Date of Lab 14/12/16　　Date of Submission 6/1/17

Laboratory Report

Title
表題 Conservation of Mechanical Energy

| Homeroom | Section | Name 氏名 | |
|---|---|---|---|
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**Summary**

In this lab, we used two different samples of the mechanical movement, pendulum and spring to examine whether mechanical energy is conserved or not. As a result, in both experiments, mechanical energy was conserved. In the first experiment of pendulum, the potential energy of weight at highest point and the sum of the potential and kinetic energy of weight at the lowest point was almost the same. Also, in the second experiment of spring, potential energy of the spring was mostly the same as the kinetic energy of the weight that was connected to the spring. Therefore, we knew that the law of conservation of mechanical energy is proven to be true because in both cases, the mechanical movement followed this law.


・Meet a deadline　・Write logically　・Write clearly　・Write with your own words
・締切り守って　・論理的に　・わかりやすく　・自分のことばで

Teacher Comments

実験もよく考察も優れている

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Due 提出期限 | Summary 要旨 | Intro. 序 | Method. 方法 | Results 結果 | Table/Fig. 表/図 | Discussion 考察 | Clearness わかりやすさ | General 全般 |
| + | | | | + | ++ | ++ | + | ++++ |

* Write your report in Japanese or in English　* Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

## 1. Introduction

**Objectives:**

Examine whether mechanical energy is conserved in the movement of pendulum and spring.

**Equation:**

E = K + U = constant

Mechanical energy = Kinetic energy + Potential energy = constant

**Hypothesis:**

1) Sum of the kinetic energy and potential energy of the weight of the pendulum at the lowest point is equal to the potential energy of the weight at the highest point.
2) Potential energy of the spring is equal to the kinetic energy of the object connected to the spring.

## 2. Experiment

**Apparatus and Materials:**

- Wooden board
- Metal stick
- Weight
- String
- BeeSpiV
- Graph sheet
- Stand with finger
- Spring

**Method:**

Experiment #1:

1. Prepare all of the materials.
2. Set up wooden board with metal stick at the top right hand.
3. Put the graph sheet on the wooden board.
4. Tie string to the weight tightly.
5. Tie another end of the string to the metal stick, and make sure that the string is not too long that the weight won't hit the ground.
6. Set the BeeSpiV at the point where the weight takes its lowest point ($h_0$)
7. Lift the weight up from the lowest point to the height $h_1$.
8. Release the hold and let the weight pass through its lowest point.
9. Read the measured value shown by BeeSpiV.
10. Repeat 7 - 11 with different height $h_1$.

Experiment #2:

1. As we did on the Hooke's Law Lab, measure the spring constant using stand with finger, and certain amount of weight.
2. Tape the sheet with scale on the table.
3. Use the stand as a pole and connect the spring to it.
4. Tie string to the another end of the spring.
5. Tie another end of the string to the weight.
6. Adjust length of the string so that the center of the weight comes at the point of scale 0 of the sheet.
7. Pull the weight back and read the scale of the center of the weight, so that you know the distance of the weight being moved.
8. Place BeeSpiv at the point of scale 0 of the sheet.
9. As you turn it on, release the hold of the weight and measure its speed.
10. Repeat 7 - 9 with different distance the weight has been moved.

## 3. Results

**Tables:**

Table of Experiment #1: (Mass of Weight, m = 0.032 [kg])

| | Maximum Height | | Minimum Height | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $h_1$ | $A = mgh_1$ | $h_0$ | v | $mgh_0$ | $1/2mv^2$ | $B = mgh_0+1/2mv^2$ | (A-B)/A x 100 |
| Exp # | m | J | m | m/s | J | J | J | % |
| 1 | 0.02 | 0.006 | 0 | 0.599 | 0 | 0.006 | 0.006 | 0 |
| 2 | 0.04 | 0.013 | 0 | 0.814 | 0 | 0.011 | 0.011 | 15.38 |
| 3 | 0.06 | 0.019 | 0 | 1.035 | 0 | 0.017 | 0.017 | 10.53 |
| 4 | 0.08 | 0.025 | 0 | 1.179 | 0 | 0.022 | 0.022 | 12 |
| 5 | 0.10 | 0.031 | 0 | 1.340 | 0 | 0.029 | 0.029 | 9.677 |
| 6 | 0.12 | 0.038 | 0 | 1.432 | 0 | 0.033 | 0.033 | 13.16 |
| 7 | 0.14 | 0.044 | 0 | 1.590 | 0 | 0.040 | 0.040 | 9.091 |
| 8 | 0.16 | 0.050 | 0 | 1.653 | 0 | 0.044 | 0.044 | 12 |

Table of Experiment #2 (Spring constant, k = 4.681 / Mass of Weight, m = 0.032 kg)

| | Spring | | Weight | | |
|---|---|---|---|---|---|
| | x | $A = 1/2\ kx^2$ | v | $B = 1/2\ mv^2$ | (A-B)/A x 100 |
| Exp # | m | J | m/s | J | % |
| 1 | 0.08 | 0.015 | 1.067 | 0.018 | 20 |
| 2 | 0.09 | 0.019 | 1.097 | 0.019 | 0 |
| 3 | 0.10 | 0.023 | 1.254 | 0.025 | 8.696 |
| 4 | 0.11 | 0.028 | 1.319 | 0.028 | 0 |
| 5 | 0.12 | 0.034 | 1.496 | 0.036 | 5.882 |
| 6 | 0.13 | 0.040 | 1.670 | 0.045 | 12.5 |
| 7 | 0.14 | 0.046 | 1.700 | 0.046 | 0 |
| 8 | 0.15 | 0.053 | 1.815 | 0.053 | 0 |

**4. Discussion**

In this lab, we did two different types of experiments to prove that the law of conservation of mechanical energy is completed. In the first experiment, we used pendulum as a sample of the mechanical energy being conserved. Although they were not completely same, sum of the potential and kinetic energy at the lowest point was likely equal to the potential energy at the highest point. Since the percentage that shows difference were random, and also because it was actually no more different than 0.01 J in number, we can say that the mechanical energy was being conserved in this case, as the result follows my first hypothesis "Sum of the kinetic energy and potential energy of the weight of the pendulum at the lowest point is equal to the potential energy of the weight at the highest point.". In the second experiment, we used spring as a sample of the mechanical energy being conserved. My second hypothesis was "Potential energy of the spring is equal to the kinetic energy of the object connected to the spring.", and the data again proved that this theory is likely to be correct. None of the potential energy was different from the kinetic energy more than 0.01 J, and in addition, half of them were completely equal. So, we can say that the mechanical energy was being conserved in this case too. By the way, when comparing the error percentage of two different experiments, I notice that the second experiment seems to have less error compared to the first experiment. I suppose this is because of the difference of the detail being converted into the data. In another words, the preparation of the pendulum was more complicated than the preparation of the spring. In the first experiment, we measured height of the weight being lifted to calculate its potential energy, and that is correct, but height is not only the factor that affects the speed of the pendulum. Since string changes its shape very easily, the data of x axis varies although the data of y axis was correctly measured. To keep this constant, the best way is to pull the string strong enough that the string is kept tight and straight. On the other hand, because we pulled the spring in only one direction, there were less difference in data.

**5. Conclusion**

As a conclusion, our data from these two different experiments were both consistent to the theory and my hypothesis. The potential energy of the weight at the highest point was mostly equal to the sum of the kinetic and potential energy of the weight at the lowest point in the pendulum experiment. Also, in the spring experiment, potential energy of the spring and the kinetic energy of the weight connected to the spring was almost the same. Adding this two conclusions together, I conclude that the law of conservation of mechanical energy is completed in any case of the mechanical movement。

**6. Opinion**

This lab was including fun and interesting experiments, but at the same time it consisted of a significant role as a navigator for us students to recognize the law of conservation of mechanical energy in our natural life. For example, pendulum is used in the old european clock, and the elasticity of the spring is used in the play equipment such as trampoline。 There are many other examples that it is impossible to explain all of them, simply because every mechanical movement can be explained by this theory we learned. It was a great achievement for me, that I could know and understand that fact.