Date of Lab 12/14/18 Date of Submission 1/17/18

Laboratory Report

Title Conservation of Mechanical Energy

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Summary

In this lab, we investigated whether the mechanical energy is conserved in the motion of pendulum and spring. We used a pendulum and a spring to prove our hypothesis; In the motion of pendulum, the potential energy at the maximum height is equal to the sum of the kinetic energy and the potential energy at the minmum height, and the potential energy of a spring is equal to the kinetic energy of an object attached to the spring. As a result, by observing and comparing the data recorded, eventhough there were some errors, we could say that our hypothesis are correct.

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words

Teacher's Comments

Good summary. Good graphs, but you must depict one more graph about $\frac{1}{2}mv^2$ ⌊ $\frac{1}{2}kx^2$

1	2	3	4	5	6	7	8	9
Due	Summary	Intro.	Method.	Results	Table/Fig.	Discussion	Clearness	General
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* Use this form as a cover sheet.

* Submit your reports by the seventh day after your lab.

2.Introduction

Objective:

Investigate whether the mechanical energy is conserved in the motion of pendulum and spring.

Hypothesis:

1) In the motion of the pendulum, the potential energy at the maximum height is equal to the sum of the kinetic energy and the potential energy at the minimum height.
2) The potential energy of a spring is equal to the kinetic energy of an object attached to the spring.

Equation:

Mechanical Energy=Kinetic energy+Potential energy=constant

Potential energy=mgh

Kinetic energy= $1/2mv^2$

3.Experiment

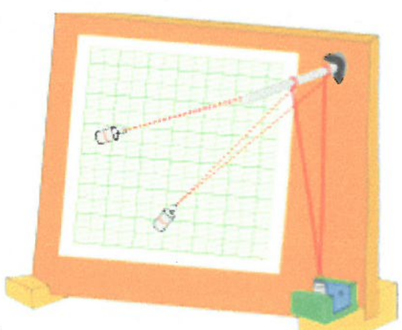
Apparatus and material:

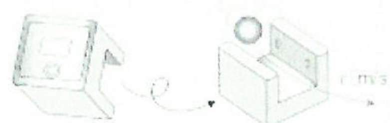
- Board
- Metal stick
- Weight
- String
- Speed meter (BeeSpi V)
- Graph paper
- Hooke's law apparatus
- Spring
- Stand

Method:

Exp 1.

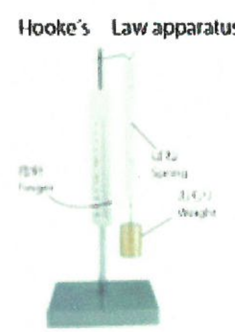
1) Tie a string on the metal bar that is attached to the board. On the other end, put on a weight.
2) Set up a speed meter (BeeSpi V) at the point where the weight takes its lowest point and adjust the speed meter, so it doesn't hit the weight.
3) Measure the minimum height of the center of the weight (h_0) and the maximum height of the center of the weight (h_1)
4) Let go of the weight at a height and measure the velocity of the weight as it passes the speed meter at the lowest point.
5) Read the measure and record the measured value of the speed meter and the height (h_1)
6) Repeat the steps 2) ~ 4) with different heights (h_1)





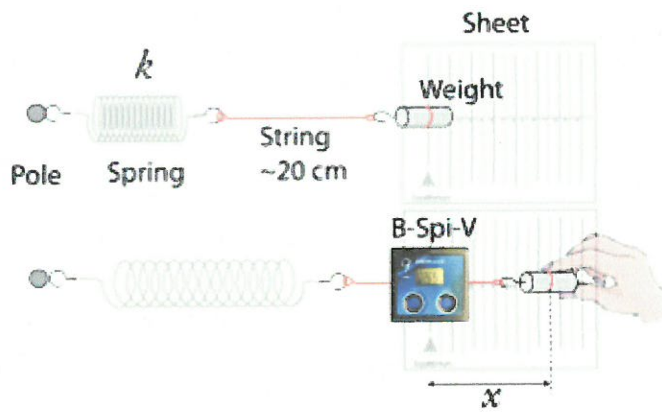
Exp 2.

1) Get a Hooke's Law Apparatus and a set of weights.
2) Put on some weights on the spring on the apparatus.
3) Calculate the elastic force (F=the gravity of the weight)
4) Measure the elongation as you put on the weights on the string.
5) Measure the elastic force, the elongation and the weight.
6) Repeat 2) ~5) with different weights.
7) Draw a graph with all the data on the elastic force and the elongation.
8) Determine the spring constant.



Exp 3)

1) Tape a sheet of paper with scale on the table.
2) Set up a stand and use it as a pole and connect the spring to it.
3) Tie a string at the end of the spring
4) Put on a weight on the end of the string.
5) Set and adjust the weight so the center of the weight comes at the scale 0 of the paper.
6) Put a speed meter (BeeSpi V) on top of the scale 0.
7) Pull the weight to a certain point and record the length pulled.
8) Release the weight pulled, and measure its speed.
9) Repeat steps 7) and 8) with different lengths of the weight pulled.



4.Results

Table 1) Exp 1 (mass of weight, m=0.032 [kg])

	Maximum Height		Minimum Height					
	h_1	A=mgh	h_0	v	mgh_0	$1/2mv^2$	$B=mgh_0+1/2mv^2$	(A-B)/A×100
Exp	m	J	m	m/s	J	J	J	%
1	0.3	0.0941	0.06	2.12	0.0188	0.0719	0.0907	3.6
2	0.28	0.0878	0.06	1.94	0.0188	0.0602	0.0790	9.9
3	0.25	0.0784	0.06	1.82	0.0188	0.0530	0.0718	8.4
4	0.23	0.0721	0.06	1.77	0.0188	0.0501	0.0689	4.4
5	0.2	0.0627	0.06	1.56	0.0188	0.0389	0.0577	8.0
6	0.18	0.0564	0.06	1.40	0.0188	0.0314	0.0502	11
7	0.15	0.0470	0.06	1.24	0.0188	0.0246	0.0434	7.6
8	0.13	0.0314	0.06	0.94	0.0188	0.0141	0.0329	4.9

Table 2) Exp 2 Hooke's Law experiment

m [kg]	0.050	0.080	0.100	0.130	0.150	0.180	0.200
F [N]	0.49	0.784	0.98	1.274	1.47	1.764	1.96
x [m]	0.012	0.021	0.027	0.036	0.042	0.051	0.06

Table 3) Exp 3

	Spring			Weight		
	x	A= 1/2 kx^2		v	B= 1/2 mv^2	(A-B)/A×100
Exp	m	J		m/s	J	%
1	0.02	0.006		0.49	0.004	33.3
2	0.04	0.025		1.21	0.023	8.00
3	0.06	0.055		1.62	0.042	23.6
4	0.08	0.098		2.15	0.074	24.5
5	0.10	0.154		3.16	0.160	3.90
6	0.12	0.222		3.32	0.176	20.7
7	0.14	0.301		3.94	0.248	17.6
8	0.16	0.393		4.88	0.381	3.05

5.Discussion

In this lab, we did three different experiments to prove that the law of conservation of mechanical energy is completed. In the first lab, we used the pendulum to investigate whether the mechanical energy is conserved in the motion. As shown in table 1, the percentage error of the values of mechanical energy at the maximum and minimum heights are not that large. Because the average percentage error is 6.9%, we can say that the mechanical energy was conserved. The second experiment allowed us to obtain the relation between the elastic force and elongation. As a result, we determined the spring constant. In the third experiment, we used the spring constant determined in the second experiment to compare the elastic potential energy and the kinetic energy of the object attached to the spring. If you see the percentage error shown in table 3, although the largest value is 33.3%, the average percentage error is 11.5%. The errors were made because unnecessary force was applied when pulling the weight. If you look at the results overall, you can say that the elastic potential energy of a spring is equal to the kinetic energy of an object attached to the spring, which is our second hypothesis.

6.Conclusion

In conclusion, by observing and comparing the data recorded, the potential energy at the maximum height is equal to the sum of the kinetic energy and the potential energy at the minimum height in the motion of the pendulum. Also, the potential energy of a spring is equal to the kinetic energy of an object attached to the spring.

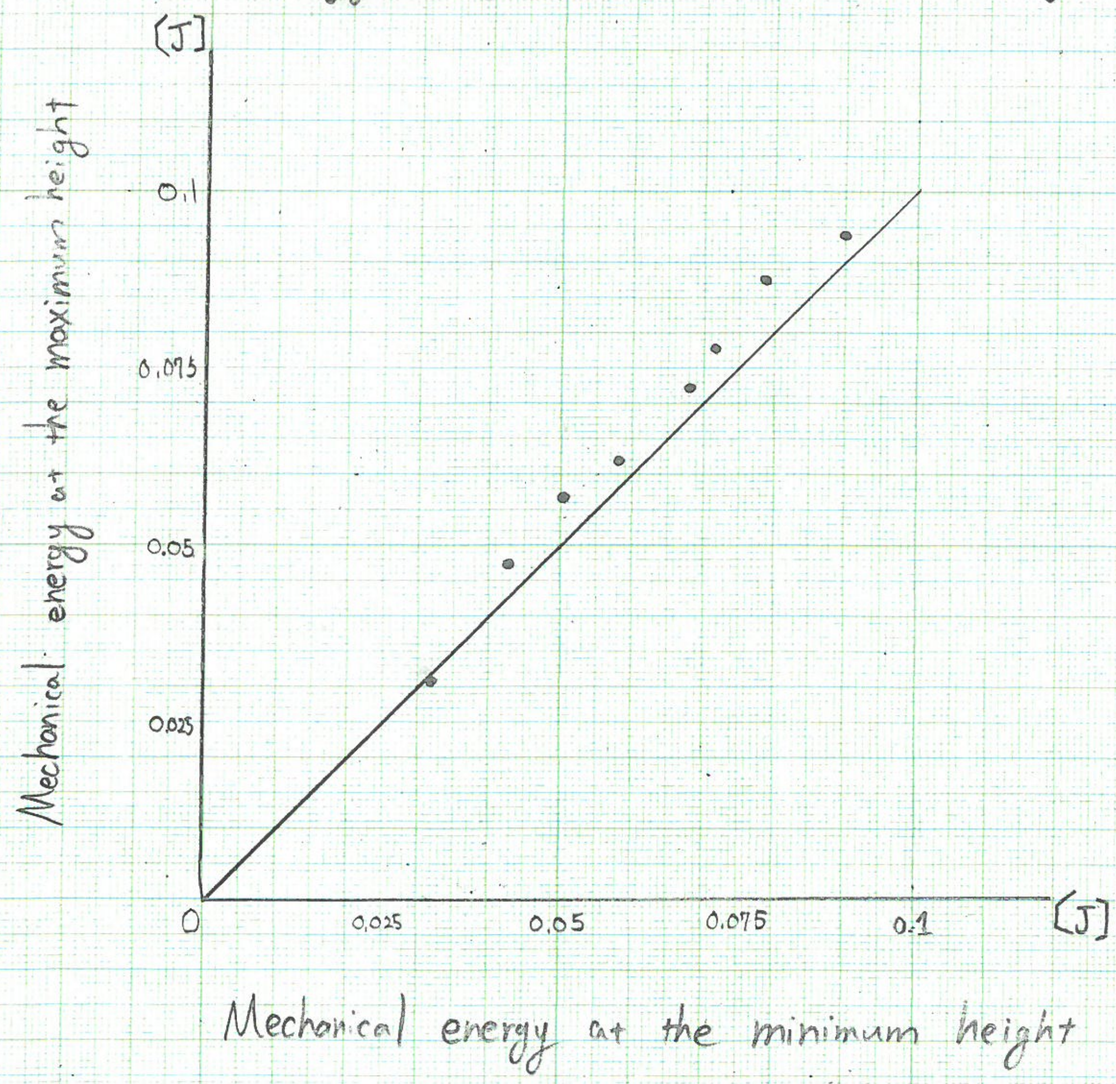
7.Opinion

This lab was hard and confusing but by organizing data and making a lab report, it helped me understand the idea of mechanical energy. By doing these labs, it helped me understand how things used in daily life works. For example, a swing uses the idea of mechanical energy of pendulum. Also, a drawn bow possesses elastic potential energy. It is very interesting to know that everything in this world can be applied and explained with ideas of physics.

8.References

Lab reports by Seri Taiga, Saori Shiba

Graph 1. Relation between the values of mechanical energy at the maximum and minimum heights



Graph 2 Relation between the elastic force and elongation