

5 Force and Acceleration

Name _____

Lab A: Acceleration Due to a Constant Unbalanced Force

AP/Inquiry Physics

An automobile accelerates through an intersection after stopping at a stop sign only to accelerate negatively again to stop at the next stop sign. An apple, being released from a tree, accelerates until it hits the ground. A baseball accelerates from rest at the back of the pitcher's throw until it has a velocity of about 90 miles per hour toward the batter. How are these events related? What causes the accelerations described? What variables are involved in producing the acceleration of an object? How are these variables related? These questions make up the goal of the next series of labs.

You will be measuring the acceleration of gliders on an airtrack. The primary advantage of such a system is its very low friction. This allows us to almost ignore frictional effects and concentrate on the interrelationships of force, acceleration, and distance.

Purpose

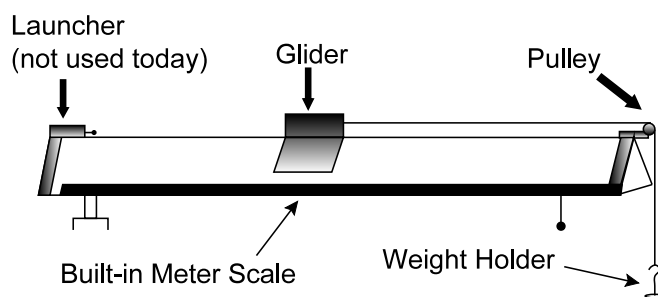
The purpose of this lab is to determine how the **acceleration** of an object changes when a constant, unbalanced force is applied over varying **distances**.

Air Track Guidelines

1. **Never** move gliders along the air track when the air supply is shut off.
2. Always be careful not to drop or damage the gliders - if one is bent, it will no longer function properly.
3. All of the equipment in this lab is quite expensive, so be extra careful and conscientious.

Procedure

In this experiment you will use an air track, a glider, a hanging weight holder with string, and a stopwatch. The hanging weight provides an **unbalanced** force, because there is no other force balancing its pull on the glider.



- Turn on the airtrack and check that the air track is level by using one of the gliders. If the glider does not remain fairly motionless on the track, but tends to accelerate one way or the other, ask Mr. M to help you level the track.
- Determine the acceleration of the glider over a distance of 0.900 meter, making at least three measurements of the time it takes the glider to start from rest ($v_i=0$) and travel the 0.900 meter. Use the built-in meter scale to determine where the glider should be placed. Record the times in the table, making certain that all recorded times vary by no more than 0.1 s. Average those measurements.
- Repeat the above procedure for the remaining distances.
- Use one of the motion equations to find the average acceleration of the cart for each distance.

Distance (m)	Time (s)	Average Time (s)	Group's Average Acceleration (m/s^2)	Class Average Acceleration (m/s^2)
0.900				
0.800				
0.700				
0.600				

Interpretation ANSWER NON-QUANTITATIVE QUESTIONS IN COMPLETE SENTENCES

1. Show the motion equation you used to calculate acceleration: _____
2. Plot the data points for your group's data to help you see the relationship, if any, between the changing distance and the calculated acceleration. Plot the independent variable on the x-axis and the dependent variable on the y-axis. Force each axis to begin at zero by clicking on the graph, opening the *Graph* menu, selecting *X-Axis Options*, and selecting *Autoscale at 0*. Do the same for the y-axis.

Notice the difference between this graph and the two graphs you generated from the data in lab 1 (the ball rolling down the ramp). Save your graph as **H#G#L5A**, inserting the appropriate hour and group numbers in place of the # signs. Show your graph to Mr. M but **do NOT print it out**.

3. One way to quantify how much change there is in a variable is to calculate the *percentage difference*. The formula is shown below. What is the percentage difference if some arbitrary *independent* variable doubles? (Make up some numbers and plug them into the formula; you need not use lab data here.)

$$\% \text{ difference} = \frac{\text{largest} - \text{smallest}}{\text{average of all values}} \times 100$$

4. Consider a hypothetical linear graph, or directly proportional relationship. If you doubled the independent variable, the dependent variable should also double. So if you had a directly proportional relationship *and* the independent variable doubled, what percentage difference would you expect to see for the *dependent* variable? _____
5. For directly proportional relationships, tripling the independent variable triples the dependent, and so forth. Thus we can generalize the concept from questions 3 and 4. When there is a directly proportional relationship, what should one expect when comparing the percentage difference of the independent variable to that of the dependent variable?

6. You will need the **class average accelerations** to answer questions 6-9. Quantify how much change there was in the **class** average accelerations by calculating the percentage difference between the highest and lowest **class** average values. (We cannot calculate *percentage error* in this situation, as we do not know the theoretical values.) Show your work:

7. To help you put this in perspective, calculate the percentage difference between the highest and lowest **distances**. Show your work:

8. Bear in mind your answer to question 5. Does the **class** data indicate a directly proportional relationship between acceleration and distance? **Explain** why or why not.

9. After considering a graph of the **class** data and the answers to questions 6-8, *precisely* describe what an object does when a constant, unbalanced force is applied to it.

10. What are the significant sources of systematic error in this experiment?

