PHYS 1401
General Physics I

EXPERIMENT 0
GRAPHS

I. OBJECTIVE

The objective of this experiment is to measure two quantities and study the relationship between them. The student will measure the diameter and the circumference of several size circles and draw a graph of these two quantities and then calculate their ratio.

II. DISCUSSION

1. Generally in a science experiment, we investigate the relationship between two quantities by measuring both as we vary one and observe the resulting change in the other. The quantity which is changed by the experimenter is called the independent variable while the other one is called the dependent variable.

2. Experimental data are usually displayed in a data table. Since it is easier to understand and interpret visual pictures, it is often desirable to exhibit the relationship visually by plotting a graph of the two quantities. If the resulting graph is a straight line, then the relationship is **linear** and the equation relating the two quantities is

$$y = mx + b \tag{1}$$

where m is the slope of the line and b is the value of y at $x = 0$.

3. The slope is a constant and is calculated from the equation

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{\Delta y}{\Delta x} = \frac{(y_2 - y_1)}{(x_2 - x_1)} \tag{2}$$

4. If the straight line graph goes through the origin $(0, 0)$, then the equation relating the two quantities is

$$y = mx \tag{3}$$

this relationship is a **direct relationship** and we say y is directly proportional to x with m, the slope, being the proportionality constant. In this case the slope is calculated from the equation

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{y}{x} \tag{4}$$

5. More complicated relationships exist between physical quantities and the study of physical phenomena where such relationships exist is more challenging and will be discussed as we study these concepts.

III. EXPERIMENTAL APPARATUS

Circles of various sizes, ruler and string.

IV. EXPERIMENTAL PROCEDURE

1. Obtain 5 sizes of circles and measure their circumferences (the way around) by wrapping a string around the circle and then measuring the length of the string in centimeters cm.

2. Trace the circle on a piece of paper, mark its center as best as you can and measure the diameter (across through the center). Record your measurements in your data table.

V. ANALYSIS

1. Find the ratio of the circumference of each circle to its diameter. Round off your results to 3 significant figures and record them in the data table. Show one sample calculation below:

$$\frac{C}{d} =$$

2. *The ratio of the circumference of a circle to its diameter is a constant and is known as π (pi) which has a value of 3.14* (to three digits).

3. Plot a graph of the circumference on the vertical axis, (y), and the diameter on the horizontal axis, (x). Use the Graphical Analysis software on the computer to plot the graph.

   (a) Open the Graphical Analysis folder (in the dock at the bottom of the screen). The screen will show an (x, y) table and a set of two axes.

   (b) Enter your data in the table.

   (c) Double click on the x in the table and label the x axis and give its units.

   (d) Repeat the above step for the y axis.

   (e) Go to **analyze** on the main menu and scroll down and select **linear fit**. This will draw the straight line which is the "best fit" for the data. Notice that we **do not connect the individual points.** Also the computer will now give you the slope of the line including its units.

   (f) Give the graph a title and write it in the graph box wherever there is space available.

4. The slope of this "best fit" line is the ratio C/d averaged over the 5 data points. You should show it on your graph and mention it in your conclusion since it is the result of this experiment.

5. Calculate the percent difference between the ratio found in this experiment (the slope) and the accepted value which is π. Use the following equation

$$\text{Percent difference} = \frac{|\,\text{Accepted - Experimental}\,|}{\text{Accepted}} \times 100$$

6. The fact we are able to draw a graph (or write an equation) expressing a general relationship between two quantities based on a limited number of measurements is an important step in the scientific method. In this experiment, we are able to find a general relationship between the diameter and circumference of a circle. This relationship has no exception.

7. The purpose of physics experiments (science experiments in general) is the discovery of general relationships in the description of natural phenomena. As we pointed out in the discussion at the beginning of this lab, the simplest relationship between two quantities is the **linear** relationship where the graph is a **straight line.** In this course, we will encounter such linear relationships often.

V. QUESTIONS

1. From the graph, predict the circumference of the two circles having the following diameters:

   (a) A circle which has a diameter $d = 2.5\,\text{cm}$ has a circumference $C =$

   (b) A circle which has a diameter $d = 6.00\,\text{cm}$ has a circumference $C =$

2. Name two advantages of plotting a graph over displaying the data in a table.

3. Write a conclusion summarizing the results of this experiment.

Experiment (2) Data Table: Circles			
	Circumference C (cm)	Diameter d (cm)	Ratio $\frac{C}{d}$
Circle 1			
Circle 2			
Circle 3			
Circle 4			
Circle 5			