Chapter 1

Graphing Skills

An important skill to master is analyzing experimental data in graphical form. Graphs can be very informative, because they allow us to see trends in the data and extract information about the measured quantities and their relationships to each other. The **experimental equation** is an equation that best represents the relationship between the variables graphed. The **linearization equation** is the equation of a best fit trend line that fits the linear graph of the data variables. The trend line added to all graphs must be linear. The type of equation that best fits the data collected is found by taking your data and making 3 graphs: y vs. x, log(y) vs. log(x), ln(y) vs. x. The graph where the R^2 value is closest to 1 tells us which type of experimental equation is used. If y vs. x is best, the plot is linear. If log(y) vs. log(x) is best, the function is a power relationship. If ln(y) vs x is best, then the data shows an exponential relationship. We will be finding the experimental equation of the data in several labs. A plot of the ordinate (Y or vertical axis) vs. the abscissa (X or horizontal axis) needs to have an appropriate scale for each axis. You want the graph to be easy to read without it being bunched up in a corner. Use a scale so most of the graph is used. If using a program (like Excel), use an appropriate graph size so that it is legible. No more than 6 graphs per page please. Graphs must contain the following:

1. Units and labels for each axis
2. A Title that is informative of what is being plotted and easily understood.
3. The **linearized equation**
4. The R^2 value
5. The data
6. The linear trend line

Below I give you the basic equations that represents the relationship between the data points graphed (experimental equation) and the equation of a best fit trend line fitting the linear graph (linearization equation). You will need to know how to recognize each type, determine the slope and y intercept of the linearization equation, and find the experimental equation. Therefore you need to be able to go back and forth between the different equations.

Type	Experimental Equation	Linearized Equation
Linear	y = mx + b	y = mx + b
Power	y = bx^m	log(y) = mlog(x) + log(b)
Exponential	y = be^{mx}	ln(y) = mx + ln(b)

In this notation, b is always your y-intercept and m is always your slope.

1.1 Solving for the Power Relationship

Take a closer look at the power relationship. From our graph, we have plotted the log of y as a function of log of x. This means that log y is along the vertical axis and log of x is along the horizontal axis. What the computer has given us back as the best fit is the **linearized equation** of this log plot. To denote the difference, I will use prime notation for the linearized equation.

$$y' = m'x' + b' \tag{1.1}$$

y' represents what is plotted along the y-axis, which for this graph is log(y), and x' is what is plotted along the x-axis which is log(x). Hence, if we compare the linearized equation to our experimental equation,

$$log(y) = mlog(x) + log(b) \tag{1.2}$$

we can see that $m' = m$ and $b' = log(b)$. To find b, we use

$$b = 10^{b'} \tag{1.3}$$

1.2 Solving for the Exponential Relationship

Likewise, from a Exponential graph, we have plotted ln(y) vs x. Here, the best linear fit gives an equation just as before

$$y' = m'x' + b' \tag{1.4}$$

but now we are comparing it to a different linearized equation

$$ln(y) = mx + ln(b) \tag{1.5}$$

Again, by comparing terms, we can see that $m' = m$, but this time $b' = ln(b)$. To get b, we can use the relationship

$$b = \exp(b') \tag{1.6}$$