

# Acceleration Lab

## Teacher's Guide

### Objectives:

1. Use graphs of distance vs. time and velocity vs. time to find acceleration of a toy car.
2. Observe the relationship between the angle of an inclined plane and the acceleration of a toy car on the inclined plane.

### Materials:

Each group must have:

Toy car, 1m inclined plane, 2 notebooks, meter stick, stopwatch

### Methods:

The most difficult part of this lab will probably be timing the cars. Make sure that students have one person with a stopwatch and two people marking positions. When the car is released, the timer starts timing and calls out every second. The students marking the position will do so by placing a finger where the car is when the timer calls out a second. For instance:

Timer	Distance marker A	Distance marker B
1s	marks with left hand	waits
2s	marks with right hand	waits
3s	waits	marks with left hand
4s	waits	marks with right hand

After doing a trial run to make sure they know how to make the measurements, students will take data for the inclined plane at two different angles (rested on 1 or 2 books). They can then calculate the distance traveled in each second, the average velocity for each time interval (distance traveled in 1 second divided by 1 second), and the acceleration (by graphing velocity vs. time).

To determine deceleration, students will do the same thing, except that they won't begin marking positions until the car has reached the bottom of the track.

This lab has many chances for error. If an inclined plane is warped, the acceleration won't be constant. Friction will lower the acceleration. Timing is difficult. This is why they do a practice run before actually taking data. If the car is moving too fast to get accurate position measurements, try lowering the board. If friction is so large that the car actually slows as it goes down the plane, try raising the board, or getting a different car. Students should also account for error on their handout.

Name: \_\_\_\_\_

## Acceleration Lab

### Objectives:

In this lab, you will be studying acceleration due to gravity by observing Hot Wheels cars on inclined planes. Your goal will be to determine the acceleration of the car with the inclined plane at different angles. The lab will show how graphs of displacement versus time and velocity versus time can be used to find acceleration.

### Materials:

Hot Wheels car, 1m inclined plane, 2 notebooks, meter stick, stopwatch

### Procedure:

- 1) Begin by designating one person to be the car holder, 2 people as distance markers, one person as a recorder, and one as a timer.
- 2) Raise one end of the inclined plane by placing the end on one notebook.
- 3) Trial run:  
Have the car holder hold the car at the top of the ramp (at 0cm). When the car holder releases the car, have the timer begin timing. The timer should call out one-second intervals. Have the distance markers mark the position of the car with a finger for each interval. HINT – Each distance marker has two hands, so if he uses a finger on his left hand to mark of interval 1 and the right hand to mark off interval 2, the next distance marker can use her two hands to mark off intervals 2 and 3, etc. In the table below, record your data:

Table 1. Data for Trial Run

Time (s)	Position (cm)
1	
2	
3	
4	

- 4) If you were not able to obtain the position for each time interval, try again until you have a system that enables you to get all four positions.
- 5) Now you are ready to begin taking data. You will be repeating the above procedure for two different heights, and for each height, you will be doing three trials and averaging your data.
- 6) Keep one end of the plane placed on one notebook. Let the car go down the ramp 3 times, and record your data for each run in Table 2. Take the average position for each time and enter it into the table. Then for each time interval, calculate the distance traveled in 1 second. This is simply the average position minus the previous average position. For the first time, it will be average position minus zero cm, etc.

Then calculate the velocity for each time interval by taking the displacement divided by the time interval (the interval is 1 second each time).

Table 2. One Notebook

	Run 1	Run 2	Run 3			
Time (s)	Position (cm)	Position (cm)	Position (cm)	Ave. Position (cm)	Distance traveled in 1 second (cm)	Velocity (cm/s)
1						
2						
3						
4						

7) Now repeat the procedure for two the plane raised on two notebooks.

Table 3. Two Notebooks

	Run 1	Run 2	Run 3			
Time (s)	Position (cm)	Position (cm)	Position (cm)	Ave. Position (cm)	Distance traveled in 1 second (cm)	Velocity (cm/s)
1						
2						
3						
4						

8) Now do an experiment to find the deceleration of your racecar. Place the car at the top of the ramp (with 3 notebooks), and let it go. Begin taking data when the car reaches the table, and record the position (from the lower end of the ramp) as you did before for 4 seconds. Do this three times with the ramp raised the same height and record your data in Table 4. Calculate the average position, displacement, and velocity in the same way as before. You may have to move your ramp to the floor and raise it even more to get enough horizontal distance to measure deceleration.

Table 4

Time (s)	Position (cm)	Position (cm)	Position (cm)	Ave. Position (cm)	Distance traveled in 1 second (cm)	Velocity (cm/s)
1						
2						
3						
4						

**Analysis:**

1) Create a position versus time graph for your two heights (number of notebooks) using the average positions you calculated and attach the graph to your report.

- 2) Now make velocity versus time graphs for your two heights and attach them to your report.
- 3) Calculate the acceleration of the car for each height by finding the slope of your velocity versus time graphs. Report the acceleration here, and show your work on your graph.

One notebook: Acceleration = \_\_\_\_\_  $\text{m/s}^2$

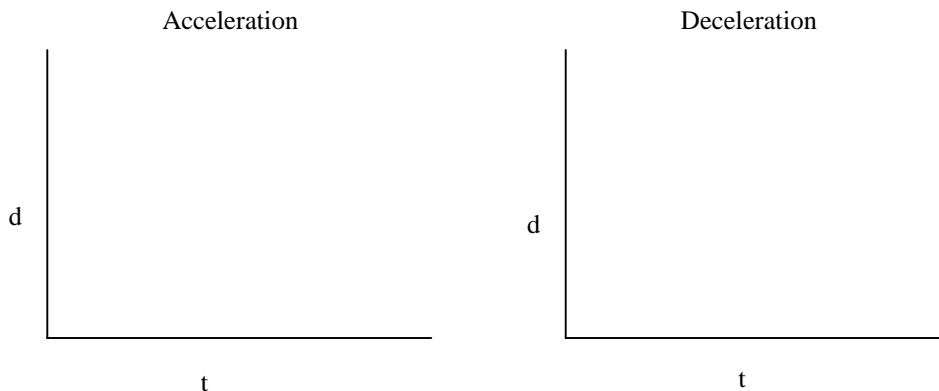
Two notebooks: Acceleration = \_\_\_\_\_  $\text{m/s}^2$

- 4) Make a position versus time graph for your data collected in Table 4.
- 5) Make a velocity versus time graph for your data collected in Table 4.
- 6) Calculate the acceleration of the car for the data in Table 4 by taking the slope of the velocity versus time graph for these data. Report the acceleration here, and show your work on your graph. Acceleration is negative for deceleration.

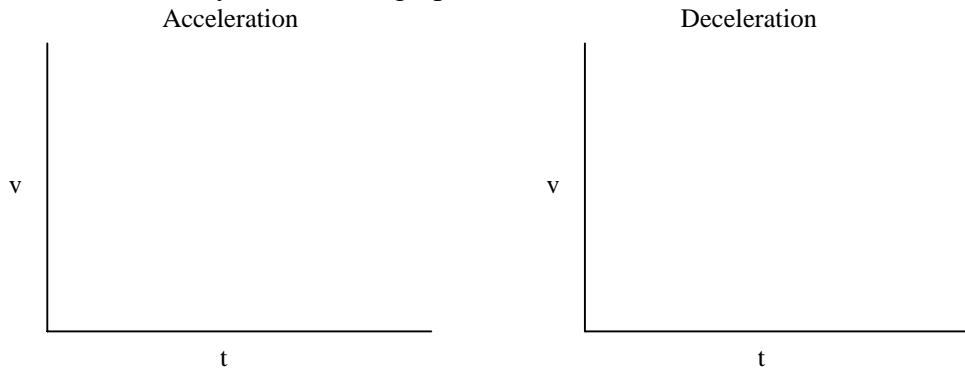
Acceleration = \_\_\_\_\_  $\text{m/s}^2$

### Questions:

- 1) What is the main difference between your position vs. time graphs and your velocity vs. time graphs for Tables 2 and 3?
  
- 2) What is the main difference between the position versus time graphs for tables 2 and 3 and the position versus time graph for table 4?
  
- 3) What is the main difference between the velocity versus time graphs for tables 2 and 3 and the velocity versus time graph for table 4?
  
- 4) Draw a position versus time graph for acceleration and deceleration.



5) Draw a velocity versus time graph for acceleration and deceleration.

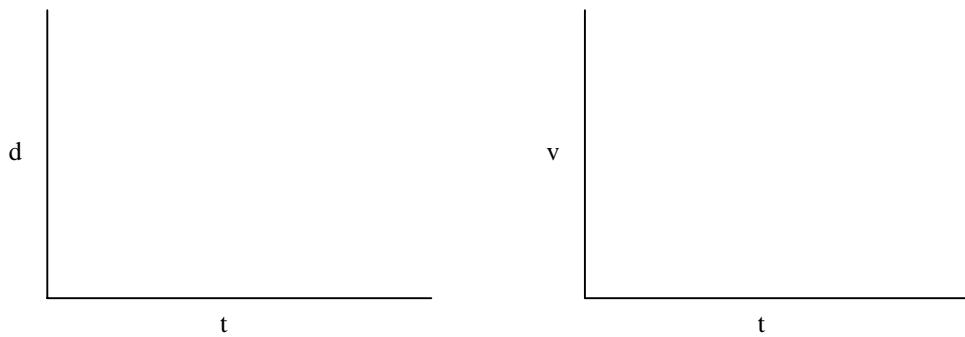


6) How does the angle of your inclined plane affect the acceleration of your racecar?

7) What are some factors that might introduce error into this experiment?

8) How could you make this experiment better?

9) What would a distance vs. time graph look like if you started taking data at the top of the ramp and continued after it reached the bottom of the ramp? How about velocity versus time?



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Acceleration Lab  
Prelab Questions

1. What are the goals of this lab?
2. Describe how you will take data to determine the acceleration of the toy car.
3. Fill in the remaining portion of the table below and then describe how you would determine the acceleration.

	Run 1	Run 2	Run 3			
Time (s)	Position (cm)	Position (cm)	Position (cm)	Ave. Position (cm)	Distance traveled in 1 second (cm)	Velocity (cm/s)
1	10	9	11			
2	30	28	32			
3	60	55	63			
4	100	95	105			

4. When do you begin marking the position of the toy car when you are taking data to determine the deceleration?

