Experiment 3:
Conservation of Mechanical Energy

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Lab performed on: May 1, 2018
Lab section: Lab 6- Tuesday 11am
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Partners' names:

2. <u>Discussion</u>:

My lab partners and I placed the position of equilibrium at the center of the 31st tooth colored green. The glider moves to the opposite direction of where it was pulled to.

I calculated the potential energy and kinetic energy at the same positions in space by calculating the average position, x_i, in meters using the formula $\overline{x}(i) = \frac{1}{2}(x_{i+1} + x_i)$ from equation 3.4 from the lab manual. Then I applied that same formula to find the time, t_i, in seconds. Afterwards, I differentiated the formula $v(\overline{x}(i)) = \frac{\Delta x}{\Delta t} = \frac{x_{i+1}-x_i}{t_{i+1}-t_i}$ from equation 3.3 from the lab manual and the two values previously calculated to get the v_i, the average velocity in m/s. Using the the formula $U = \frac{1}{2}kx^2$ from equation 3.1 from the lab manual and x_i, I was able to calculate the potential elastic energy. Using the formula $K = \frac{1}{2}Mv^2$ from equation 3.2 from the lab manual and v_i, I was able to calculate the kinetic energy of the glider. To find the total energy, I added the potential energy and kinetic energy together.

3. <u>Plots and Tables</u>:

Mass of the glider with its photogate comb: m = 0.244±0.005 kg

Applied Force, F (N) δF = ±0.0005	Displacement, x (m) δx = ±0.001
0.0294	0.004
0.0745	0.011
0.1911	0.030
0.2362	0.037
0.3391	0.054

Table 1— Applied Force F (N) and Corresponding Displacement x (m). This table shows the data recorded with the five different masses attached to the comb using the string on the pulley. The displacement (m) from the equilibrium position and its corresponding masses (kg), which was converted into force (N), were also recorded. This data was then used to plot a graph that resulted in the value of the spring constant.

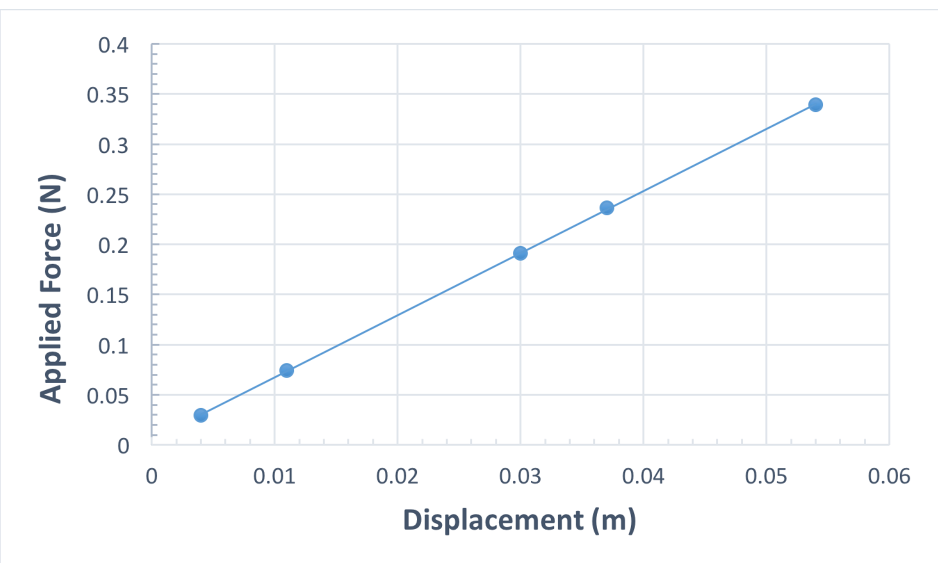

Figure 1— Applied Force F (N) vs. Displacement x (m). This graph shows the linear relationship between the applied force and displacement. From this, I was able to calculate the spring constant used during the experiment with the comb on the glider and the photogate. The slope gradient is equal to the spring constant *k*, which is equal to 6.19±0.03. The equation of the fit line is y = (6.19±0.03)x + (0.0056±0.0001)

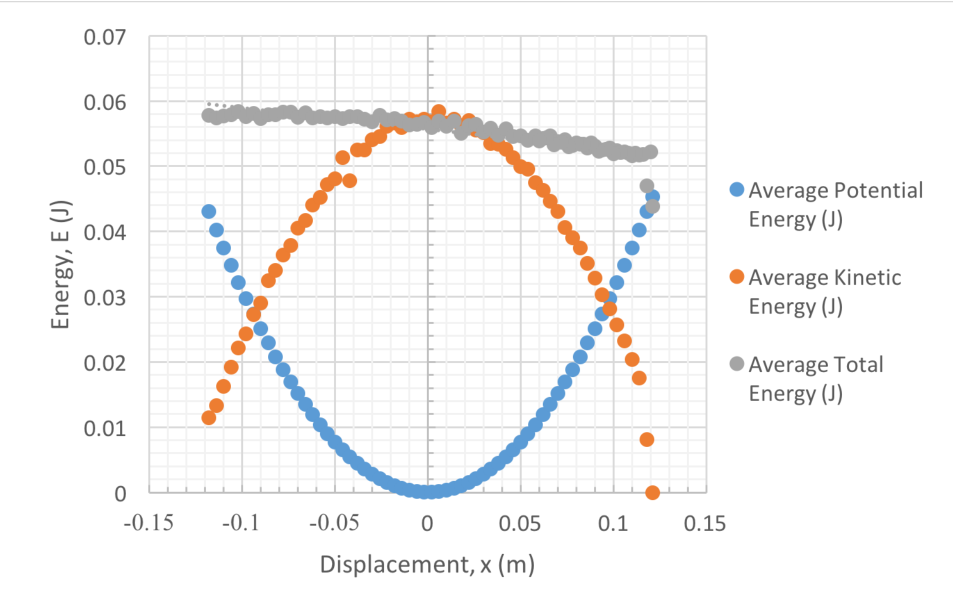

Figure 2— Mechanical Energy of System vs. Distance of Equilibrium. Potential energy is based on the distance from the origin whereas kinetic energy was based on differentiating the distance and time data. The overall average total energy is the linear fit y = -(0.0323±0.0004)x + (0.0557±0.0006). There is a negative slope gradient is the result of constant force of friction between the glider and air track. The value of the coefficient of friction μ was calculated as 0.1351 ± 0.0003 using the formula $\mu = \frac{|slope\ gradient\ value|}{mg}$.

4. Extra Credit:

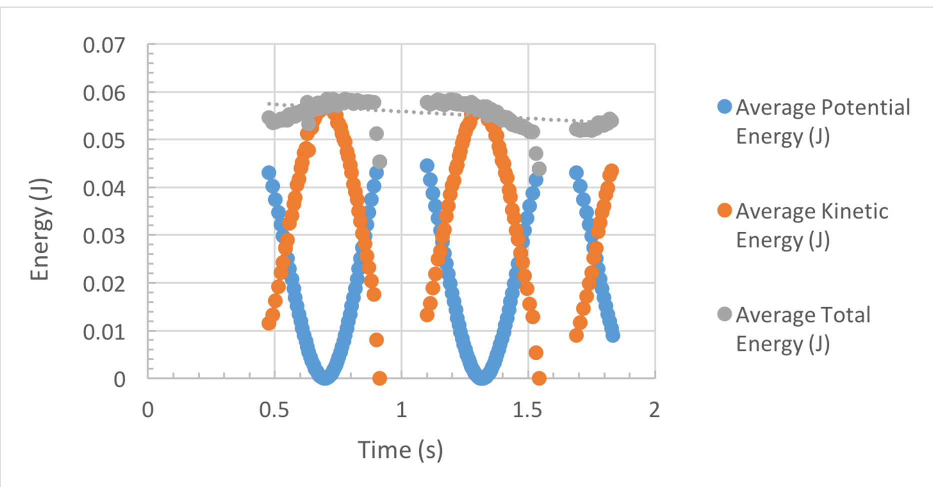

Figure 3— Energy vs. Time for Harmonic Oscillator. Determine how long it would take for the amplitude A to decrease by a factor or e using the equation obtained from the graph. $x(t) = 0.0589e^{-0.052x}$.

The initial displacement is at the maximum, so it equals to the amplitude of oscillations:

$A = x(0) = 0.0589$

Then the expression for the displacement in t is equal to the amplitude decreased by factor of e:

$\frac{A}{e} = 0.0589e^{-0.052x}$.

$\frac{0.0589}{e} = 0.0589e^{-0.052x}$

$e^{-1} = e^{-0.052t}$

$t = \frac{-1}{-0.052} = 19.2$ seconds

It would take the glider approximately 19 seconds to decrease its oscillation amplitude by a factor of e.

Presentation Mini-Report

Mechanical Energy on a Harmonic Spring Oscillator

D. Wang[1]

In this experiment, the system was a photogate comb that was attached on a glider that moved freely on an air track. This system was connected to two equal springs that made the comb on the glider oscillate when disturbed from its equilibrium position. In order to analyze the degree in which energy is dissipated due to friction between the glider and the air track, I used the principle of conservation of mechanical energy. The degree does not completely eliminate friction and is dependent on coefficient of friction. I calculated the spring constant, which was 6.19$\pm$0.03 and used a photogate to record the time it took for the teeth of the comb on the glider to block signal from the photogate. Afterwards, I calculated the average distance from the equilibrium position and its corresponding time, which allowed me to calculate the values of velocity by differentiating the calculations from the average distance. Then, I used the formula for elastic potential energy ($U_{sp} = \frac{1}{2}kx^2$) and kinetic energy of the system ($U_k = \frac{1}{2}mv^2$) to plot the total energy against distance. From this plot, the resulting fit was linear and the slope gradient represented the constant force of friction, which was 0.1351$\pm$ 0.0003.
(198 words)

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