Name: ______________________ Partner's Name: ______________________

Conservation of Mechanical Energy

In this experiment, you will test if the conservation of mechanical energy can be applied to an isolated system.

APPARATUS:

- Tripod base, long rod, short rod, right-angle clamp.
- Hose, thread, matches.
- Photogate timer, meter stick.

PROCEDURE:

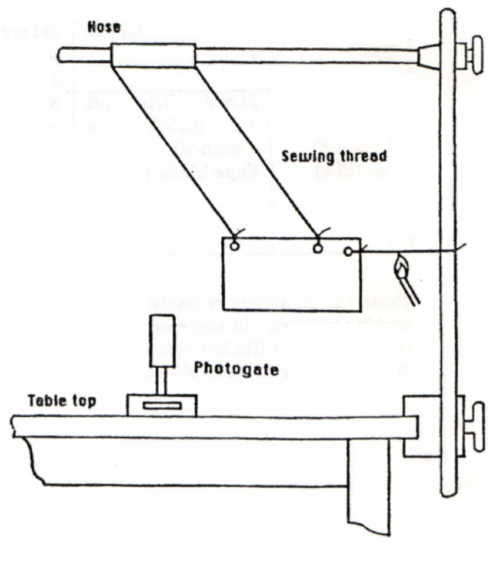

Figure 1: Pendulum at rest at height h_0 with the photogate in position.

1. Set up the apparatus as shown in Fig. 1. The length of hose used should equal the separation distance of the vertical support holes in the metal plate, can you explain why? Adjust the metal plate for levelness by sliding the thread through the hose. Explain why the plate should be level. The photogate timer should be positioned so that the plate is centered in it when hanging at its equilibrium position. Why is it important that you position the photogate in this way?
2. The following measurements should be made: the length of the plate l, the height h_e above the table of the bottom edge of the plate at equilibrium, the height h_0 above the table of the bottom edge of the plate at the point of release.

3. Pull the plate toward the vertical bar and attach it with a piece of thread. The vertical threads should be parallel. Why should they be parallel? With the photogate set to GATE, release the plate by burning the thread. Why is it important that you burn the thread (instead of cutting it with scissors, for example)? The photogate will display the time for the plate to pass through the sensor.
4. Make a data table of equilibrium heights h_e, initial heights h_0 and times, with extra columns for the change in height ($\Delta h = h_0 - h_e$), velocity and velocity squared. Take a total of ten data points by varying the initial height of the plate.
5. Before the plate is released, all the energy is potential, $E_i = mgh_0$. At the bottom of the plate's path, the energy is both kinetic and potential, $E_f = mgh_e + (1/2)mv^2$. Therefore, $mg\Delta h = (1/2)mv^2$ or $v^2 = 2g\Delta h$. Graph v^2 versus Δh, (should the origin be included?), draw a best fit straight line and determine the slope.
6. Find the acceleration of gravity.
7. Calculate the % error between your value and $g = 9.80$ m/s^2.
8. List ways in which the data could be improved.

DUE IN TWO WEEKS...

1. Full Lab Report

REFERENCES

[1] NC State Univ. reference page on writing lab reports, http://labwrite.ncsu.edu/po/po-selfguide.htm

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Tips for writing a good physics lab report

1. Do not assume that the reader knows the experiment/setup, or what is coming up in the report. Every section of the report should be able to be read (and make sense) on its own (the Discussion and the Conclusion are the only exceptions). If you have to refer to other sections of the report, you can do that only if that other section has already been discussed. Do not include information of the setup in the Introduction. One can only know what the setup is after reading the Materials and Methods and that comes after the Introduction. However, you can refer to the setup in the Discussion, if your components of the setup have contributed to the error.
2. A lab report is a document that is written around the figures. If you have decided what figures you are going to have in a scientific paper, then the whole paper is written in a way that will tell a story around those figures (it will explain why these figures are important, where they came from, what they mean and what the implications are)
3. Before you use a scientific word, make sure you understand its meaning. Words have specific meanings in science so make sure that what you write is what you mean to write.
4. Be consistent. If you start writing the report using ”we”, do not switch to ”you” half way through. In addition, do not change the name of variables (eg. go from KE to K_e for the kinetic energy)
5. Do not use generalities. Be specific in terms of results, examples, etc. Avoid sentences such as: ”CME has many applications in daily life”. Such a sentence will be marked with the comment: ”such as?”
6. Reread your report before you hand it in!
7. Avoid lists. A lab report is not a recipe.
8. The lab reports are not graded based on your English (spelling, grammar, syntax). My English is not good enough to justify grading your reports based on that. However, I do expect to see sentences that have a very clear content so that I understand what you are trying to say when I read them. **Keep your sentences short, concise, to the point.** If you have a convoluted sentence that is 5 lines long and has many secondary clauses then that means that you are trying to include too many points all at once and therefore the main idea of your sentence is not going to be clear, which will force me to mark this sentence as awkward. (Did you just see what I mean? This last sentence was 3 lines long!)

Title:

I know you can be more creative than saying Conservation of Mechanical Energy.

Abstract:

Each sentence should have a logical connection to the following sentence. Do not make a list (eg.In the Introduction, we talk about the equations, in the Material and Methods, we talk about the setup, etc.). Also, use numbers if appropriate. If the goal of the experiment was to determine g, then say what you got! Report the % error. Say if that was a good way to determine g… Do not say, "we determined a value for the gravitational acceleration" and leave it at that…

Introduction

For the introduction, you need to start from the beginning of the story. What is CME? What is the equation that describes CME? Give each equation its own line but define each variable (include units) in a sentence form. Number the equations so you can refer to them later in the report (in the Results and Discussion, that comes in handy). For example "CME is described by the equation

$$KE_i + PE_i = KE_f + PE_f, \tag{1}$$

where KE is the kinetic energy of the system (in Joules), PE is the potential energy of the system (in Joules) and the subscripts i and f refer to their initial and final values, respectively." Also, do not omit steps. If the mass will cancel out, say that it does. If there is an equation that you will be using, say it, explain it and describe how it can be used. In addition, since the Materials Section is coming up, do not assume that the reader knows what the setup is. Do not start referring to the plate in the middle of the Introduction. Instead, say something like: "If initially an object is at rest, that means that $v_i = 0$ and, therefore, based on equation (3) $KE_i = 0$. Therefore, equation (1) now becomes …" In addition, make sure you understand that you are not interested in the height of the plate, but in the difference between the initial and final heights (Δh in the relevant equation).

Materials and Methods:

Always include a picture (more on figures later) with the description of the setup. Otherwise, I do not care how good your description is, it will be hard to understand (again, assume that the reader does not know this experiment). Also, always label and caption your figures and include on them the components that are important. For example, show on your figure which component the plate is, where the timer is located, etc. In addition, your tone should show what you did, not what I (or the reader) should do (in other words, do not give orders). Sentences such as "Make sure that the plate is level" do not define an acceptable tone.

Results:

Do not just throw tables and graphs without (i) explaining them in the text, (ii) labeling them and including a good caption, and (iii) including axes labels (with UNITS). Also, say which data are quantities you measured and which are quantities you calculated. If the latter, explain how you calculated them (you might have to refer to equations that you introduced in the Introduction).

Discussion:

Again, be specific. Refer to equations from the Introduction and tables/graphs from the Results. How are they connected? Why is there so much error? Why did you use that specific analysis? And finally, has your hypothesis been verified and why? BE SPECIFIC! If you are listing sources of error, make sure that these sources are consistent with your results. For example, if your g is greater than 9.8 m/s^2, then air drag is not the main source of error (can you see why?) Be specific when you think of ways that the experiment could be improved. There is no such thing as the perfect experiment.

Conclusion:

Avoid generalities. Do not just say that there are applications, give specific examples.

Physics Lab Report Evaluation Sheet

1. Scientific validity and style 14 points

1. Does the author tell a story in the report as a whole and in each section of the report? Is there a beginning, middle and an end to the story? Is there too much repetition? (a good story should not be repetitive)
2. Does the author avoid generalizations and vague statements, such as: There are many applications of CME in everyday life?
3. Is the author consistent with the style (does not alternate between we and I and sticks with one tense, etc.)?
4. Does the tone indicate what the author did instead of telling us what we should do?
5. Are scientific terms used in their proper meanings? For example, are they referring to g as the gravitational acceleration instead of just gravity or gravitational force, etc.
6. Are abbreviations used only for scientific notation and after these abbreviations have been defined?
7. Does the author use short but concise sentences that only try to make one point?
8. Does the author avoid awkward sentences (i.e., is the syntax proper)?
9. Does the author avoid spelling mistakes?
10. Are all figures/tables/graphs labeled, titled, with the proper units, and axes labels, etc.?
11. Are all figures/tables/graphs easy to see and understand (not too small, not too big, easy to read, etc.)
12. Do all figures/tables/graphs have a proper caption? Are the captions descriptive?
13. Are all figures/tables/graphs explained and discussed in the main text?
14. Is it obvious to the reader what point the author is trying to make by including each figure/table/graph?

2. Title 2 points

1. Is the title catchy? Are you interested in reading the report after looking at the title?
2. Does it provide a one-sentence description of the whole report?

3. Abstract 5 points

1. Does the abstract provide a one-sentence summary from each of the subsequent sections (except for the references)? Is the abstract well balanced? (for example, does it have too much information for one of the sections of the report at the expense of the other sections?)
2. Are these sentences connected logically to each other in a smooth way? (avoid lists!)
3. Does the author avoid mentioning unnecessary details that the reader can only understand after reading the report? (the author cannot assume that the reader knows the experiment)
4. Does the author avoid referring to equations and figures via the use of their numbering (eg., equation 2, figure 3, etc)
5. Are the important results/highlights of the experiment mentioned, with specific numbers, when appropriate?

4. Introduction 8 points

1. Is there a story? Does the author start with the concept under investigation, the equations that describe it, the derivations from one equation to the next, the point of the experiment?
2. Have all the necessary concepts and equations been introduced and derived?
3. Are the derivations explained step by step (instead of just listing each step)?
4. Are all equations given their own line and number?
5. Are all the new variables defined (including SI units) after each equation where they first appear?
6. Are all the important variables explicitly stated? (important variables are those that you measure, calculate, etc. If a variable appears in a figure/table, then it is definitely an important variable)
7. Does the author avoid referring to details that the reader can only know after reading the whole report (i.e., the author cannot assume that the reader knows the experiment)?
8. Is there a thesis statement (i.e., what will the author try to accomplish by doing this experiment, what is the hypothesis)?

5. Materials and Methods 4 points

1. Is a figure provided that explains the setup? Is the figure referenced in the main text?
2. Are the important components of the setup indicated on the figure?
3. Are important details of the setup and procedure stated and explained?
4. Will a person unfamiliar with the experiment be able to reproduce it after reading this section? (Is it easy to understand the setup based on the authors description?)

6. Results 7 points

1. Are all results presented in a way that conveys the point the author is trying to make (i.e., use a table instead of a graph, etc.)?
2. Are the results/tables/figures explained in the main text?
3. Is the order in which the results are presented logical?
4. Are important intermediate results included (even if they are not directly asked in the lab handout)?
5. Does the author specifically state which results are raw, calculated, intermediate, etc.?
6. For the calculated results, does the author explain how the calculation was made by referring to equations from the Introduction?
7. Has the data analysis been done correctly?

7. Discussion 4 points

1. Does the author discuss the results by referring to equations from the Introduction and connecting them to figures/tables/graphs or important calculations from the Results section?
2. Are the sources of error listed and explained in a way that is consistent with the results?
3. Has the author discussed if the hypothesis was verified? Has the author explained the reasons why the hypothesis has been verified or not?
4. Are improvements to the experiment listed and discussed? Is it clear how these suggestions will improve the experiment?

8. Conclusion 2 points

1. Does the author provide a summary of the experiment with all the highlights reviewed?
2. Is the author specific when listing the applications of the concepts and equations described in the report?

9. References 2 points

1. Does the author use the appropriate format for the references?
2. Are all references included?

Total number of points: 48 points (+2 free points for a total of 50 points)

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Conservation of Mechanical Energy