THE SIMPLE PENDULUM: AN APPLICATION OF DIMENSIONAL ANALYSIS

Objectives:
- Construct a formula for the period of a simple pendulum based on dimensional analysis.
- Compute uncertainty in period using propagation of error.
- Experimentally check the formula for the period.

To Do Before Lab:
- Read this lab
- Read "Phys190 Uncertainties II", and, for more depth, Taylor 3.7

Apparatus: Motion detectors, string, mass, clamps, etc for pendula, measuring tape, ruler, protractor, stop watches, Excel

Introduction: A *simple pendulum* consists of a mass swinging gently at the end of a light string. By "light" we mean that the mass of the string can be neglected compared to the hanging mass. By "gently" we mean that the mass does not deviate far from its equilibrium position. The pendulum is free to swing back and forth, and the time required for the mass to return to the same positions and momentum is called its *period*. To find a formula for the period of a simple pendulum (abbreviated *T*) in terms of physical parameters, we'll use *dimensional analysis* and then check the validity of this "guestimate". (You're actually standing on pretty firm ground due to Buckingham's theorem.[1]) For this week we will assume that $g = 9.80\ m/s^2$, exactly.

Procedure:

1. List the physical parameters that could possibly affect the period of the pendulum. Strive to construct a list of complete and independent parameters.

2. Use dimensional analysis to "guestimate" a formula for the period that involves those physical parameters. Describe your reasoning.

3. Compute, via propagation of errors, the uncertainty in the period. This uncertainty is due to uncertainty(ies) in the parameter(s) of part 1. Make a short list of the uncertainties in the period for the pendula that you will construct in part 4.

4. Test your prediction experimentally. Plot your data on a graph to check the functional relationship you suspect and determine any numerical constants. Show your data, graph, and calculations.

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[1] "When a complete relationship between dimensional physical quantities is expressed in dimensionless form, the number of independent quantities that appear in it is reduced from the original *n* to *n-k*, where *k* is the maximum number of the original *n* that are dimensionally independent." A. Sonin, "The Physical Basis of Dimensional Analysis" http://web.mit.edu/2.25/www/pdf/DA_unified.pdf section 3, or F. Giordano et. al., "Dimensional Analysis" 1983 UMAP Unit 526.