Class: PHYS 100
Lab: Lab 03
Lab Title: Acceleration on a Ramp
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Abstract
The measured acceleration of a glider on a frictionless inclined plane is proportional to the sine of the angle of the incline of the ramp. The results were independent of mass for gliders of mass 189 g and 390 g.

Introduction
A glider sliding without friction down an inclined plane has a lower acceleration than an object falling freely through the air. If we assume constant acceleration, a, and release the glider from rest on a frictionless inclined plane, the final velocity of the glider, v_f, can be predicted using the third kinematic equation for motion, where Δx is the distance the glider traveled.

$$v_f^2 = 2a\Delta x \tag{1}$$

By measuring final velocity of the glider for a given angle of incline, the acceleration of the glider will be determined using Equation 1. The relationship between acceleration and angle of incline will be explored by graphing acceleration versus the sine of the angle of incline.

Procedure
For angles between 10˚ and 25˚ in approximately 5˚ increments we measured the velocity of the glider after it had traveled 1.0 m for two gliders of mass 189 g and 390 g. The final velocity of the glider was determined by measuring the time required for a glider to travel between a pair of photogates set at a distance of 1.5 cm apart. The velocity of the glider was calculated using Equation 2,

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_o}{\Delta t} = v_f \tag{2}$$

where Δx is the distance between the photo gates and Δt is the time for a glider to travel between photogates. The final velocity was assumed to be equivalent to the average velocity through the photogates at the end of the incline because speed of the glider was expected to change insignificantly in the short distance of 1.5 cm between the photogates.

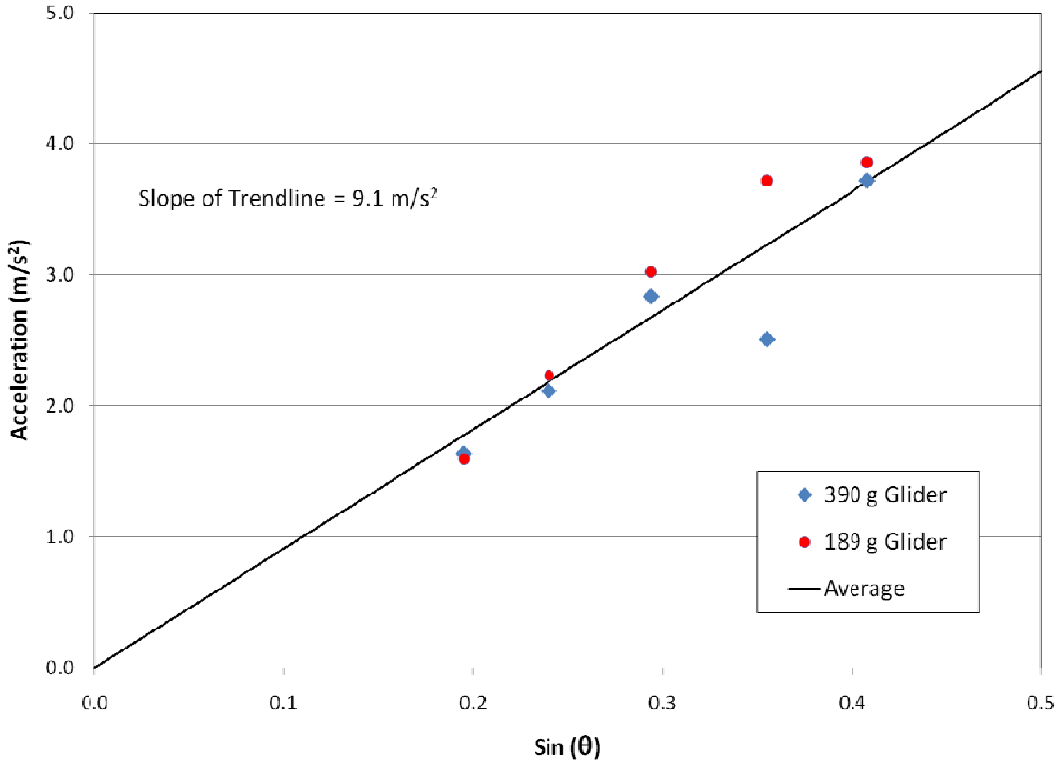
Results and Discussion
Figure 1 shows the measured acceleration of two gliders of different mass as a function of the sine of the angle of the incline of the ramp. Raw data and calculations are included in the Appendix.

The acceleration of the gliders is proportional to the sine of the angle, θ, of incline of the ramp and independent of mass. The best fit linear relationship for combined data from both gliders passing through the origin is shown in Equation 3.

$$\text{Acceleraton} = 9.1 * \sin(\theta) \ \ (\text{m/s}^2) \tag{3}$$

The proportionality constant or slope of the line is near the known value for the acceleration of gravity equal to 9.8 m/s^2.

Figure 1: Glider acceleration as a function of the sine of the angle of the incline of the ramp.



Appendix

Table A.1: Data and calculations for 189 g glider.

Incline Angle (degrees)	Sin (θ)	Photogate Time (s)	Final Velocity (m/s)	Glider Acceleration (m/s^2)	a/sin(θ) (m/s^2)
11.2	0.20	0.0084	1.8	1.59	8.2
13.9	0.24	0.0071	2.1	2.23	9.3
17.1	0.29	0.0061	2.5	3.02	10.3
20.8	0.36	0.0055	2.7	3.72	10.5
24.1	0.41	0.0054	2.8	3.86	9.5

Table A.2: Data and calculations for 390 g glider.

Incline Angle (degrees)	Sin (θ)	Photogate Time (s)	Final Velocity (m/s)	Glider Acceleration (m/s^2)	a/sin(θ) (m/s^2)
11.2	0.20	0.0083	1.8	1.63	8.4
13.9	0.24	0.0073	2.1	2.11	8.8
17.1	0.29	0.0063	2.4	2.83	9.6
20.8	0.36	0.0067	2.2	2.51	7.1
24.1	0.41	0.0055	2.7	3.72	9.1