LAB SECTION: ______________________________ NAME: ______________________________

EXPERIMENT 1: MOTION

Introduction: In this lab, you will manually record the position, as a function of time, of a toy car moving first along level ground, and then uphill. The uphill experiment will be repeated three times; each time, the ramp will be made increasingly steep. In all of these cases, the car will be moving at a constant speed, although the speed will be different in each case. For each case, you will make a graph of the position of the car versus time. In the second part of this lab, you will manually record the position versus time for a wheel-and-axle rolling down a sloped track created from two parallel metal rails. Once again, you will make a graph of position versus time from your measurements. In contrast to your first two graphs, this will be a graph of position versus time for an object that is speeding up as time passes.

Procedure

Part A: Constant Speed - Level Motion

1. With masking tape, secure a length of paper, or paper tape, across the floor. Your toy car should take at least 8 seconds to cross the length of this paper. You can reduce the speed of your car by replacing one of its batteries with an aluminum cylinder, which is provided with your equipment for this lab.
2. One person with a stopwatch will call out equal time intervals that are manageable, but which will result in at least five data points for the total trip. Another person will mark the position of the moving car on the paper when each time is called. Mark the position from behind the car each time (including the starting position, which we take to be position zero).
3. Measure the positions of the time marks relative to zero at the starting position. Record these positions, and their respective times, in Data Table 1.1.
4. Make a graph that describes the motion of the car by placing the position on the vertical axis and the time on the horizontal axis. Draw the best straight line as close as possible to the data points. Calculate the slope and record it on the graph.

Part B: Constant Speed - Uphill

1. This is similar to Part A, but the toy car will move up an inclined ramp that is at least 1.0 m long. Elevate the ramp so that the point 1.0 m from the low end (1.0 m along the ramp) is 10 cm higher than the lowest point. As in part A, one person will call out manageable time intervals while another persons marks the position of the car when the time is called. Measure the position of the time marks relative to zero

at the starting position (all positions should be marked from behind the car). Record your data in Data Table 1.2.

3. Elevate the ramp to 20 cm and repeat. Then elevate the ramp to 30 cm and repeat once more. Also record the data for both of these experiments in Data Table 1.2.
4. Use the data from Data Table 1.2 to create three lines on a single graph. Calculate the slope of each line and record that calculated slope somewhere on the graph.

Part C: Motion with Increasing Speed

1. You will be provided with a wheel, having a narrow axle, and a sloped track (a pair of metal rails) on which the wheel-and-axle can roll. When the wheel-and-axle is released from rest near the top of the sloped track, it should roll down the slope with an increasing speed. Your objective will be to mark the position of the axle every three seconds. To insure that your measurements are reasonably repeatable, you will be asked to record positions for several (at least two) descents. To aid in producing repeatable releases, the intended release point has been marked on each rail near the top of the slope, and a line has been drawn on one side of the wheel; for runs that will be recorded, the wheel-and-axle should always be released with this line on the north side of the wheel, parallel to the rails, and pointing downslope. Also, before release, you must be sure that the plane of the wheel is oriented along the centerline between the two rails. Test your apparatus by watching descents for several practice releases. In particular, watch the wheel immediately after release; if the line on the wheel has any upward movement at all, then you will know that the release has not been clean.
2. To record the positions, station two students, each with a marking pen, on the north side of the track; one student will mark the positions of the moving axle near the top of the track, and the other student will mark positions nearer the lower end. Have the student controlling the stopwatch count down to "go" ("3, 2, 1, go"), and then call "now" every three seconds. Release the wheel-and-axle on "go," and then mark the position of the moving axle on each "now." Use the measuring tape to measure the positions of the marks; measure from zero at the release position. Record your measurements in Data Table 1.3, then erase your marks and take another trial. You may consider your measurements to be satisfactorialy repeatable if the measured positions at 3.0 s differ by no more than 3.0 mm. Once you have two satisfactory trials, then enter the average positions for those two trials in column five of Data Table 1.3.
3. Using the average positions from column five, make a position-versus-time graph for the motion of the descending wheel-and-axle. In this case, your points should not fall on a straight line. Draw a smooth curve through your data points.

Data Table 1.1 Position and Time for Toy Car on Level Track

Total Time (s)	Position (cm)

Data Table 1.2 Position and Time for Toy Car Going Uphill

Total Time (s)	Position (10 cm case) (cm)	Position (20 cm case) (cm)	Position (30 cm case) (cm)

Data Table 1.3 Wheel-and-Axle Descending Sloped Track

Time (s)	Position Trial 1 (cm)	Position Trial 2 (cm)	Position Trial 3 (cm)	Average Position (cm)	Change in Position (cm)
0					
3					
6					
9					
12					
15					
18					
21					

Results

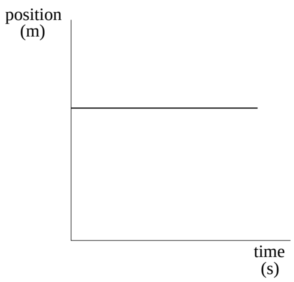
1. Look at your graphs. For motion with constant speed (any case), how do the changes in position (the distances traveled) compare for equal intervals of time? As an aid in finding the answer, add to your graph for part (A) by plotting all of the position points on the vertical axis; by doing this, you will have created a scale model of your original motion diagram which should make the answer to this question easy to see.

2. What was the speed of your toy car (a) over level ground and for each of the three elevations (cases (b), (c), and (d))? Show your calculations as well as giving your results.

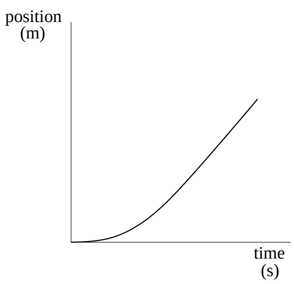
3. Look at your graph for part (C). For this motion with increasing speed, how do the changes in position (the distances traveled) compare for equal intervals of time? As an aid in finding the answer, add to your graph for part (C) by plotting all of the position points on the vertical axis; by doing this, you will have created a scale model of your average motion diagram for the wheel-and-axle which should make the answer to this question easy to see. Also, fill out column six of Data Table 1.3 (there will be no entry for time zero, since the first change in position is from time zero to time 3.0 s). The numbers in column six will again help you to answer this question correctly.

4. For part (C), how might the speed at some given time be estimated from your data, or from your graph?

5. Describe in words the motion of the object for which a position-versus-time graph is sketched below.



6. Describe in words the motion of the object for which a position-versus-time graph is sketched below.



7. Sketch a graph of position-versus-time for an object that is going fast when you first look at it, but then slows down and eventually comes to rest. (When you first look, the object is at position zero going fast; it finally comes to rest somewhere away from position zero.)