**AP Physics Lab #1- Mass on Spring and Period of Oscillation**

**Read the following reminders for ALL labs CAREFULLY (Do NOT include this section in your Lab #1 write-up but DO follow all of the directions in it including #8):**

1. In our labs, you will be typically performing the procedure of the experiment with at least one lab partner. However, the lab write-up is COMPLETELY an INDIVIDUAL responsibility (you do NOT work together on the lab write-ups). I consider it cheating to electronically (or otherwise) copy or borrow from any other person's lab write-up, whether it be from your lab partner or any other student (current or former). You must do the write up yourself and "from scratch" (you *may* borrow electronically from the parts of the lab that *I* post online).
2. All write-ups will receive fifteen points for including the following elements correctly done: Title (including personal information—please keep the formatting the same as I have it in the lab components I give you), purpose/problem, hypothesis (when applicable), materials, experimental design/procedure, analysis (including all guiding questions and appropriate work shown), conclusion, and error analysis. Raw lab notes from notebook will be stapled to the back of each lab. All labs *must be word processed* at home and should be printed at home. They should be stapled rather than paper clipped and they will go into a lab book at the end of the year—I will be explaining this in more detail later. I will grade them and return them after which you need to SAVE THEM for the lab book.
3. Use the passive voice in lab procedures and analysis and conclusions. Never use the first person ("I") or the second person (“you”) or slang in a lab write-up. Also, edit any parenthetical statements in the procedure or analysis sections that I have provided which should not appear in your write-up (Sometimes these *do* use first or second person and therefore need to be edited). These are formal write-ups of which you should be proud at the end.
4. Every time you make graphs (all year), make sure that they have appropriate titles, that they begin at the origin (0,0), that all axes are properly labeled (including units), and that all axes have continuous (NO breaks) and regularly graduated scales.
5. Mathematical analysis should be done in the section labeled "Analysis", not in a data table. Show *all* of your work for each calculation. You must show an equation *every* time used, use appropriate subscripts, plug in values *with units*, and show answers.
6. Equations should include any Greek symbols used in class (i.e. use v = x/t, NOT

d = vt and especially NOT D=RT). You will *not* get full credit if you use your own version of an equation unless variables are clearly defined and derived from equations established in class.

1. SAVE your graded labs to put in your lab book that will be submitted at the end of the year. You ONLY get credit for your originally graded labs in that lab book—do not lose them or throw them away!
2. If you want credit for Lab #1, write the following sentence *in pen* after the conclusion to Lab #1: I \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (print your name) have read and understand the “Reminders for ALL Labs” section posted online at the beginning of Lab #1 and understand that I will be held responsible for its contents especially in regard to academic integrity and the lab book due at the end of the school year. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Sign your name)

**Name:**

**Lab Partners:**

**Course: AP Physics**

**Period:**

**Date:**

**AP Lab #1 – Mass on Spring and Period of Oscillation**

**Purpose/Problem:** To determine the relationship between how much mass is bouncing on a spring and the period of oscillation (the time it takes to repeat a cycle of motion).

**Materials:** Meter stick or tape measure, hooked masses, spring scale, ring stand, horizontal crossbar and clamp, stopwatch

**Experimental Design & Procedure:**

1. Set up the apparatus as illustrated below:

Horizontal Crossbar

Clamp

Spring Scale

Spring

(dotted line)

Ring Stand

Hooked Mass

1. Hang a hooked mass from the spring scale. Pull it down a small distance and release it from rest, allowing it to “bounce” up and down smoothly.
2. Use a stopwatch to measure the time it takes for the mass to complete ten oscillations. You’ll be able to figure out how long it takes to complete each bounce with this information. The time to complete one cycle of motion (one “bounce”) is called the *period* and represented by a capital “t” (T).

1. Repeat with a different mass. Do this at least four more times so that you have at least 5 points to plot. This should allow you to decipher the precise relationship between how much mass is oscillating (“bouncing”) on the spring and how much time it takes to oscillate once (the Period).
2. Measure the distance on the spring scale from the 0 to the last marking. Also record the maximum force value listed on the spring scale. These will be used to determine the theoretical spring constant.

**Observations & Data:**

|  |  |  |
| --- | --- | --- |
|  | Maximum Value on Spring Scale: | Distance from Zero to Maximum Value on the Spring Scale: |
| Trial | Hanging Mass(kg) | Time to complete ten oscillations(s) | Period(s) | Whatever else you might need this for(units?) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Analysis (Please include questions along with the answers in the lab report):**

1. Graph period as a function of mass (period vs. mass) by hand on an attached sheet of graph paper (remember that in physics, unless otherwise stated, ALWAYS start “x” & “y” scales at zero, use as much of a piece of graph paper as possible, and use regular increments). Use a new page for each graph – make it big. *Draw the best-fit line or curve* for the data on each graph. Always use a straight edge for graphs that are linear.
2. Notice that the graph shows that the mass significantly affects the period of the mass-spring system but the relationship is non-linear, so plot the following on graph paper: T vs. 1/mass, T vs. mass2, T vs. √mass. Because each graph needs to be generated by a data table, this lab write-up contains *four* data tables (not merely the original in the prompt above —make sure you use units in the table and graph appropriate to the quantity) and *four* graphs. If you obtain a straight line plot for any of these graphs, it means you are close to determining the mathematical relationship between period and the mass, showing that the stuff on the *y*-axis is directly proportional to the stuff on the *x*-axis.
3. Calculate the slope of the linear graph by choosing two convenient points *on the line* and circling them in pen on your graph. Remember to include the points on your *line* that you chose.
Show the calculation here, including the equation you used to calculate it and the units for numerical values.
4. The theoretical relationship between mass on a spring and the period is T2=(4)(π2)(m/k). Algebraically rearrange this relationship so that the equation is in the form of *y=mx+b*, where *y*= what’s on the *y* axis of the linear graph and *x*=what’s on the *x* axis of the linear graph. Some degree of inverting and/or squaring may be necessary. In other words, linearize the relationship so that it can be compared to your graph.
5. Use your slope to find the value of the *k* in the theoretical equation. Show all calculations here. Include units. (This step requires you to ignore *y*, *x*, and *b* for now, and to set what is multiplied by whatever in the equation is graphed on your *x*-axis equal to the slope value you calculated from the line drawn on your graph. This should leave you with an equation that contains only one variable that can be solved for algebraically.)
6. The *k* in the equation stands for the spring constant, which is the ratio of how much force it takes to stretch the spring a certain distance divided by how much distance it is stretched. Calculate the theoretical spring constant *k* by dividing the maximum force (in Newtons) by the distance stretched (in meters). For now, consider a marking of 100g on the spring scale equal to 0.98N. Show your work here.
7. Compare your experimental value of *k* (obtained from the best-fit line on the graph) to the theoretical value (from the last step). Remember that in Physics, “compare” means to *calculate the percent error* between the two values. Show all work including the initial equation used and the values plugged in.
8. Was the *y*-intercept zero as expected? Suggest a reason for an offset of the *y*-axis on the linear graph of your experimental data. (Hint: Think about what the *y*-axis represents.)

**Conclusion (Use the hints below but do NOT include them in your write-up):**

1. State what can be concluded from the analysis. Include anything that can be observed from an analysis of the data, but particularly whatever answers the question this lab set out to answer. What do you conclude and what have learned (or should have learned) from doing the lab? In this particular lab, it will definitely include a discussion about the meanings of graphs including graph shapes and slope. Also include the word “proportional” in this one.
2. Always relate the conclusion to the purpose/problem and/or hypothesis (as appropriate/relevant).
3. Always argue from evidence. Reference such values as are necessary (% error, slope, etc)
4. Do **not** repeat procedure, observations, or data; rather, **conclude** (Hint: look at your answers to analysis questions for good concluding thoughts; i.e., what did you learn from doing this lab)
5. Do **not** include any "fluff" statements (if you want full credit) regarding your emotional responses to the lab or your lab partner. Do **not** tell me **that** you learned; rather, tell me **what** you learned!

**Error Analysis (Use the hints below but do NOT include them in your write-up):**

1. Make sure that this is **at least** a five sentence, well-developed paragraph outlining what range of values is significant (precision) in each direct measurement (and why) and any unmeasured values that throw off the final value and by how much (and why).
2. Diagrams can be helpful here. Draw something that focuses the reader on what you’re looking at – including labels and a caption. Photos are also acceptable.
3. Quantify everything (always include numerical values – even when they must be estimated)
4. **Never** say, "Our error **was probably due to 'human' error." Never say, "Our error was due to faulty equipment or using it incorrectly**." These statements do **not** relate to error but rather incompetence and no one on my team is incompetent!
5. Use the passive voice. Never use the first person ("I") or the second person (“you”) or slang in a lab write-up. These are formal write-ups of which you should be proud at the end.

***Lab Report* Rubric**

**AP Physics 1 Lab #1: Mass on Spring and Period of Oscillation**

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period\_\_\_\_\_\_\_\_\_

 **15 pts**

Penalty Box (check means that there are problems in that area)

|  |  |
| --- | --- |
| □ lab notes not attached to lab report□ doesn’t use third-person voice□ lab framework is not followed (calculations not in analysis section, data tables not together in proper section, etc) | □ more than a few obvious spelling/grammatical errors□ math is not easy to follow (original algebra not shown, plug-in not shown, unclear progression) |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Missing** | **Inadequate** | **Needs** **Improvement** | **Adequate** | **Points** |
| **Title, Heading, Purpose, Hypothesis, Materials** (1 pt) |  |
| **Graphs**(3 pt) | Concern with 3 or all:\* correct labels & units\* axes are scaled correctly\* best-fit line\* detailed title | Concern with two:\* correct labels & units\* axes are scaled correctly\* best-fit line\* detailed title | Concern with one:\* correct labels & units\* axes are scaled correctly\* best-fit line(points drawn from table rather than line)\* detailed title | \* correct labels & units\* axes are scaled correctly\* best-fit line(s)\* detailed title(s) |  |
| **Diagrams & Data Tables**(2 pt) | \* diagram is missing\* data tables are missing or extremely vague(i.e. numerical values only) | \* diagram is unclear or unrelatedor has major omissions \* data tables have major omissions(i.e. table missing for a graphed set of data) | \* diagram is vague or has minor omissions \* data tables have minor omissions(i.e. units incorrect or missing) | \* diagram present & clear\*diagram labeled and captioned as necessary\* data tables clear and complete\* tables include labels and proper units |  |
| **Procedure & Conclusion**(2 pt) | \* procedure or conclusion extremely vague or missing altogether\*unintelligible\*missing: no attempt made to explain | \*major problems with procedure and conclusion\*unclear with important details missing\*lengthy/unrelated digressions\*vague or ambiguous statements | \* minor problems with procedure and conclusion: unclear\*vague details or omissions\* effort required to comprehend the progression\*unrelated digressions\*All logical steps present, but in non-sequential order  | \* procedure clear & complete, matching what was actually done\* conclusion is drawn that is related to the purpose/problem\* makes sense on 1st read-through\* organized, sequential, argues from evidence |  |
| **Error Analysis**(2 pt) | \*error analysis missing\*emotional response\*”miscalculation” or ”mistake”\*”faulty equipment”\*”human error” | \*estimated values not related to calculated results\*no attempt/failed attempt to quantify\*ambiguous, unclear language\*missing necessary diagrams\*incorrect statements | \*sources of error identified, but focus on non-major sources\*estimated values unfounded or unreasonable--related loosely/not related to calculations\*ambiguous, unclear language\*incorrect statements | \*major sources identified & explored\* quantified (amounts estimated)\*shows effect on calculation\*diagrams included |  |
| **Analysis Questions**(5 pt) | These are graded question by question.-please include questions along with the answers in the lab report- |  |
| **Total :** |  |