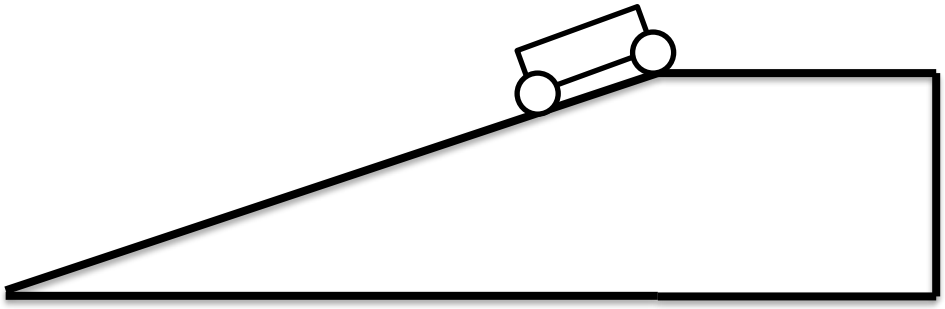
Physics 12 Lab: Inclines

Purpose: compare the predicted and measured accelerations on a low friction inclined plane

Experimental skills: working with uncertainties, graphing and linearizing, writing discussions

Equipment: metre stick, stopwatch, dynamics cart, ramp, tape

Diagram:



Procedure:

1. Raise your ramp up on one side using a wood block.
2. Measure the distance of your ramp (d) and its vertical rise (h).
3. Calculate the angle of the ramp. Using force analysis, find a value for the theoretical acceleration of a frictionless object on this ramp. Show all work.
4. Use a strip of tape and mark a start line at the top edge of the ramp.
5. Place a finish line about 0.3000 m away from the start line. Measure the distance from start to finish and record.
6. Have one person prepare to CATCH THE CART. Have another person hold a dynamics cart in place at the start line with a pen and hold a stopwatch in the other hand (they can release the cart and start timing with less error if one person does both at the same time). Stop timing when the cart touches the finish line. Record the time.
7. Move the finish line to a different point and repeat. Do this for at least 5 distances that cover the whole length of the ramp. You may choose to perform repeated trials for each distance.
8. Create a data table and record the distances and times for each trial. It is also good to observe and take note of what errors could affect your data collection.
9. Answer the uncertainty questions within your lab group.
10. Linearize the data to achieve a straight-line plot.
11. Find the percent difference between the theoretical acceleration (your calculations) and the value for acceleration from the linearized graph.
12. Read "how to write a discussion", then write a discussion of your results with your lab group.

Uncertainty Analysis:

1. Write the uncertainty of your distances measured
2. Find the uncertainty in your timing by testing your reaction time on this website (and/or calculate uncertainties accordingly):
http://www.bbc.co.uk/science/humanbody/sleep/sheep/reaction_version5.swf
(or Google "sheep dash reaction time")
3. Not all the **relative** time uncertainties will be the same. Which trial(s) gave you a larger **relative** uncertainty? Explain why in your discussion.
4. Make sure to propagate your uncertainties and graph your error bars.

Calculations:

1. Calculate the predicted (theoretical) acceleration of the cart.
2. Calculate the measured (actual) acceleration of the cart from your graph. You should have 1 non-linearized graph and 1 linearized graph. Analyze slope and derive the meaning of the slope.
3. Find the percent difference between the acceleration values

$$\frac{|\text{measured}-\text{predicted}|}{\text{predicted}} \times 100\%$$

How to write a discussion

No measurement can be perfect. Measurements always have some uncertainty. Due to the presence of measurement uncertainty, measured values will never be equal to predicted values. So the question is not: "are the values equal to each other" but instead "do the values agree with each other within uncertainty".

In this lab, the timing introduces an uncertainty of about 10%. The values should agree within this margin, i.e. the percent difference should be less than the 10% percent uncertainty If the values are in agreement, we will conclude that the data has supported the predictions of the theory. No data can ever prove a theory, only support or disprove. If the values do not agree, then there may have been sources of error in your lab.

Sources of error

These describe what could've gone wrong with your lab. These errors may be out of your control while you were performing your experiment. Refer to the sources of error document for examples. It might be a good idea to record some observations during your lab of what you noticed could affect your data collection.

Discussion:

1st paragraph:

i) Restate the purpose: what were you trying to measure? What is your prediction?
ii) State the measured (and % uncertainty) and predicted values
iii) State the percent difference between these values
iv) State whether the values agree (is the percent difference less than the percent uncertainty)
v) State whether your predicted value is supported by your data

2nd paragraph:

vi) Discuss the sources of error in your lab. Make sure to discuss how the sources of error affected your results quantitatively, not just qualitatively.

3rd paragraph:

vii) Discuss how could you reduce the impact of these sources of errors in your lab. What other improvements could you suggest for this lab?