Acceleration LAB 2013

[*Note: The entire lab report should be completed in notebook paper in the order listed here. The data table and graph should be stapled to your lab report at the appropriate locations.*]

Objectives

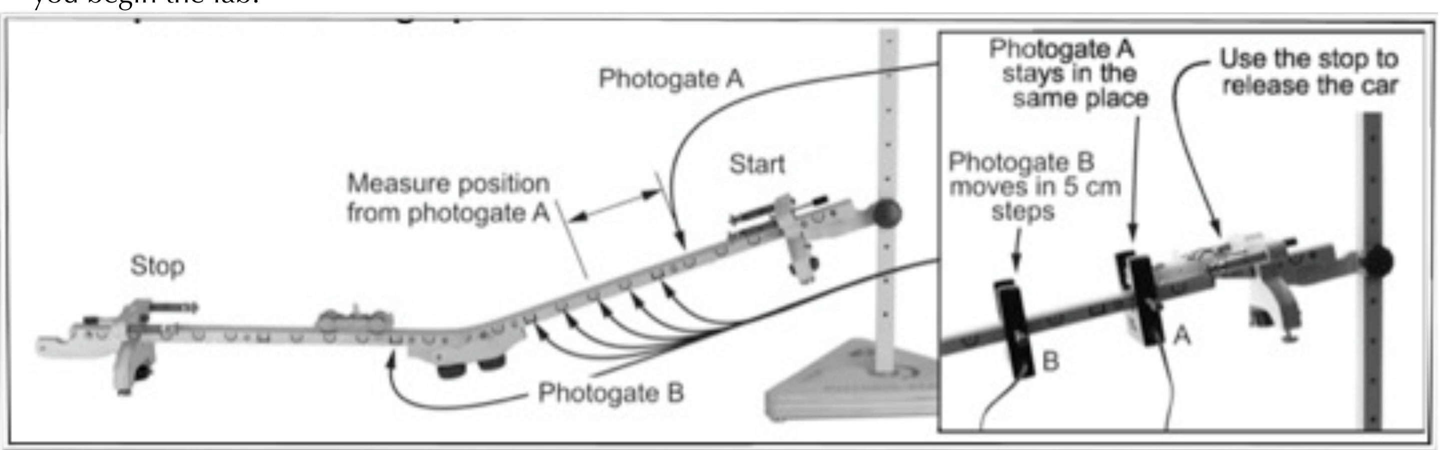
1. To demonstrate the relationship between distance, time, velocity, and acceleration for an object rolling down a ramp.
2. To represent accelerated motion on *distance vs. time* and *velocity vs. time* graphs.
3. To compute the acceleration of a rolling object.

Hypothesis: What do you think will happen to the velocity of the car as it rolls down a ramp? Do you think it will accelerate the whole time? Increase in acceleration as it goes down? Accelerate and then travel at a constant speed? Make your predictions in the following format: **As the car travels down the ramp, I believe that it will ____. Sketch a distance vs. time graph that represents your hypothesis!**

Materials: CPO track and stand, CPO timer, 2 photogates, 1 car

Procedure:

1. Assign roles for this lab: dropper, timer, recorder. If a group has four people, the fourth is the calculator.
2. Construct your CPO stand as it is shown in the image below WITH THE EXCEPTION THAT YOUR TRACK WILL BE **STRAIGHT**, NOT **BENT**. Check with your teacher to be assured that everything is set up correctly before you begin the lab.



3. Set photogate A near the top of the hill and **<u>leave it there</u>**.
4. Set up photogate B 10 cm away from photogate A (FYI the distance between each dot is 5 cm). Place a piece of Play-Doh at the stopper at the bottom of the ramp.
5. Connect your photogates to the CPO timers and check to make sure everything is working properly. Set the timer to "Interval".
6. Place your car at the top of the ramp, and keep it in place with your finger. **Make sure to note your dropping location so that the car can be released from the same position each trial**. The nose of the car should not be within the photogate prior to release!
7. Release the car and record the time it took the car to pass from photogate A to photogate B (make sure both A and B are lit up on the timer!).
8. Repeat Step 7 two more times, and record the times in your data table.
9. Move photogate B 10 cm further down the track, and repeat steps 7 and 8.
10. Continue moving photogate B until you have recorded data for 7 different positions.

Calculations.

1. Convert your distance in cm to a distance in meters. Fill in this distance in the appropriate space in your data table.
2. Average your three time trials for each distance traveled, and record the average time in the appropriate space in your data table.
3. Calculate your average velocity (in METERS/second) by dividing the distance traveled (in meters) by the average time (in seconds). Record your average velocities in the data table.

Graphing. **[You will be constructing two graphs, one distance vs. time graph, and one velocity vs. time graph. Either use the top half of your sheet of graph paper for the first graph, and the bottom half for the second graph, OR place the first graph on the front of your sheet of paper, and the second on the back.]**

GRAPH ONE.

4. Create a distance vs. average time graph with the <u>average time on the x-axis</u> and the <u>distance (in CM) on the y axis</u>. Label the graph and the axes, and make sure to title your graph.
5. Plot your points on the graph.
6. If the points appear to be LINEAR (form more or less a straight line), draw your line of best fit. If your points fall into a NONLINEAR pattern, draw a smooth CURVE of best fit that more or less passes through each point.

GRAPH TWO.

7. Create an average velocity vs. average time graph with the <u>average time on the x-axis</u> and the <u>average velocity (in CM/S) on the y axis</u>. Label the graph and the axes, and make sure to title your graph.
8. Plot your points
9. Draw your line of best fit that more or less passes through each data point.
10. Find two spots ON THE LINE and mark them CLEARLY with an "X". These are the points you will use to calculate the slope of your line of best fit!
11. Find the (x, y) coordinates of those two spots and calculate the slope of your line of best fit according to the following formula.

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

where are points ALONG (x_1, y_1) and (x_2, y_2) THE LINE OF BEST FIT! (Not necessarily actual data points!) Make sure to show all of your calculations somewhere on the graph itself, and INCLUDE UNITS! Simplify your answer.

Analysis

12. In the distance vs. time graph, were your points linear or nonlinear? What does the shape of this graph tell you about the motion of the car as it moves down the ramp? (You should reference the time it took to travel each 5 second interval!)
13. In the average velocity vs. time graph, were your points linear or nonlinear? What does the shape of **this** graph tell you about the motion of the car as it moves down the ramp?
14. What physical quantity is represented by the slope of your average velocity vs. time graph? (HINT: Look at your units!)
15. Assume that you "supersized" this lab, and released a toy car from some height down a ramp and on to a straight stretch of track until it came to rest. What do you think would happen to the speed of the car as it traveled along the straight track?
16. Draw a simple distance vs. time graph to represent the predicted motion of the vehicle as it traveled along the straight track and came to rest some distance away from the track. What might a corresponding average velocity vs. time graph look like? Justify your answers.
17. Using the value you calculated for your slope, at what velocity would you expect your car to be moving after 10 seconds? (assuming your track was actually long enough to allow the car to move for 10 seconds)? **Show all of your work in F,G,E,S!**

Conclusion Write a conclusion paragraph (or paragraphs) that includes the following items <u>at a minimum</u>:

- the purpose of the lab
- what you did in this lab (summarize your procedures in approximately two sentences)
- what you determined was the physical meaning of the slope of your v-t graph
- explain the shape of each of your graphs (what is the significance of linear/nonlinear data)
- Explain the relationship you determined between distance, velocity, time, and acceleration.
  - Did your car have a constant velocity at any point? How do you know by looking at your graphs?
  - Did your car accelerate at a constant rate for all of your tested distances? How do you know by looking at your graphs?

Distance (in cm)	Distance (in m)	Time from A to B (s)	Average Time from A to B (s)	Average Velocity (m/s) [divide distance (in m) by average time]
10 cm		Trial 1: Trial 2: Trial 3:		
20 cm		Trial 1: Trial 2: Trial 3:		
30 cm		Trial 1: Trial 2: Trial 3:		
40 cm		Trial 1: Trial 2: Trial 3:		
60 cm		Trial 1: Trial 2: Trial 3:		
70 cm		Trial 1: Trial 2: Trial 3:		
80 cm		Trial 1: Trial 2: Trial 3:		
90 cm		Trial 1: Trial 2: Trial 3:		

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80 cm		Trial 1: Trial 2: Trial 3:		
90 cm		Trial 1: Trial 2: Trial 3:		

USE A PENCIL ONLY!