramp. The rectangle drawn around that vector has two similar triangles to the ramp (triangle). From the ratio of the triangle sides, we can find the portion of g (component) which is down the ramp. The ratio of the side opposite to angle θ and the hypotenuse is the trig function sin(θ). From this ratio we can say that $a_{ramp} = g \sin(\theta)$ or that $g = a_{ramp} / \sin(\theta)$.

Apparatus:
Stopwatch, protractor, meter stick, cart and track, motion detector apparatus

The purposes of this experiment are:
1. To measure the acceleration due to gravity
2. Confirm the vector component representation of acceleration on a ramp - $g = a_{ramp} / \sin(\theta)$
3. To gain experience with error analysis
4. To gain additional experience with the motion detector

Method I – Direct "Time of Fall" method
- Set up the ramp at a reasonable angle, measure a distance for the cart to travel on the ramp; release the cart from the top of that distance, and measure the time of travel for the cart.
- Determine the angle of the ramp.
- Record the measurements above and perform the calculations on the lab report sheet.
- Report the acceleration due to gravity (g) and record it as a value +/- a percent error.

Method II – Motion Detector Determination of g
- Load the appropriate software and set up the motion detector at the top of the ramp.
- Release the cart and collect d-t, v-t, and a-t graphs of the motion.
- Examine the graphs and select an appropriate portion for analysis.
- Find the average acceleration from a large portion of the a-t graph.
- Record the appropriate information on the lab report for this method.
- Report the acceleration due to gravity (g) and record it as a value +/- a percent error.