LAB 6 STANDING WAVES

EXPERIMENTAL GOAL

In this lab you will be working with a wave machine constructed of 30 parallel rods of length L separated by a distance d = 3.0 cm. When the rods are in equilibrium, they are held parallel to each other by a pair of strings under tension that go through holes in the rods that are a = 5.0 cm apart. If the rods are twisted, the tension on the strings tends to pull them back toward alignment but also cause the rods to interact with each other in a way that sets up waves. Your task is to use standing waves on the rod to determine, with uncertainties, how the wave speed depends on the rod length L and the magnitude of the tension force F_T on the string.

LABORATORY SKILLS you will be developing

1. Familiarity with standing waves and frequency / velocity / wavelength relationships.
2. Determining functional relationships using graphing.
3. Practice with uncertainties.
4. Writing a full lab report.

SOME PROCEDURAL SUGGESTIONS AND NOTES

This is the first lab of the semester where, instead of being graded on your checkout interview, you will write a full lab report. You must still do both a procedure and a checkout interview interview for this lab, but do these interviews with your helper. (You may also freely ask any lab staff person for help if your helper is busy.) You can assign roles in your group as you see fit this time (rather than following a strict rotation as before).

You should begin by playing around with the wave machine. Talk in your group about how you might measure the speed of waves on this machine. While one can attempt to measure the wave speed directly by timing how long it takes a pulse to travel from one end of the machine, one can use standing waves to measure the speed somewhat more indirectly but more accurately. How can one do this, and why is this approach to measuring the speed more accurate?

Develop a detailed procedure for measuring / calculating this wave speed and its uncertainty as a function of the tension force on the strings. (You should limit the hanging mass to between 3 kg and 15 kg for best results.) When you think you have a good procedure, ask your helper for a procedure interview. He or she will make sure that your procedure is sound before you spend a lot of time making pointless measurements.

After you have taken your data, process it to determine the values and uncertainties v and F_T at each tension, and using an appropriate graph, determine the functional dependence of v on F_T. Try assuming that v is proportional to an integer or simple fractional power of F_T.

The wave machines at the different lab stations have different rod lengths L. We will combine everyone's results to determine how v depends on L. For this reason, *everyone* should measure v at an agreed-upon tension (say, the tension supplied by a hanging mass of 10.1 kg). The lab TAs will gather results from each group for this tension and post the results both on the board and on the Physics 51 web site. When you write your full report, you should use this data to determine how v depends on L. Again, look for a integer or simple fractional power.

When you think you have completed your the lab, ask your helper for a checkout interview. Your helper will want to see your completed graph of v on F_T, record your value of v for 10-kg-worth of tension, and generally ask questions to make sure that you are ready to write your report. When your helper states that you are ready, you are free to go. *Do not leave the lab room until you have had a checkout interview*!! Your full report is due at the beginning of next week's lab. Though you can discuss your report with your teammates, *your final report should be entirely in your own words* (i.e. you should write the report *individually*, not as a team).

[If you are interested in earning the respect and admiration of everyone, see if you can derive the wave equation for this apparatus and determine the wave speed for such a wave machine in terms of L, a, d, and F_T and compare with your data. This is *optional*, not required.]