Pendulum Laboratory

Tuesday of week 1, 1st hour: Data collection. Tuesday 2nd hour: Group work on analysis. Wed: class self-assessment of analyzed data; more physics, modeling. Friday: Lab report due –see write-up assignment handout for details.

In this laboratory exercise you will measure properties of the pendulum motion and analyze them. The primary aspects of the lab are:

CALIBRATION: Determine how the computer records the pendulum angle.

DATA COLLECTION: Measure the motion of the pendulum as a function of time, including large and small oscillations. Measure the physical parameters of the pendulum to allow you to predict the period from the model.

DATA ANALYIS: Examine the motion. Extract the period of the motion for several different amplitudes. Plot your results along with the values calculated from the models we have considered.

MODELING: In a group exercise that you'll start in class and finish for homework, we will examine a model for the motion of the pendulum and predict (numerically) the outcome of the period measurements. You'll need the result of this prediction in your report.

REPORT: Present & describe the raw data, data analysis, modeling & results. Pay attention to organization, clarity, and presentation. See write-up assignment for details.

CALIBRATION: The measurement apparatus must be calibrated so that you know how the recorded resistance data correspond to the pendulum's angular position. This is easily done by holding the pendulum at some fixed angles (e.g. 0°, ±90°, ±150°, *etc*.) and recording the corresponding signal.

DATA COLLECTION & ANALYSIS: Record the motion of the pendulum. Make sure you record the motion for small angles all the way for angles as close to 180° as possible. If the pendulum goes over the top, you **must** bring it back to the original position to record data. The axle can rotate ONLY 3 times – forcing the system beyond this will destroy it. Equilibrium has been set to the middle. The period of the pendulum can be measured on the computer screen using the cursors. The amplitude can be similarly obtained (in resistance units, though). You should also export the angle *vs*. time data to Excel or another program, so that you can access it for presentation purposes and for any further analysis.

TECHNICAL DETAILS: The pendulum swings on an axle that is connected to a potentiometer or variable resistor. As the angle changes, the resistance between two output leads changes, and the resistance is recorded by LabPro, a data acquisition system made by Vernier. Pendulum $\theta(t)$ data is recorded with a program called Logger-Pro, which you'll find on the computer desktop. Pushing the `collect` button will start data-taking; a screen display results. You can set the data acquisition rate and the total time under the `Experiment->Data Collection` pull-down menu. The graphics cursor allows quick and easy analysis.

REPORT: (see write-up assignment handout for details, and seek feedback from instructors) For this first lab report, you will focus on presenting the experimental data and the analysis of those data. This means recording critical aspects of the experimental setup, organizing the data in tables and/or graphs where appropriate, and discussing how the data is analyzed. You should pay careful attention to graphs – are the data presented in the clearest possible way? Are axes labeled sensibly and informatively? Is your graph easy to read? Do you give units? You should also pay careful attention to tables – are the data organized sensibly? Have you used the correct number of significant figures? Pay attention to your prose – clear exposition is needed. Is there a way to misinterpret your words? Have you been succinct?

MODELING: Comparison of your data with a model, and confronting discrepancies is very important. Discrepancies may point to errors in technique, or to limitations of the model, which in turn causes us to be cautious about the model's predictive power. For this lab, you will (in class groups) calculate the period numerically based on the model we develop in lecture.

INDEPENDENT WORK:
You collect data in groups, so each group member has identical data, but the analysis and write up of the experiment **must be independent**. Consult with one another, but be responsible for your own learning. Healthy collaboration has independent analyses going simultaneously with brainstorming at stumbling points. You do yourself (and science) no good by leaning too heavily on the talents of others, and likewise you do your peers a disservice by supplying answers too readily. Science makes progress because different people bring fresh perspectives. Have confidence in yourself, and have the confidence to question others and yourself. Develop a healthy skepticism and a sense of what constitutes evidence and proof. ALWAYS QUESTION!

TIMELINESS AND PROFESSIONALISM:
Professional integrity demands that you learn as much as possible from the exercise, and that you acknowledge specific assistance from all sources. Professional courtesy requires that you complete work on time. This means starting early and working diligently at all times. Should circumstances preclude timely completion, consult with the instructor ahead of the deadline. You should never allow a deadline to pass without consulting the instructor.