PHY 157
Linear Regression Analysis of Data
(Experiment 1)

Name: ____________________________________

1 Introduction

This laboratory experiment will give you practice in using linear regression to analyze data. You will be given two data sets and asked to find the best-fit line through the data points using linear regression.

2 Apparatus

- Graphing calculator or computer

3 Procedure

1. **Data Set 1.** Imagine that a cart is rolling smoothly along a level track from left to right. A motion detector is placed at the left end of the track and is used to record the position of the moving cart at equal intervals of time. Assume that the forces of friction are very small and can be neglected in your data analysis. The results are shown in this table:

Time, t (sec)	Position, x (m)
0.20	0.73
0.40	0.88
0.60	1.14
0.80	1.39
1.00	1.64
1.20	1.78

Enter the data into a calculator or computer program. Plot the data (x vs. t) and examine the resulting graph. Often it is best to plot data as points only and omit the connecting lines between the points. Most plotting programs allow you to display the plotted data either way.

(a) Make a sketch of the resulting graph. Include axis labels on your sketch.

(b) Does the graph show a linear relationship?

(c) Do a linear regression analysis of the data. Report the slope and y-intercept with proper units.

(d) Plot the regression function on the same graph as your plotted data. How well does the function fit the data?

2. **Data Set 2.** Imagine that you are on Mars and have done the following experiment: a small ball, held about 10 meters above the surface, is released from rest and allowed to fall freely. A motion detector placed below the ball records the position-time data shown in this table:

Time, t (sec)	Position, x (m)
0.20	9.83
0.60	9.52
1.00	8.12
1.40	6.30
1.80	4.05
2.20	1.19

Assume that air friction is so small that it can be neglected in your analysis.

Enter the data into a graphing calculator or computer program. Plot the data (x vs. t) and examine the resulting graph.

(a) Make a sketch of the resulting graph. Include axis labels on your sketch.

(b) Does the graph show a linear relationship?

(c) From classical mechanics, we expect a functional relationship between position and time to be

$$x = \frac{1}{2} g t^2 + x_0. \tag{1}$$

We can therefore *transform* the data to "linearize" it by simply squaring all the time values. The following table shows the transformed data. The positions x remain the same as in the table above, but the times are the squares of the times in the previous table. Square each of the times in the previous table to fill in the first column of this table:

Square of time, t^2 (sec^2)	Position, x (m)
	9.83
	9.52
	8.12
	6.30
	4.05
	1.19

Plot the transformed data (x vs. t^2) from this table. Make a sketch of the new graph. Does the graph show a linear relationship?

(d) Do a linear regression analysis of the data. Report the slope and y-intercept with proper units.

(e) Plot the regression function on the same graph as your plotted data. How well does the function fit the data?

(f) The acceleration due to gravity on Mars is just twice the slope you just found. What is the acceleration due to gravity on Mars?