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 use a stopwatch to time a ball rolling down a tilted track; you will record the time required for that ball to roll a number of selected distances. By plotting the selected distances versus your measured times, you will then create a graph which is equivalent to a graph of position-versus-time for a ball released (with zero speed at release) from the top of your ramp. 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 U-shaped track and a steel ball which rolls smoothly on that track. The tracks are 163 cm in length. Elevate your track a distance of 30-45 cm at a location which is about 20 cm from the upper end of the track. Record this elevation at the top of Data Table 1.3.
2. Select six to eight positions on the ramp from which to release the ball; mark those positions with masking tape. PLEASE DO NOT PUT PERMANENT MARKS ON THE TRACK. One position should be the near the uppermost end, and the other positions should be equally spaced, as measured from the bottom of the track. Hold a ruler across the track with the ball behind it; release the ball by lifting the ruler up in the same manner everytime. Start a stopwatch when the ball is released, and stop it when the ball reaches the bottom of the ramp. Placing a block at the bottom of the ramp will provide a sound that will help to signal when to stop the stopwatch.
3. For each selected position, take three time measurements. Record these measured times in Data Table 1.3. For each position, calculate the average of the three time measurements; we will take the average value to be the correct time for that position.
4. Make a graph of the data in Data Table 1.3. In this case, we are selecting the positions and measuring the times; strictly speaking, we should put the positions on the x-axis of our graph and the times on the y-axis. However, we wish to create a graph which can easily be compared with our previous graphs of position-versus-time. Therefore, in your graph, put position on the vertical axis, and time on the horizontal axis. You will thus create a graph which is the equivalent of the graph of the motion of a ball released (with no speed at release) from the top of the ramp, with zero position being located at the top of the ramp. It is as if we released the ball from the top of the ramp, called out the times (i.e. the times that we in fact measured), and marked the position of the ball with a pencil as the times were called. Such an experiment would of course be impossible, because the ball is eventually moving too fast; for that reason we did this experiment using a different procedure than was used for the toy car.

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 Ball Rolling on Ramp Elevation = __________ cm

Distance from Bottom (cm)	Time Trial 1 (s)	Time Trial 2 (s)	Time Trial 3 (s)	Time Average (s)

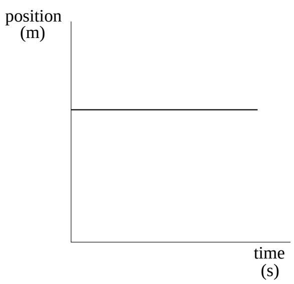
Results

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? Explain your answer in terms of how speed can be calculated from your data.

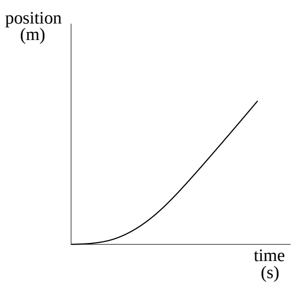
2. What was the speed of your toy car (a) over level ground and for each of the three elevations (cases (b), (c), and (d))? Show your calculations as well as giving your results.

3. Look at your graphs. For motion with increasing speed, how do the changes in position (the distances traveled) compare for equal intervals of time? Explain your answer in terms of how the speed at some given time might be estimated from your data.

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



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



6. 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.)