Data Analysis and Graphing Lab

Name____ **Group#**________

Course/Section______________________________________

Instructor____

Introduction

The purpose of this exercise is to learn some basic techniques of data analysis: conversion of units, plotting data, calculating the slope of a graph, using the slope to find a physical quantity, and calculating the percent error of your results.

Exercise 1.

Table 1 show the data collected by a motion sensor for a ball, initially at rest, then allowed to freely fall straight downward.

Table 1

sssTime, t(s)	Distance from the sensor (m)	$t^2(s^2)$	Displacement, Δy(m)
0	0.872		
0.10	0.922		
0.20	1.061		
0.30	1.287		
0.40	1.635		
0.50	2.079		

1. Fill in the t^2, and the displacement columns. Remember that displacement is direct line length directed from the initial position to the current position. (5 points)

2. Plot displacement vs time (Δy vs. t). This means that Δy is the ordinate (vertical axis) and t is the abscissa (horizontal axis). (6 points)
3. Plot Δy vs. t^2. Then draw a Best-Fit Line through the data points. Find the value of the slope of this line, and its units. (show calculation, and units together on the graph paper) (6 points)
4. What physical quantity (velocity, acceleration, etc.) does the slope of this graph represent? (Please note; **you are NOT being asked to describe the relationship between displacement and the square of the time shown by the graph**) Here is a hint: The magnitude of the displacement of a freely falling mass with the initial velocity of zero is given by $\Delta y = \frac{1}{2}gt^2$. (3 points)

5. From the value of your slope determine your experimental value for g. (3 points)

6. Find the percent error of the experimental value of g, using $g = 9.81\ m/s^2$ as the accepted value. (2 points)

Exercise 2.

Table 2 shows the acceleration of different masses on a level surface, with the same constant force being applied to each mass separately.

Table 2

Mass, m(g)	Acceleration, a(m/s^2)	Mass, m(kg)	1/m (kg^{-1})
50.	15.72		
100.	8.37		
200.	4.02		
400.	1.98		
800.	1.03		
1,600	0.47		

1. Complete the above data chart. (5 points)

2. Plot a vs m, where mass is in kilograms. (6 points)
3. Plot a vs 1/m, where mass is in kilograms. Draw a Best-Fit Line through the data points. (6 points)
4. Find the value of the slope of the Best-Fit Line, with its units. (4 points)

5. What physical quantity does the slope represent? What is the correct name for combination of units the slope possesses? (4 points)

Exercise 3.

The period of a pendulum *T* is given by the following equation.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Where *l* is the length of the pendulum, and *g* is the gravitational acceleration 9.81 m/s^2. Table 3 shows the data of the period of a pendulum as a function of length.

Table 3

l(m)	*T(s)*	*$T^x(s^x)$*
0.200	0.910	
0.400	1.26	
0.600	1.58	
0.800	1.80	
1.00	2.08	
1.20	2.22	

1. Plot *T vs. l.* (10 points)
2. Plot T^x *vs. l.* Before you do this, however, you need to determine the numerical value of x. Hint: Using the given equation for the period of a pendulum, **ALGEBRAICALLY** solve for $\frac{T^x}{l}$. (10 points)

3. Find the Best-Fit Line of T^x *vs. l.* Calculate the slope's value, with its units. (5 points)

Exercise 4

The number of radioactive nuclei decrease exponentially with time as given by the following equation.

$$N = N_o e^{-\lambda t}$$

Where *N* is the number of nuclei present at time *t, N_o* is the original number of nuclei present (i.e. at time t = 0), and λ is the decay constant of the process (i.e. the probability that any single nucleus will decay in one second). This function can be also straightened out as follows. First, dividing both sides of the equation by *N_o*. gives

$$\frac{N}{N_o} = e^{-\lambda t}$$

Then taking the natural log of both sides yields

$$\ln\left(\frac{N}{N_o}\right) = -\lambda t$$

1. Make a Chart with columns for t, N, and $\ln\left(\frac{N}{N_o}\right)$. Calculate the values for each at 2.0 minutes increments, but the time must be in seconds. Let $N_o = 5.0 \cdot 10^{22}$, and $\lambda = 5.66 \cdot 10^{-4} s^{-1}$. (10 points)

2. Plot $\ln\left(\frac{N}{N_o}\right) vs. t$. (10 points)

3. Calculate the slope of the Best-Fit line, with its units. (3 points)

4. What physical quantity does the slope represent? (2 points)