Physics Laboratory Report

Lab number and Title: Lab 125 - Conservation of Energy in Spring-Mass System

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Group ID: 3

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Course & Section Number: PHYS111A - 011

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1. INTRODUCTION

1.1 Objectives

Today's experiment had us go over a spring mass system. This is a system where there's a spring attached to a hanging mass, which there are several lengths involved. We learned about this in class, and found out that the higher the mass is, and the lower the spring constant is, the more the spring will stretch, while the reverse will make it stretch less. Our objective today was to implement the formulas learned in class and relate them to previously learned concepts of energy, velocity, mass, and acceleration due to gravity.

1.2 Theoretical background

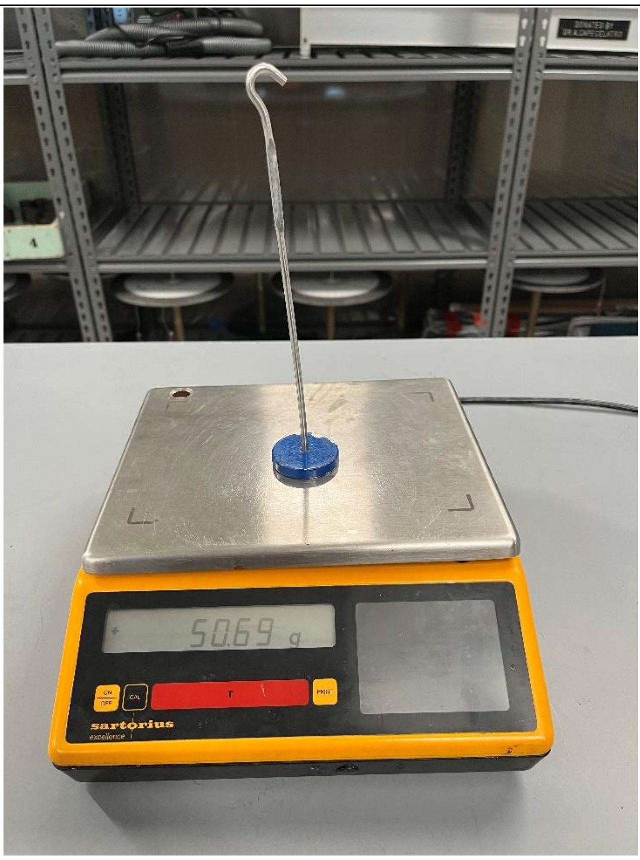
In class and in our regular Physics class, we learned about the formula that dictates how elastic potential energy is calculated. That formula is $Ug = ½kx^2$ or $F_{spr} = kx$, depending on if we're looking for energy or force. We also know that the energy formula is the integral of the force one. Another fundamental concept that we were told about is how spring equilibrium works. This is an important thing to understand since the spring has an original, standard length, but can stretch to a much longer length depending on how much force is being applied. This is what we used to understand what the lab was in class.

2 EXPERIMENTAL PROCEDURE

Part One

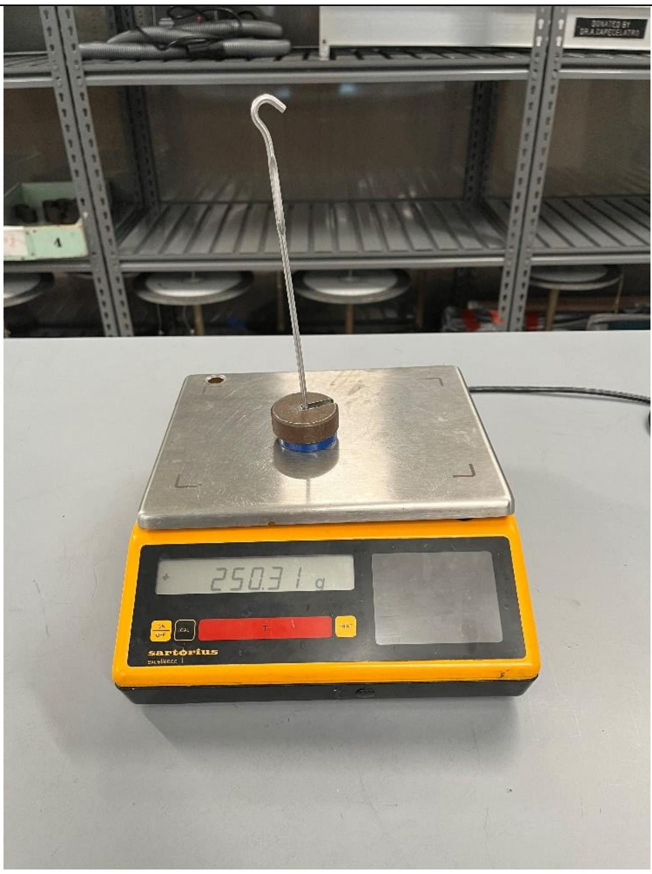
We used the same procedure as the manual instructed.

Masses



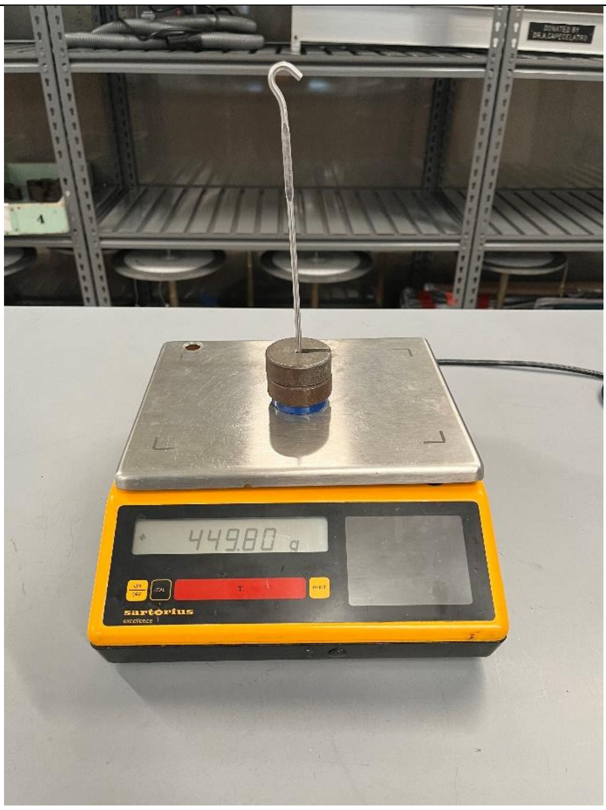
Individual Hanging Mass (0.05069kg)

Mass 1 (0.15044kg)

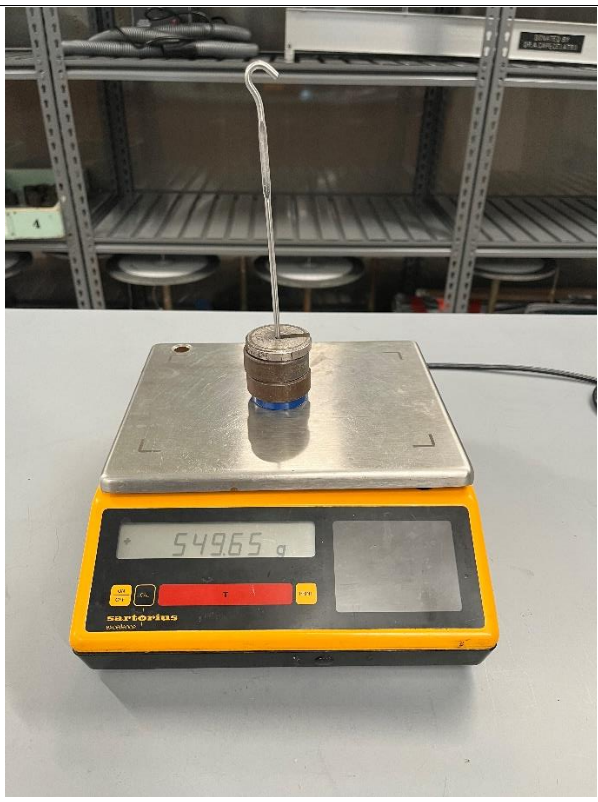


Mass 2 (0.25031kg)

Mass 3 (0.35016kg)



Mass 4 (0.44980kg)



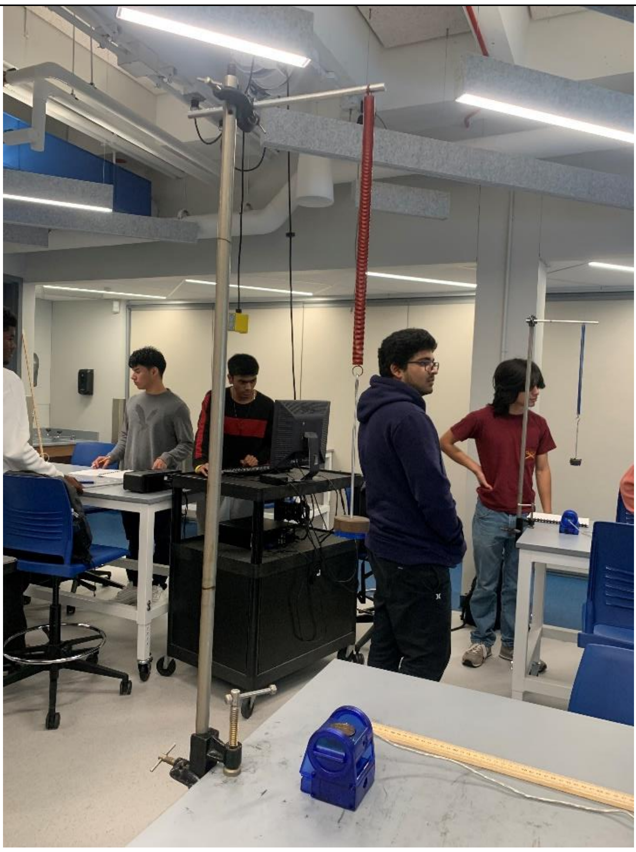
Mass 5 (0.54965kg)

Spring Setup

Spring Setup Without Weight

Hanging Mass (no extra weight)

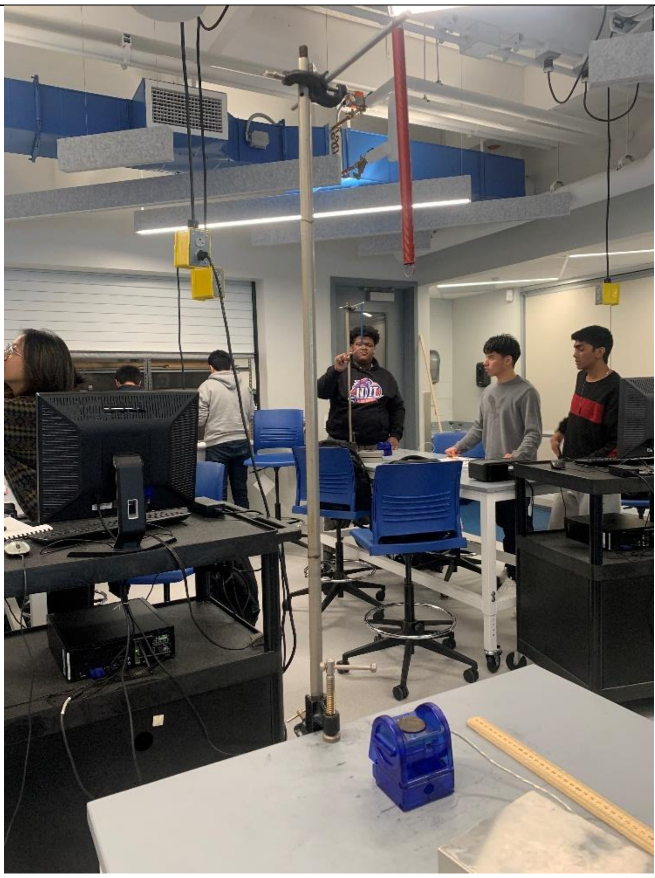
Mass One



Mass Two

Mass Three

Mass Four



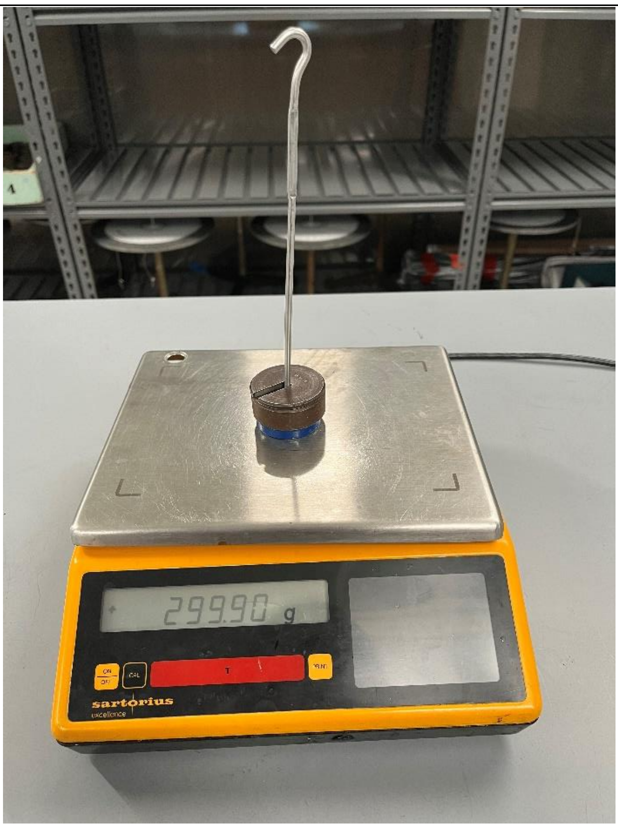
Mass Five

Variables

- Mass (m)
    - Value of mass changes for each run.
- Gravity (g)
- Height (x)
- Spring Constant (k)

Part Two

For part two, we made one change in comparison to the lab manual. The lab manual says to use 300grams of weight on top of the hanging mass (which is around 50 grams), but in class we were instructed to instead use 300 grams as the total (or add 250 grams). All other parts are the same.

 Mass (0.29990kg)	 Experiment Setup

Variables

- Mass (m)
- Gravity (g)
- Equilibrium Position (x)

- Spring Constant (k)
- Kinetic Energy (KE)
- Potential Energy (U)
- Mechanical Energy (E)

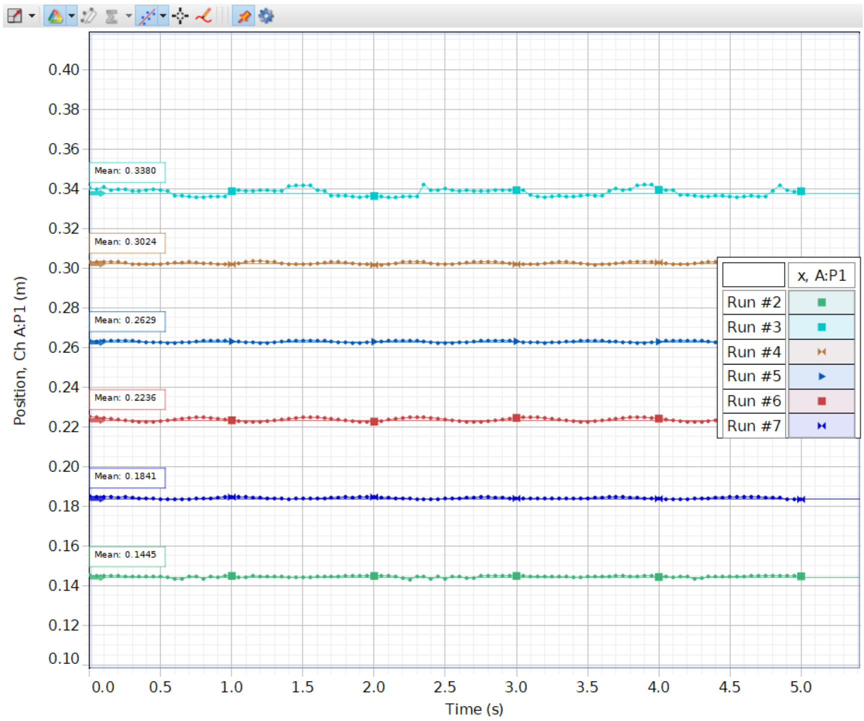
3 RESULTS

3.1 Experimental Data (15 points)

Part One

Mass of Weight Hanger M = 0.051kg

	M	M + 100g	M + 200g	M + 300g	M + 400g	M + 500g
Weight [N]	0.4998	1.4798	2.4598	3.4398	4.4198	5.3998
Position [m]	H_0 0.3380	H_1 0.3024	H_2 0.2629	H_3 0.2236	H_4 0.1841	H_5 0.1444
Displacement [m]	Set as 0	0.0356	0.0751	0.1144	0.1539	0.1936

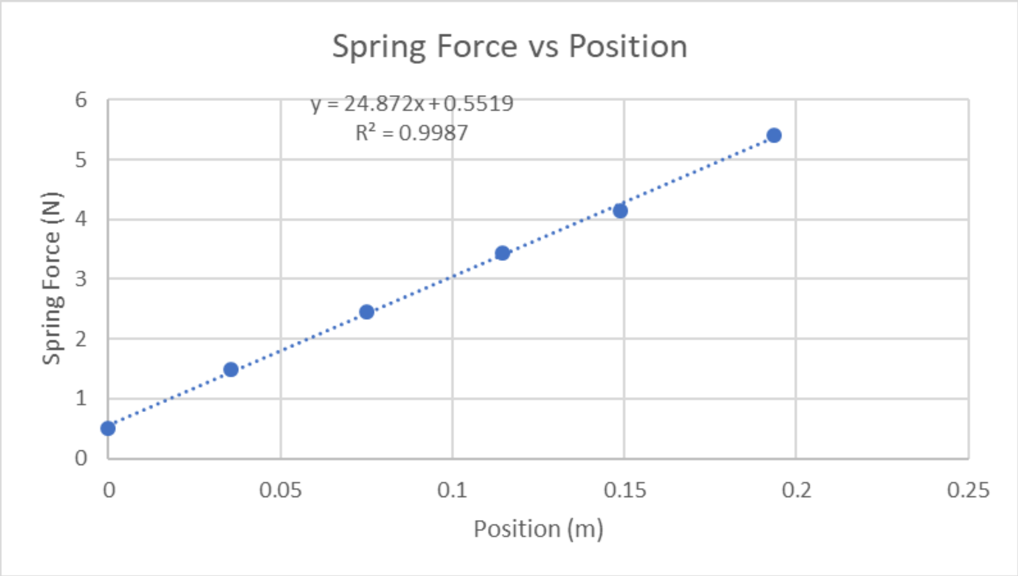


Position vs. Time

Data of Hanging mass and position

	Set: Mass added to a mass-hanger (kg)	Set: Position (h) (m)
1		
2	0.051	0.3380
3	0.100	0.3024
4	0.200	0.2629
5	0.300	0.2236
6	0.400	0.1891
7	0.500	0.1444
8		
9		
10		
11		
12		

Used data from this to create a spreadsheet and chart which is in the next photo.



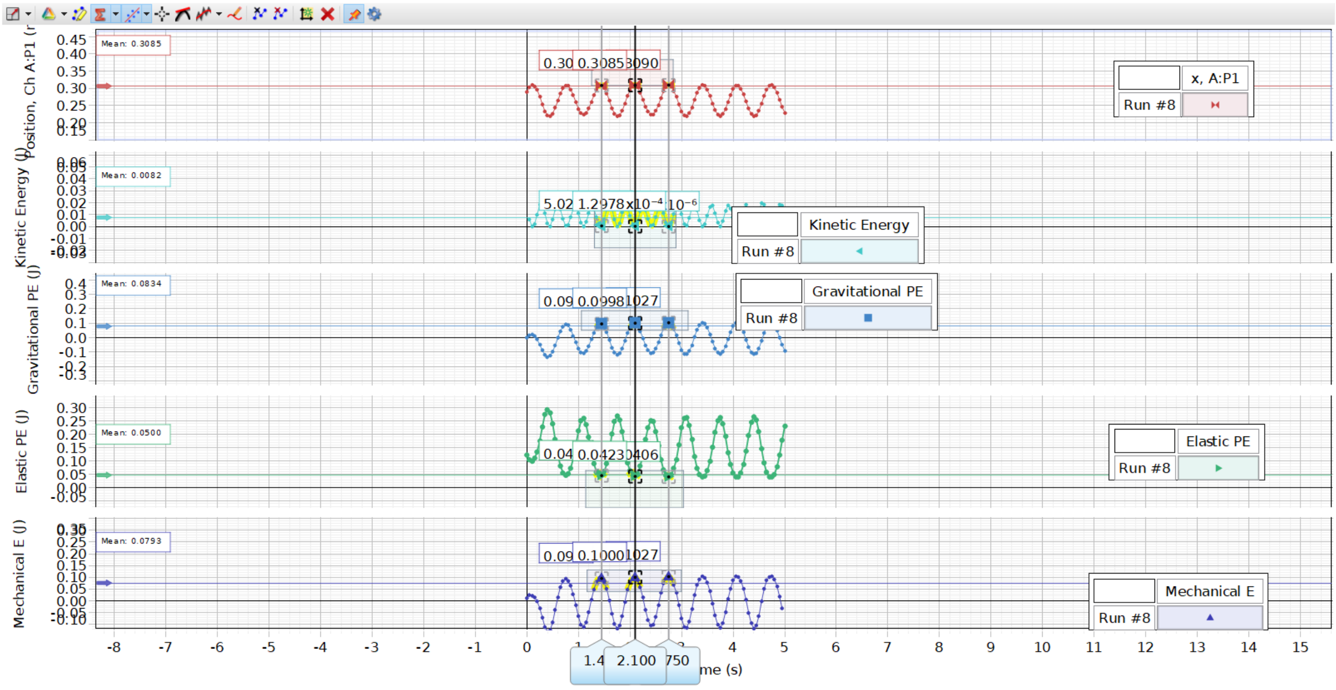
The spring constant is 24.872.

Part Two

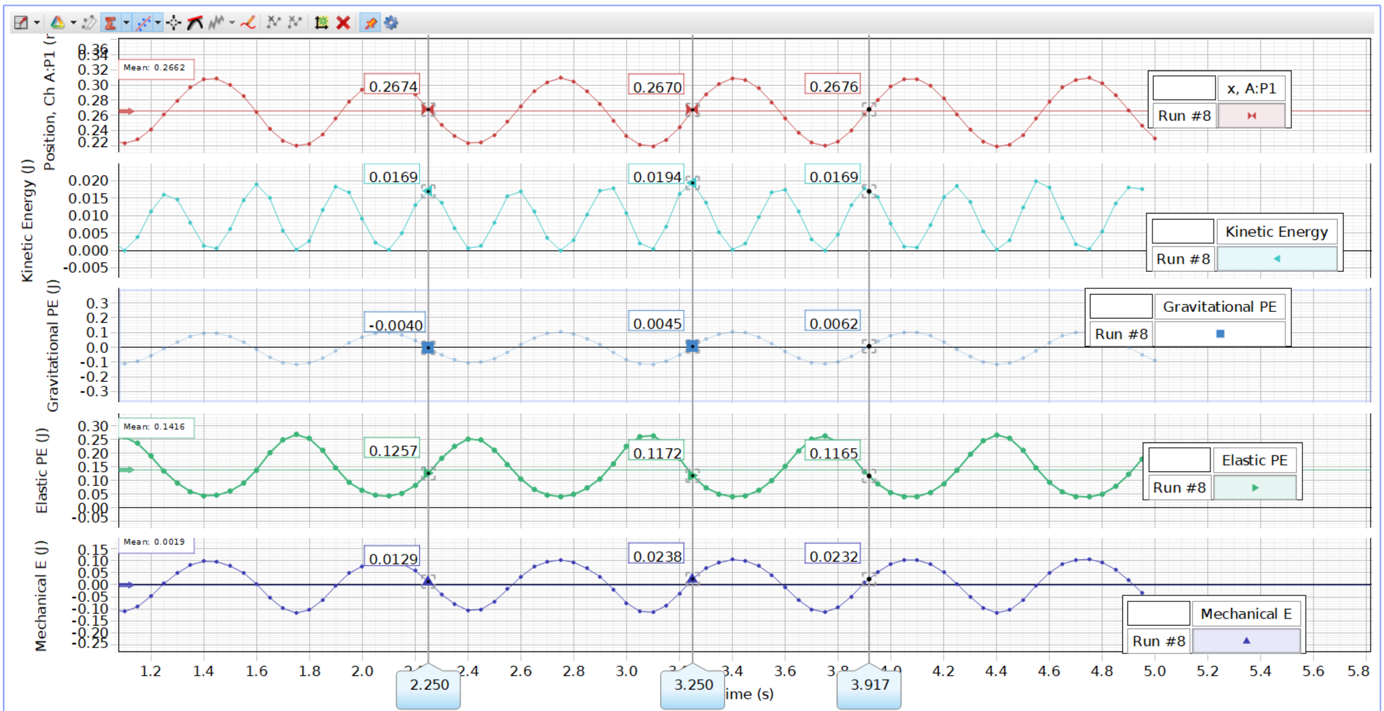
m = M + 0.20kg = 0.251kg

Equilibrium Position (h_0) = 0.2629m

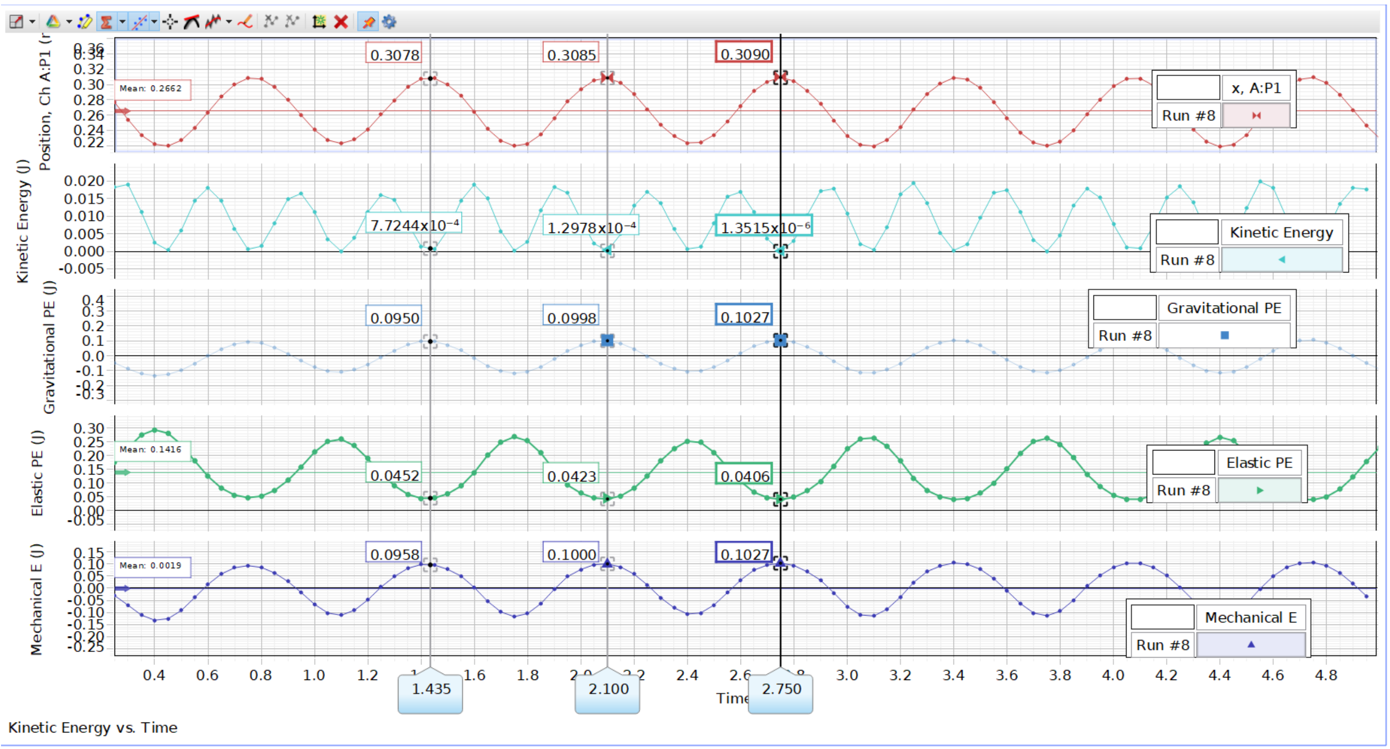
Point #	Displacement (m)	Velocity (m/s)	KE (J)	PE (J)	E_{mech} (J)
1 (High)	0.0455	0.00	0.00	0.142	0.0995
2 (Middle)	0.004 (around 0)	0.375	0.0177	0.122	0.0599
3 (Low)	-0.0422	0.00	0.00	0.150	0.112



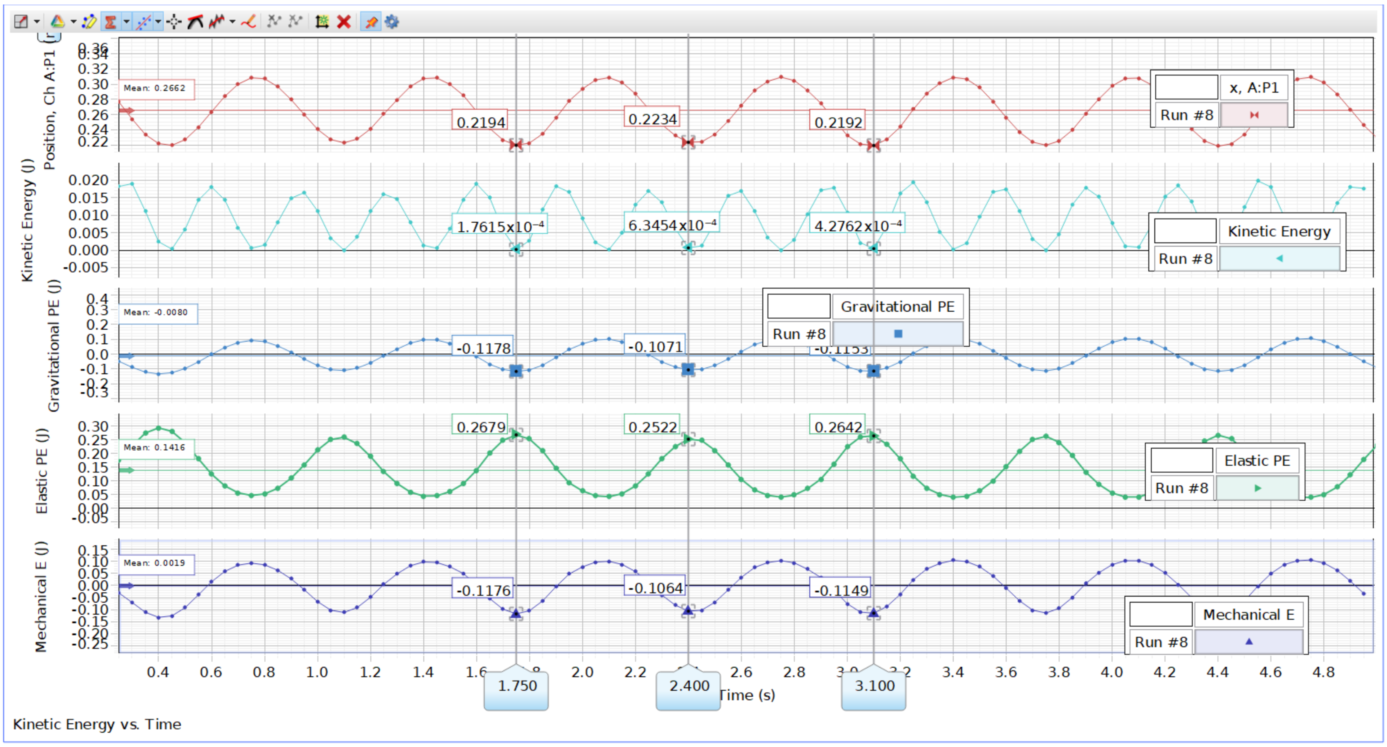
Kinetic Energy vs. Time



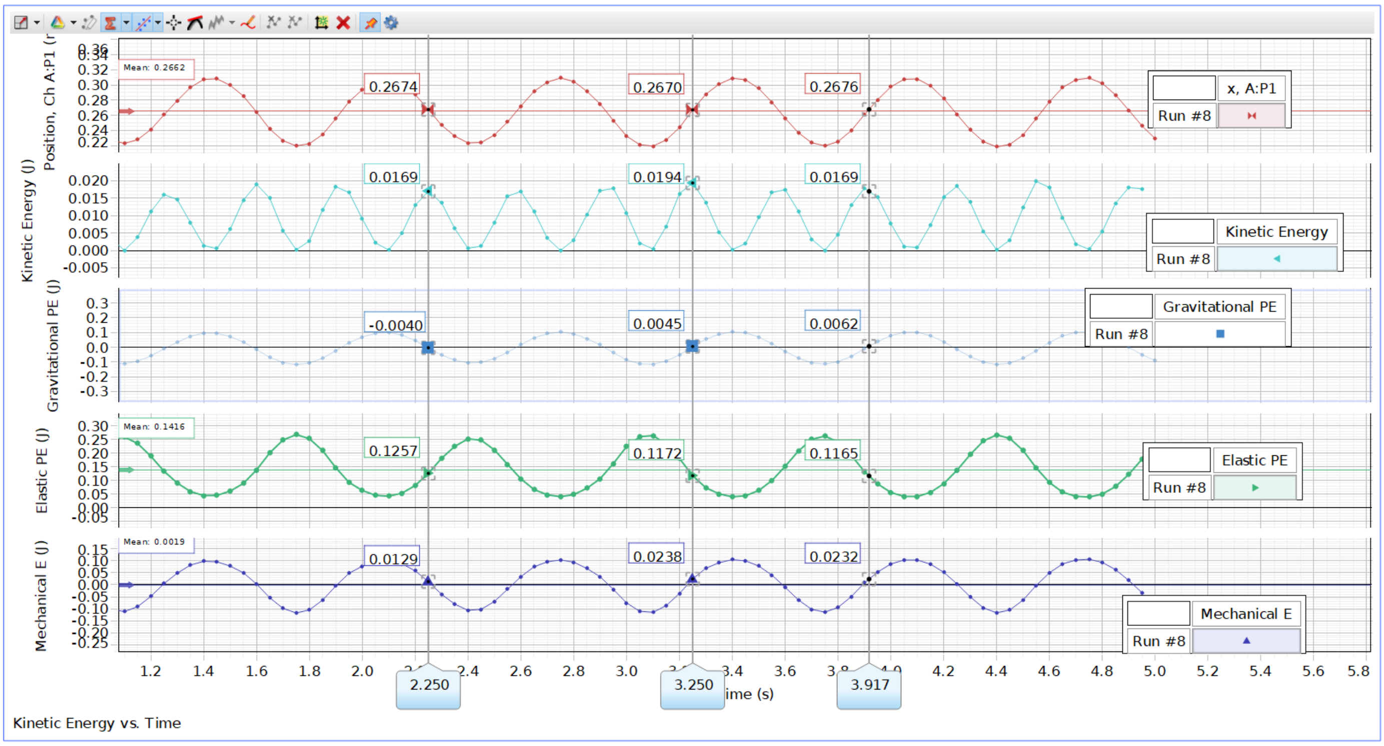
Kinetic Energy vs. Time



Three High Points



Three Low Points



Three Middle Points

We didn't use hand-written calculations to create the work. Most values were either taken from the data of the computer or done using a calculator.

4 ANALYSIS and DISCUSSION

We used a couple of important formulas to calculate the value of each of the things we were calculating. For part one, we used the force of spring formula (F = kx) in order to solve the values and understand what exactly we were looking for. The computer already gave us the change in displacement, which we used to solve for the spring constant. For part two, which was much more complicated and took us a lot more time, we had to solve a couple of different things. There were two types of energy (kinetic and potential), the sum of those two (total mechanical energy), and also other variables which we did not calculate but the computer provided (velocity, displacement). For KE, we used the mass that we already knew and the velocity that it provided to get the answers. For PE, We used the displacement and spring constant (from part one) to solve. And for E_{mech}, we simply used the sum of those two values. What we learned is that the value of KE went to 0 at the endpoints, and PE was closest to 0 in the middle points (although it wasn't entirely 0).

For part one, we were provided with an R^2 which represents how much error would be in the system. The number given was 0.9987, which is a very high level. Since we know that 1 would mean perfect (or very close), the number we got means that our results are reasonable and align with the theory. For part two, we do not have an immediate way to recognize error analysis since the data was given by the computer and not measured by us, but the computer capped out at three significant figures, which leaves a +-0.001, which is very nominal. The two parts of the error analysis prove that the lab is good.

There was one discussion question provided in the lab manual, asking about the shaking and movement at the bottom with the x vector. In a perfect system, the spring should only move in the y vector, being completely motionless in the x vector, but in our experimentation that was not the case. The reason for this was because of systematic errors that play a small role in changing the experiment. The mass was likely not perfectly even, and therefore the center of the mass was probably being moved around, causing the motion. Fortunately, this does not change much in the experiment since the values were only collected in the y vector by the sensor at the bottom.

5 CONCLUSIONS

In summary, we learned how springs work and how it relates to other things we already learned. Furthermore, we learned how to apply the formulas of energy, force, and kinematics towards one another to get the values we wanted. I found this lab to be a great amount of experience which I will be applying in my main physics class. I have more questions, especially from when the discussion question raised concerns about factors we might not have brought into question. Is air resistance and the type of objects we use (in terms of shape) important in changing the values we get? I would like to have new experiments where we change those values in the future. Overall, I found this lab very insightful.