Name _____ Date _____

Partners _____

Empirical Equations: Mechanics Lab #1 (A Challenge)

Objective: to learn some techniques for making measurements and for making predictions from a small number of observations.

Equipment: 5 standard metal rings of different sizes, stopwatch, Universal Lab Interface, motion detector, knife edge support structure, meter stick, balance, photogate timer, Excel, various rings as unknowns

Procedure: This is a challenge lab. The first hour will be devoted to taking measurements and analyzing them as outlined below. This will count for up to 75 points. Then you will be given a challenge object and you must predict its behavior. This will be measured with the instructor watching. You will earn up to 25 points if you have predicted the behavior accurately.

1. Set up the knife edge support structure.

   Place the largest ring on the knife edge so that it can oscillate as a pendulum.
   Use the motion sensor apparatus to record its oscillation. First turn on the ULI box with the motion sensor attached to port 2. Then select Start, Programs, Vernier Software, Logger Pro. The default graph is not correct for what we want to do, so select Open, Probes & Sensors, Motion Detector, Motion Detector. View Graph layout, one pane only.

   Set the ring swinging. Click the Collect button. Print. Then calculate the ring's period for one oscillation.
   Also use the stopwatch to measure the oscillations. Is the difference small enough?

2. Measure all the other physical parameters of the ring that you can think of.

3. Repeat for each of the other four standard rings.

4. Enter your data into an Excel spreadsheet. Read Excel Tips for guidance. (csam.montclair.edu/~west/exceltips.html)

5. Make graphs (XY scatter) of the oscillation period vs. each parameter in turn.
   If the graph seems to show a relationship (not just a scatter diagram), then add a trendline, and try linear, and exponential, and power law. In every case, use Options, Display the equation on the graph and display the R-squared value on the graph. Record these equations and R-squared values.

6. Recall that Nature prefers small integers in equations. Make a judgment about which is probably the most reliable equation you can use to predict the period of oscillation of a non-standard ring.

Conclusion: State your conclusion in one equation and explain it in one sentence. (Communication is a valuable skill.)

The challenge: Request a non-standard ring.
Make whatever measurements you want on it, except for oscillation.
Call the instructor, and wait for her. Together we will measure the period of oscillation.
If you are within 5 %, you earn 25 points.
If you are within 10 %, you earn 20 points.
If you are within 20 %, you earn 10 points.

If you are more than 10% off, you can earn up to 10 points by explaining briefly why you were so far off.
The instructor will initial your score.

Lab Report:
Staple a copy of the spreadsheet with small graphs to each person's lab report. Remember to use Print Preview first.

Reference:
Greer, A.J., Bierman, J.D., Challenge Laboratories, The Physics Teacher, November, 2005, p 527