PHYSICS
Lab 1-1: Analyzing Motion by way of Position-Time Graphs

Objects can move in very simple or very complex ways. One important distinction is between motion in a straight line and motion in a curved path. Another fundamental distinction drawn is between motion at a constant velocity and motion with a changing velocity. To keep things simple, we begin in this experiment by analyzing the motion of an ordinary moving in a straight line path along a flat surface.

PROCEDURE:

Part A: A bowling ball will be released at the top of a short ramp and then allowed to roll across the floor at the front of the classroom. Students with stopwatches will be placed every 2 tiles (*the length of one floor tile is 30.5 cm*). Students will start their stopwatches as the ball hits the floor and stop their stopwatches when the ball reaches their assigned position. A table of position/distance vs. time can thus be constructed for the ball. This data can then be graphed and analyzed.

Instructions for graphing with Excel in Windows Vista

1.	Double click on the **Excel** icon. A new worksheet (spreadsheet) will appear with columns (vertical) and rows (horizontal), and a toolbar at the top

2.	Type in your X (horizontal axis) quantity's data in each cell (box) in a column and repeat for your Y (vertical axis) quantity. Excel will assume that your 1st (left-hand) column are your X-values and your 2nd (right-hand) column are your Y-values. Don't expect it to read your lab mind or your lab handout for you.

3.	Click and drag the mouse starting at the top left cell to the bottom right cell of the data you wish to graph - note that the top left cell will not look highlighted, but it is!

4.	Click on the **Insert** tab, second from the upper left on the toolbar. In the Charts section of the Insert toolbar which comes up, click on the **Scatter** tab. Choose the top left option in the pulldown menu which comes down (the one where the points are not connected).

5.	Under Chart layouts, click on the left option, so that your graph will now show up with generic axis and heading titles. Replace these titles with appropriate labeling for your particular graph (including both the quantity being measured and units of measurement on the axes, of course). Delete the box which says **Series 1** -- all it does it take up space.

6. Right click on the data to highlight it and select **Add Trendline** in the pulldown menu. At the bottom of the Format trendline menu box, select the boxes which say **Display Equation on Chart** and **Display R-squared on Chart**. _The R^2 value tells you how well the best-fit equation fits your data set: the closer it is to 1, the better the fit_. Try <u>linear</u>, <u>power</u>, and <u>quadratic</u> regressions to see which fits your data best.

7. After choosing an equation, manually click on the box containing the equation so that you can go it replace the generic "y" and "x" variables in the equation with variables appropriate to the graph you just made (x and t, or d and t, etc.). Also, round the numbers in your equation to a number of digits appropriate to the level of precision in your data (how many digits do you have in your data?).

8. If you want to change the maximum or minimum values, divisions, etc., on one of your axes, right click on the numbers along the axis and choose **Format Axis** at the bottom of the pulldown menu. You will now have options to manually set the maximum, minimum values, and increment values on your axes. You can also change the gridlines if you want to (or add gridlines for the x values, if you want a more traditional looking grid)

9. If you want to change the appearance of the graph, right click anywhere on the graph and select **Format Plot Area**. You will then be given options for colors, shading, etc.

10. Before printing (or after), take a moment to make sure that the data on your X and Y axes actually represent what they are supposed to represent (check the numbers!). Reversing your X and Y data is easily done, and usually renders the entire graph completely useless.
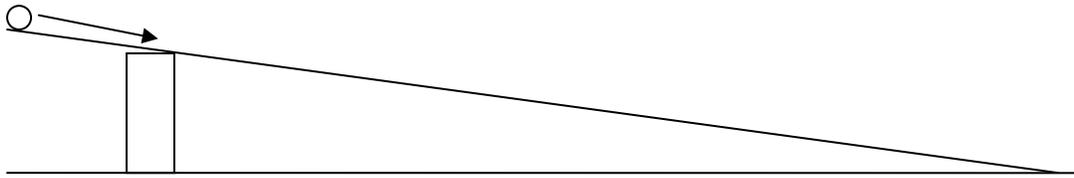
Part B: This part of the experiment will be done in groups of two or three. Ramps will be set up in the lab and each group will have a steel ball and a pair of stopwatches. Measure out a series of distances (at least 6) on the ramp, release the ball at the top of the ramp, and measure the amount of time it takes for the ball to roll each distance. Do 2 runs at each position to make sure that your data is reasonably consistent (so you will be rolling the ball at least 6 X 2 = 12 times). Average the usable data and construct another table of position/distance vs. time.

YOUR REPORT FOR THIS LAB SHOULD INCLUDE:

- **Data tables for both parts A and B**
- **Graphs of position/distance vs. time for both parts A and B. Each graph should include an appropriate best-fit equation, with the R^2 value displayed.**
- **A conclusion in which you discuss what is demonstrated by your results. <u>Based on the data, graphs, and/or excel best-fit equations</u>, what can you conclude about the motions of the bowling ball and the steel ball? What do you see as the main sources of error in the experiment and how might these have affected your data?**