Pendulum Laboratory

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

CALIBRATION:	Determine how the computer records the pendulum angle.
PERIOD:	Measure the pendulum period as a function of amplitude.
ANHARMONICITY:	Determine the anharmonic content of the pendulum motion.
RECORD KEEPING:	Record, organize, analyze, and discuss the data.

CALIBRATION: The measurement apparatus must be calibrated so that you know how the recorded data correspond to the pendulum's angular position. This is easily done by holding the pendulum at some fixed angles (e.g., 0˚, ±90˚, etc.) and recording data. It is also important that you record the equilibrium position of the pendulum. You also must determine the time scale for the recorded data by noting how many points are recorded in a specific time interval.

PERIOD: The period of the pendulum can be measured on the computer screen by observing the time difference between successive zero (equilibrium) crossings with the same slope. You can also save the data on the computer and analyze it with Maple or Excel. Measure the period at a series of different amplitudes from small angles up to angles close to 180˚. If the pendulum goes over the top, you must bring it back to the original position to record data. The Pendulum Period Worksheet that you complete will provide you with some theoretical expectations for the amplitude dependence of the period that you can compare to the data.

ANHARMONICITY: The anharmonic content of the pendulum motion is determined by Fourier analysis. Recorded data must be saved on the computer and then analyzed with the *fitting_fourier_simple.mws* Maple worksheet.

RECORD KEEPING: An important aspect of the scientific enterprise is the proper handling of the data. You must record and report sufficient information for you or another person to repeat and hence verify your experiment. This means recording all aspects of the experimental setup, organizing the data in tables and/or graphs where appropriate, and discussing how the data is analyzed.

TECHNICAL DETAILS: Pendulum data is recorded with a program called Epp Logger on the desktop. The single button will cause a single record of data to be taken and displayed in the screen. The total time for the trace is displayed in the upper right hand corner. Note this time whenever you take data, as well as the number of points recorded (this can be changed in the menu Display->Plot Controls). The time for a trace is controlled by the time delay value in the system controls window (a value of 524650 gives almost exactly 6 seconds of data). Other parameters in that window are (1) board gain (leave set as is), (2) offset, and (3) display scale. The recorded data is related to the pendulum angle θ by the equation

$$\text{data} = \frac{C\theta + B + \text{offset}}{\text{scale}},$$

where C is a constant and B is a constant approximately equal to 1024. The display can show recorded data values only from 0->256, so the scale and offset need to be set appropriately. The defaults (scale=4, offset=-700) should allow all possible motions to be displayed clearly, but small angle motion may appear too small to resolve clearly. If that is the case, you can zoom in by setting scale=2 and offset=-950. All changes must be noted in your log book so the data can be properly analyzed.

FINAL REPORT: Your final report can follow the example provided by LabAWorkbook (on web site) or your own format. Either way, a rough outline (*i.e.* what is required) is

1) Experimental details (diagram, important technical info)
2) Calibration: Data and results
3) Period: Data, results, comparison with expectations, graph of comparison
4) Anharmonicity: Data, results, comparison with expectations, graph of comparison
5) Conclusion: Summarize important aspects of results