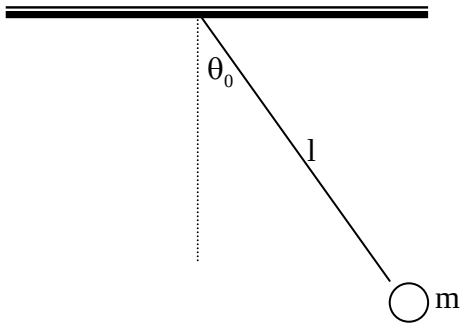
AP Physics B Name: _____

Experiment, String Tension in a Pendulum

The purpose of this experiment is to measure the maximum and minimum tension in the string of a simple pendulum. A simple pendulum, consisting of a large concentrated mass supported by a light string, will be created as shown below.



A force sensor will be placed at the pivot point of the pendulum. We will use the force sensor to measure the minimum and maximum tension in the string as the pendulum oscillates. Using Newton's Second Law and conservation of energy, the minimum and maximum tensions can be written as a function of the mass of the bob m, the maximum angular displacement θ_o, and the acceleration due to gravity g: $T_{\min F.S.} = mg\cos^2\theta_o$ and $T_{\max F.S.} = mg(3-2\cos\theta_o)$. The tensions are those measured by the force sensor.

The data for this experiment will consist of varying the bob mass and measuring the maximum and minimum values of the tension. Be sure to keep that maximum angular displacement θ_o constant, and be sure that you take enough measurements that you can later calculate θ_o using geometry.

Plot the minimum tension versus the mass and the maximum tension versus the mass. Using Newton's Second Law and Conservation of Energy, derive the theoretical expression for the minimum tension and the maximum tension (given by the expressions above). Compare your theoretical equation with the data that you collected with the force sensor by looking at the best fit line equations of your graphs.

DO NOT, under any circumstances, plug in individual data points when performing your analysis for this lab.

In the report for this experiment include the following:

(1) Title, Names, etc. (Section 1 on the handout: Lab Write Ups)
(2) Purpose (Section 2 on the handout: Lab Write Ups)
(3) Data (Section 4 on the handout: Lab Write Ups)
(4) Analysis (Section 5 on the handout: Lab Write Ups)
Include a graph of minimum tension versus mass and maximum tension versus mass. Add a regression equation to these graphs. Derive the theoretical expressions for these graphs. Include a percent error for the appropriate value(s) in your measured equation.
(5) Conclusion (Section 6 on the handout: Lab Write Ups)
Compare your theoretical and experimental expressions. How well do they compare?

These instructions take you through the program needed to perform the Pendulum Experiment.

- Turn on both your Calculator and your LabPro
- Run program: FORCE
- PERFORM NEW calibration
- With no mass on the force sensor, watch the calculator display. When it settles to a stable value, press ENTER. The reference will be 0.
- Add a 500 g mass to the force sensor, and watch the calculator display again. When it settles to a stable value, press ENTER. The reference value will be 4.9.
- The usual calibration values have magnitudes around 10. Make sure your values are consistent with this. If your values seems reasonable, choose CALIBRATION OK
- Time between data points should be 0.05 with 100 data points. Then, you will run the experiment for 5 seconds.
- Use this time set-up.
- When prompted to CHOOSE FILTER, select NONE.
- Before you begin to collect data, start the mass oscillating.
- Once the LabPro has finished collecting data, press ENTER to obtain a Force versus time graph. You may use the arrow keys to trace along the graph to obtain numerical values of the maximum tension and the minimum tension. If you press ENTER again, the calculator will display the minimum and maximum tensions for you.
- Press ENTER
- You may repeat the experiment, perform a new experiment, quit, etc. You only need to calibrate and set up the calculator once. So, if you repeat, begin with the step where you set the mass oscillating.