Lab 7: The Inclined Plane

Objective: To study accelerated motion on an inclined air track.

Procedure

Part I: Varying the Slope of the Incline

1. Set up your air track apparatus. Level it very carefully. Set up two photogates as shown below:

2. Find or make an index card flag of length 10-11 cm. Measure its length, $d$, in meters using the Vernier caliper. Attach the flag to the top of your cart.

3. For spacers, we will use slotted masses. For the first trial use one 100-g mass. Measure its height, $h$, with the Vernier caliper.

4. Turn on the computer and launch Capstone. Plug photogates into Digital Inputs 1 and 2. Use Hardware Setup to chose Photogate for both digital inputs.

5. User the Timer Setup menu to make a Pre-Configured Timer for Two Photogates (Single Flag) so you can measure the acceleration of the system. Enter the Flag Length in #5. Create a table to display the Acceleration Between Gates.

6. Make sure that the high end of the track is the side with photogate 1. Adjust the height of your photogates so they are blocked by the flag. Place the cart against the stop at the top of the raised track and let your cart coast down the track. Catch the cart at the bottom of the track so it doesn’t crash into the stopper.

7. When you are ready to take data, click Record and release the cart so it travels through the photogates. You may make multiple measurements before you click Stop. Make a table in your notebook to record ten trials for this spacer height and calculate the mean acceleration value for the ten trials.

8. Repeat the procedure using spacers of 200 g, 300 g, 400 g, 500 g, 600 g, and 700 g. Measure the height, $h$, of each set of spacers in meters with the Vernier caliper and record next to each data table.

9. Record the mean accelerations in your notebook in a summary table with columns for spacer height (m), $a$ (m/s$^2$) and sin $\theta$.

10. Measure and record the distance between the air track supports, $l$, so that the sine of the angle of the track can be calculated. Measure $l$ carefully with a meter stick. Measure from left edge to left edge of the supports, since it would be difficult to measure from middle to middle precisely.

Part II: Varying the Mass of the Cart

1. Use the balance to measure the mass of your cart and flag.

2. Use 300 g of slotted masses to elevate your air track. In Part I of the experiment, you ran a trial with this height. Take that result as the first data for Part II.

3. Each of the round donut masses in your air track accessory kit has a mass of 50 g. Add one mass to each peg on your cart and repeat the procedure.

4. Finally, add the remaining two 50-g masses to the cart, repeat the procedure, and record the data for the acceleration.
5. Make a summary table with two columns: mass (kg) and acceleration (m/s²).

**Data Analysis**

1. Calculate values for the third column in your Part I summary table, \(\sin \theta\). Instead of measuring \(\theta\) and calculating its sine, we can just use \(\sin \theta = \frac{h}{l}\). See diagram below.

![Diagram](https://via.placeholder.com/150)

3. Theoretically, the acceleration along the plane should be \(a_x = g \sin \theta\). So if we make a graph of acceleration vs. \(\sin \theta\), the slope should just be \(g\). Use Capstone to make this graph. Make sure that you graph the independent variable on the horizontal axis.

4. Perform a linear curve fit on your graph. Print copies of the graph for each person in your group to include with your lab report.

**Questions**

1. Comment on the comparison of your slope to the accepted value of \(g\), 9.80 m/s². Do your results seem reasonable? What are some possible sources of error?
2. From what you have learned of physics, what was supposed to happen to the acceleration of the cart when you varied its mass? Is this what you observed in this experiment? Explain why there may have been differences.