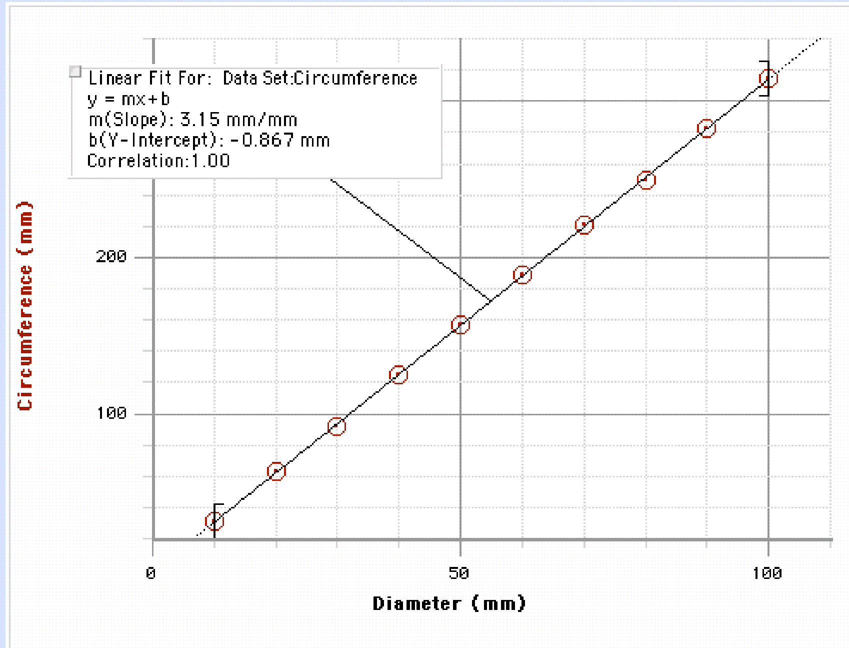
Physical Interpretations and Graphical Analysis

Creating realistic models from data requires more than a blind "best fit" strategy. A physical model needs to be created from an algebraic model if the new model is to have any useful meaning. For instance, let's say that an experimenter measures the circumferences of a number of circular disks, as well as the diameters of these disks. There will be measurement error associated with each determination of circumference and diameter. A graph of circumference versus diameter produces the following result with the use of *Graphical Analysis*:

Data Set	Data Set	
Name	Diameter	Circum
Units	(mm)	(mm)
1	10	31
2	20	63
3	30	92
4	40	125
5	50	157
6	60	189
7	70	221
8	80	249
9	90	283
10	100	315
11		



Note that an algebraic relationship results from a linear fit (y = mx + b) that is of the following form:

$$y = 3.15x - 0.867mm$$

Identifying *y* with circumference, *C*, and *x* with the diameter, *D*, the equation translates to the following form:

$$C = 3.15 \times D - 0.867mm$$

This relationship suggests that if diameter equals zero, the circumference would have some negative value. This clearly is incorrect in our physical world. If *D* = 0, then *C* must equal 0. The way to resolve is problem is to create a physical model. Clearly, the relationship is linear, but the regression line must pass through the origin (0,0).

A physical model can be created by forcing the regression line to pass through the origin. This is NOT done by including the data point 0,0; it IS done by using a different regression model, a proportionality (y = Ax), for the curve fit. Such a curve fit produces a different equation that we would call a physical model.

$$C = 3.14D$$

or more commonly

$$C = \pi D = 2\pi r$$

where *r* is the radius of the circle. This physical model is not weighed down by the non-zero y intercept. When interpreting graphical results in lab, be certain to use an interpretation that corresponds to the physical world as we know it.