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Physics 590
Dr. Larry Gladney & Bill Berner
Group Assignment
Motion Lab Report

Abstract:

We tested equations for motion with a nearly frictionless air track. We observed the motion of the glider by exerting force. The motion was measured with a sonic ranger, and we studied the relationship between distance, time, velocity, and acceleration.

Data & Calculations:

Finding velocity (slope)

	Point 1		Point 2		Slope
	Time	Distance	Time	Distance	
Steep Slope	2.000 sec	1.410 meters	3.500 sec	1.863 meters	0.3020 m/s
	and				
	1.050 sec	1.112 meters	2.300 sec	1.500 m	0.3104 m/s
	Approximate Uncertainty: Average Velocity = (0.302 m/s + 0.3104 m/s) / 2 = 0.306 m/s 0.306 m/s – 0.302 m/s = 0.004 m/s 0.306 m/s – 0.310 m/s = - 0.004 m/s ± 0.004 m/s **Velocity = d/t = 0.306 ± 0.004 m/s**				
Shallow Slope	12.00 sec	0.383 meters	14.50 sec	0.896 meters	0.2052 m/s
	and				
	11.65 sec	0.321 meters	13.10 sec	0.610 meters	0.1993 m/s
	Approximate Uncertainty: Average Velocity = (0.2052 m/s + 0.1993 m/s) / 2 = 0.202 m/s 0.202 m/s – 0.2052 m/s = - 0.003 m/s 0.202 m/s – 0.1993 m/s = 0.003 m/s ± 0.003m/s **Velocity = d/t = 0.202 ± 0.003 m/s**				

Comparing Calculated Velocity to Velocity Measured by Sonic Ranger

	Steep Slope	Shallow Slope
Calculated Velocity	0.306 ± 0.004 m/s	0.202 ± 0.003 m/s
Sonic Ranger Measurement	0.302 m/s	0.204 m/s

Finding Acceleration (slope)

<table>
<tr><td rowspan="2"></td><td colspan="2">Point 1</td><td colspan="2">Point 2</td><td rowspan="2">Slope</td></tr>
<tr><td>Time</td><td>Velocity</td><td>Time</td><td>Velocity</td></tr>
<tr><td rowspan="4">Steep Slope</td><td>2.000 sec</td><td>0.294 m/s</td><td>3.500 sec</td><td>0.294 m/s</td><td>0.00 m/s^2</td></tr>
<tr><td colspan="5">and</td></tr>
<tr><td>1.050 sec</td><td>0.314 m/s</td><td>2.300 sec</td><td>0.318 m/s</td><td>0.0032 m/s^2</td></tr>
<tr><td colspan="5">Approximate Uncertainty:
Average Acceleration = (0.00 m/s^2 + 0.0032 m/s^2) / 2 = 0.0016 m/s^2 = 0.002 m/s^2

0.0016 m/s^2 – 0.00 m/s^2 = 0.0016 m/s^2 = 0.002 m/s^2
0.0016 m/s^2 – 0.0032 m/s^2 = - 0.0016 m/s^2 = 0.002 m/s^2 ± = 0.002 m/s^2

Acceleration = v/t = 0.002 m/s^2 ± 0.002 m/s^2</td></tr>
<tr><td rowspan="4">Shallow Slope</td><td>12.00 sec</td><td>0.203 m/s</td><td>14.00 sec</td><td>0.203 m/s</td><td>0.0 m/s^2</td></tr>
<tr><td colspan="5">and</td></tr>
<tr><td>11.65 sec</td><td>0.156 m/s</td><td>13.10 sec</td><td>0.207 m/s</td><td>0.0352 m/s^2</td></tr>
<tr><td colspan="5">Approximate Uncertainty:
Average Acceleration = (0.00 m/s^2 + 0.0352 m/s^2) / 2 = 0.0176 m/s^2 = 0.02 m/s^2

0.0176 m/s^2 – 0.00 m/s^2 = 0.0176 m/s^2 = 0.02 m/s^2
0.0176 m/s^2 – 0.00352 m/s^2 = - 0.0176 m/s^2 = 0.02 m/s^2 ± 0.02 m/s

Acceleration = v/t = 0.02 m/s^2 ± 0.02 m/s^2</td></tr>
</table>

Comparing Calculated Acceleration to Acceleration Measured by Sonic Ranger

	Steep (fast) Slope	Shallow (slow) Slope
Calculated Acceleration	0.002 m/s^2 ± 0.002 m/s^2	0.02 m/s^2 ± 0.02 m/s^2
Sonic Ranger Measurement	0.302 m/s^2	0.204 m/s^2

Verification of our numbers using the given formulas:

Formula	Our Numbers	Calculations	Sonic Ranger	Analysis
$v_f = v_o + at$	$v_o \sim 0.3$ m/s $a = 0$ m/s^2 $t = 3.5$ s	$v_f = (0.3 \text{ m/s}) + (0)(3.5 \text{ s})$ $v = 0.3$ m/s	0.294 m/s	Number is significantly similar
$x_f = x_o + v_o t + ½ at^2$	$x_o = 0.85$ m $v_o = 0.3$ m/s $a = 0.0$ m/s^2 $t = 3.5$ s	$x_f = 0.85 \text{ m} + (0.3 \text{ m/s})(3.5 \text{ s}) + ½ (0)(3.5 \text{ s})$ $x_f = 1.90$ m	1.863 m	Number is significantly similar
average $v = (x_f - x_o) / t$	$x_f = 1.863$ m $x_o = 0.85$ m $t = 3.5$ s	average $v = (1.863 \text{ m} - 0.85 \text{ m}) / 3.5 \text{ s}$ average $v = 0.289$ m/s	0.294 m/s	Number is significantly similar
$x_f = vt + x_o$	$v = 0.294$ m/s $t = 3.5$ s $x_o = 0.85$ m	$x_f = (0.294)(3.5) + (0.85)$ $x_f = 1.879$	1.863	Number is significantly similar

Data for the inclined trial:

For our first slope of our trial as the glider is moving away from the sonic ranger, we found the slope to be 0.623 m/s. At this same time interval, the velocity is 0.248 m/s. When we first looked at this data, we assumed the data to be incorrect since they were not the same, however upon further investigation, this data makes sense. The slope of an incline is not constant. At every instant the slope is changing therefore making the instantaneous velocity at that one second be that value. If we move one second further though the velocity would be different. Given this conclusion, we took another point on the graph and decided that since we could not directly compare the distance/time slope to velocity we would compare the two velocities to see if that made sense. At the next time interval that we analyzed, the slope was 0.426 m/s. This value is less than the first slope we looked at so we assumed that to go along with our former analysis, we would find that the instantaneous velocity at this point would be proportionately less as well. This was true. The velocity at that point in time was 0.137 m/s. We see that since 0.137m/s<0.248m/s the velocity is in fact decreasing at that point which is exactly what was happening on our graph.

As far as the acceleration it maintains somewhat of a constant acceleration. For example, at two points we noticed some variance in the acceleration graph, but when we took the averages of the high and low points we found that at both points, the average acceleration was -0.1475m/s^2 and -0.143m/s^2. This is very close and therefore the difference can just be attributed to factors such as measurement error (which was addressed in the previous section), noise, the added motion due to a rubber band versus a wall, and finally air resistance. Taking this into account we found the error due to air resistance by finding the average acceleration in two spots and realizing the difference between the two. Air resistance attributes to 0.0045m/s^2 and therefore this was where our difference was.

Analysis and Conclusions:

The above data proves the analysis for the lab experiment. We found through experimentation that the values show that Δdistance/Δtime is equal to the average velocity. We also found through experimentation that Δvelocity/Δtime is equal to average acceleration.

We were also able to prove this using the given equations. Please see attached sheet for this information.

Contributions:
Carrie was our primary recorder. She recorded all data points off of our data, and found the slopes of our graphs. She also was the primary data interpreter of the group.

Jill was the primary computer operator in the lab determining the graphs, and point values. She also helped in finding the comparison between the graphs and the formulas, as well as the accountability for air resistance.

Keith was the primary member of the group proving through equations that the values would prove the formulas. Keith also helped Jill and Carrie work through the error throughout the lab.

Wendy was the main recorder for the final copy of the lab report, as she put together all of our graphs, and data.

Paul was the primary person performing the lab and working the glider, changing our angle, and making sure our graphs and tools were measured accurately.

As a group we all worked together to analyze the data, and helped complete the final lab report.