DATA ANALYSIS -- THE PENDULUM PROBLEM

This exercise is to investigate if there is a relationship between the length of a pendulum and the amount of time it takes to make a complete swing (its period).

DATA COLLECTION

One way is to hang a basketball attached to a strong string from the ceiling. At every 10 cm on the string, make a black mark on the string.

You must also find the diameter of the basketball. First "eyeball" it. Second, wrap string around the ball and measure the "length around" the ball in cm (we call this the circumference, of course). Using $C = \pi d$, you can substitute the value for C that you obtained and solve for the diameter, d.

For example, the circumference of the basketball I used was 72 cm. 72 divided by π is 22.9 or 23 cm to the nearest whole number.

The time consuming part is the data collection. With the help of my trusty assistant, Amy Guy, we obtained the data using the following procedure:

First I measured the length of the pendulum including the diameter of the basketball, which was 53 cm. We then conducted 3 to 4 "trials" for this length. Using a stop watch, I had Amy record how long it took for the pendulum to make 3 complete swings. She divided that by 3 to find the average for one swing. Then I had Amy record how long it took for the pendulum to make 4 complete swings. She divided that by 4 to find the average for one swing. And so on for 5 swings and sometimes 6 swings. We then found the "average of the averages". That value was used with 53 cm (for our calculations it was 1.43 sec rounded to the nearest hundredth)

Second I made the pendulum 10 cm longer (using the black marks on the screen) and repeated the process described above.

I continued this until the pendulum was 153 cm long.

ENTER THE DATA

L	53	63	73	83	93	103	113	123	133	143	153
T	1.43	1.53	1.67	1.76	1.93	1.98	2.08	2.21	2.28	2.38	2.43

Where L is Length of the pendulum in cm and T is the time in seconds for one swing of the pendulum.

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Clear the data in lists L1 and L2. Enter the lengths into L1 and the times into L2.

Using an appropriate window: $X[50, 175]_{25}$ $Y[1.25, 3]_{.1}$

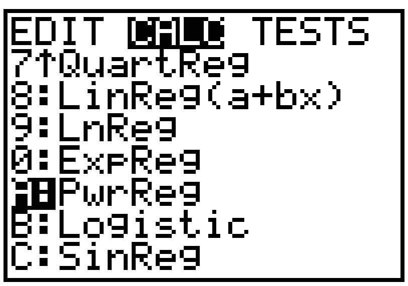
Graph the points to see if there is a mathematical relationship here.

It is a bit difficult to see but besides looking like it might be linear, it also might be a form of square root of x , $y = \sqrt{x}$, which is a power function in the eyes of the TI-83, $y = x^{\frac{1}{2}}$.

PERFORM A POWER REGRESSION

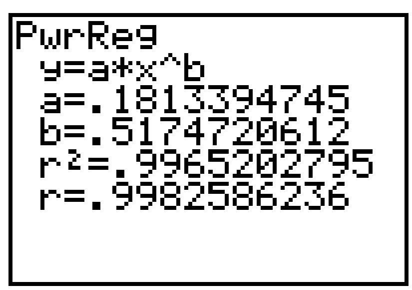
To do so, type in the following commands:

STAT CALC A PwrReg



L1,L2,y1

<ENTER>



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$$\therefore \quad y = .18x^{.52} \quad or \quad to \quad the \quad nearest \quad tenth \quad y = .2x^{.5}$$

Another way to write this using T for time and L for length:

$$T = .2 * L^{.5} \qquad or \qquad T = .2\sqrt{L}$$

Now this in itself was kind of neat because the curve was a pretty good model of the data. However we can take this further.

From a physics text, the formula for the time T for one complete swing of a clock pendulum is given by

$$T = 2p\sqrt{\frac{L}{g}}$$

where L is the length of the pendulum and g is the acceleration due to gravity, which for this would be 980 cm/sec^2 , and T is in seconds.

Again, so what? Well if you do the algebra and approximations, see what you get.

That is, $$T = 2p\sqrt{\frac{L}{g}}$$

$$T = \frac{2p}{\sqrt{g}}\sqrt{L}$$

$$T = \frac{2p}{\sqrt{980}}\sqrt{L}$$ Now $$\frac{2p}{\sqrt{980}} \approx 0.2$$

so $T = .2*\sqrt{L}$ (now where, oh where, have I see *this* before?) ☺

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