Investigating the oscillation period of a mass attached to a spring. PH 220 Lab

In this experiment, a variable amount of mass m is suspended from a spring and allowed to oscillate. Qualitatively, the period T of small vertical oscillations of the mass increases as the mass increases. The goal here is to go further than this unsurprising observation and conduct a scientific examination of the relationship between the mass m and the period T. So, we want the mathematical equation relating m and T. To keep things practical, consider three hypothesis equations, shown below. You need to do an experiment to find which hypothesis is most consistent with the empirical data.

Here are the three hypotheses:

$$m = a\,T$$
$$m = b\,T^2$$
$$m = c\,T^{1/2}$$

The quantities a, b, c are constants. If an equation is consistent with the experimental data, we can find the value of the constant(s) in the equation. In all our graphing experiments, we have found the values of constants in the hypothesis equations using the slope or intercept of a straight-line graph. Use the techniques you have learned to do the same here.

What to hand in: Your investigation needs to be presented in the form of a brief written report with the four headings **Question**, **Method**, **Analysis**, **Discussion**. Use the cover page provided. Note that the report will be assessed using the given rubric.

Some notes:

1. Use the terminology as given: the time taken to complete one cycle is called the period, and has symbol T. Use the symbol m to indicate the total amount of mass suspended from the spring.

2. Given information: the period does not depend on the amplitude of the oscillation. (The amplitude is the distance from the resting position to the highest point (or, alternatively, to the lowest point). Without knowing this, you would need to maintain a constant amplitude as you varied the masses. But knowing this, you can simply leave the system oscillating with small motions eyeballed at about an inch or so.

3. Emphasize the logic and reasoning behind your process. It is not sufficient to only say what you did; you also have to say why you chose to do that. For example, writing 'We plotted intensity versus current' only says what was done. Instead, the sentence should continue: 'We plotted intensity versus current, because…'
Make sure you use connecting terms like 'because' or 'since' frequently.

4. Use full sentences and clear language throughout. A person that was not in the lab ought to be able to read your report and understand reasonably well what you did.

5. Equations can be entered in a Word file relatively easily. Enter 'Alt=' and explore the options there if you are not familiar with this.

6. Your work will include an appropriate table and graphs. Make sure you follow the quality standards for these: see the handout from the Graphing lab at the start of the semester.

Cover page: PH 220 **Mass and Spring Investigation** NAME: _____

Partners: _____

- This cover page should be the first page, with your report attached after that.
- Each person must write their own report, which must be word processed.
- Use the section headings: **1. Question, 2. Method, 3. Analysis, and 4. Discussion.**
- Your work will also be assessed based on critical thinking skills:
  Evidence: base your conclusions on the experimental evidence you found.
  Integration: combine information from different parts of the experiment logically.
  Evaluation: Draw rational conclusions based on your experiment.

Grading Rubric:

1. **Question**. State what the experiment is, using the recognized terminology. State what the variables are, and pose the experimental question that you are asking. Include a brief discussion of the hypothesis equations. Give enough detail so that someone not familiar with the experiment can understand what you are interested in finding out. This must be a clear paragraph, written in full sentences.

   _____/5pts

2. **Method**. The measurements you take are the **evidence** upon which you draw your conclusions. So, provide a brief but clear discussion of the process used to gather this evidence. Include the following, and anything else that might be relevant:
   (a) Explain what graphs you plan to make and how your approach will identify the best hypothesis.
   (b) Discuss how each measurement is made. Explain how reliable the measurements are by considering significant digits, for example.

   _____/5pts

3. **Analysis**. Present your table(s) and graphs together with explanatory discussion. Make sure the tables and graphs meet the usual quality standards of presentation (see graphing handout).
   Integrate the information you found from your tables, graphs, and calculations to form a logical sequence.

   _____/5pts

4. **Discussion**. (a) State the hypothesis equation that best matches the data, and give the quantitative value of the relevant constant. Make sure your conclusions are based on this experiment and the results you found.
   (b) **Evaluate** your results critically. Discuss weaknesses and strengths in your experiment and how you might change things in future.

   _____/5pts