PHYSICS 4AL

EXPERIMENT 3: CONSERVATION OF MECHANICAL ENERGY

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Contents

DISCUSSION

We aligned the photocomb at the 36th tooth from the left. We then correspondingly always pulled the glider to the left when performing our experiment.

Potential energy of a spring is given by the equation $F = -kx$, where F is the force exerted on the spring, k is the spring constant, and x is the distance pulled. To obtain our potential energy calculations, we first obtained the spring constant k by hanging a mass from the spring and measuring the distance stretched, shown in **Figure 3.1**. k is found to be 6.016 ± 0.001 N/m.

To calculate both the kinetic and potential energy in space, block event times were measured using the DAQ. Because we know that each tooth and gap between each tooth is 2 mm ± 30 μm, each block event time represented an increase in 4 mm. The potential energy is calculated with the average distance $\bar{x}$ using the formula $E_p(\bar{x}(i)) = \frac{1}{2}k\bar{x}^2$ and calculated k.

Velocity of the glider was calculated by differentiating displacement with respect to time using the equation $v(\bar{x}(i)) = \frac{x_{i+1}-x_i}{t_{i+1}-t_i}$. Because kinetic energy E_k can be found by the formula $E_k(\bar{x}(i)) = \frac{1}{2}mv(\bar{x}(i))^2$, when can substitute $v(\bar{x}(i))$ and obtain kinetic energy with this final equation $E_k(\bar{x}(i)) = \frac{1}{2}m\left(\frac{x_{i+1}-x_i}{t_{i+1}-t_i}\right)^2$.

We then plotted $E_k(\bar{x}(i))$, $E_p(\bar{x}(i))$, and $E_{total}(\bar{x}(i))$ on a plot with respect to average distance $\bar{x}$. The potential energy is an upward facing parabola, while kinetic energy is a downward facing parabola. When the spring is pulled, potential energy is at it's maximum and kinetic energy is zero. When the spring and glider system is released, potential energy is transformed into kinetic energy and the glider gains speed, until it reaches the equilibrium point where kinetic energy is maximized. After, kinetic energy is transformed once again into potential energy as the spring pulls on the glider. Other than a slight loss of energy to friction (shown in **Figure 3.2**), the energy level of the system remained the same. Energy was only being transferred between potential and kinetic energy as the glider moved.

PLOTS AND TABLES

Mass of Glider with Photogate Comb = 0.225 ± 0.0005 kg

Hanging Mass (kg)	Applied Force (N)	Glider Displacement (m)
0.100 ± 0.0005	0.98 ± 0.005	0.162 ± 0.00005
0.060 ± 0.0005	0.588 ± 0.005	0.099 ± 0.00005
0.035 ± 0.0005	0.343 ± 0.005	0.056 ± 0.00005
0.020 ± 0.0005	0.196 ± 0.005	0.032 ± 0.00005
0.005 ± 0.0005	0.049 ± 0.005	0.008 ± 0.00005

Table 3.1 Force exerted on spring vs displacement. 9.8 m/s^2 was as the acceleration due to gravity to calculate applied force.

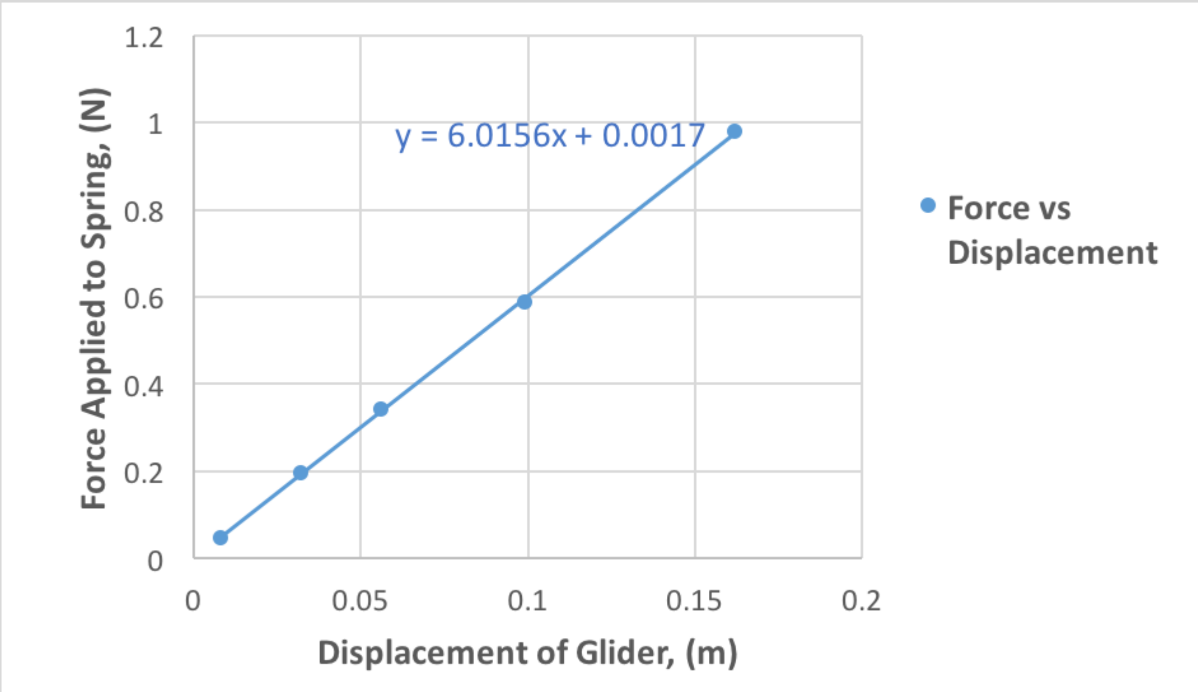

Figure 3.1 Measuring Spring Constant by comparing force applied by hanging mass and displacement. The spring constant found in this case is $k = (6.016 \pm 0.002)$ in N/m.

The slope of the best fit line calculated in **Figure 3.2** represents the energy lost per meter, in units of J/m. This is equivalent to the friction force that opposes the motion of the glider. Friction is equal to the coefficient of friction times the normal force, or $F_{friction} = \mu * N$, where N is the normal force due to gravity. The normal force is equal to the weight of the glider, which has a mass of 0.225 kg. The normal force N of the glider is equal to (0.225 ± 0.0005) kg * 9.8 m/s = (2.205 ± 0.005) m/s^2. Having found the normal force, we can find the coefficient of friction, where $\mu = \frac{F_{friction}}{N} = 0.0004 \pm 0.0002$.

Because the value of μ is very small, We can see that we the energy lost to friction is extremely small because our glider was on an air track designed to minimize the coefficient of friction, making our energy loss almost zero.

Report

EXPERIMENTAL PROOF OF CONSERVATION OF ENERGY

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Abstract

We set out to prove the principle of convervation of energy in a closed system. To accomplish this, we used a glider with a photocomb on top attached to a spring was put on top of an airtrack. We measured

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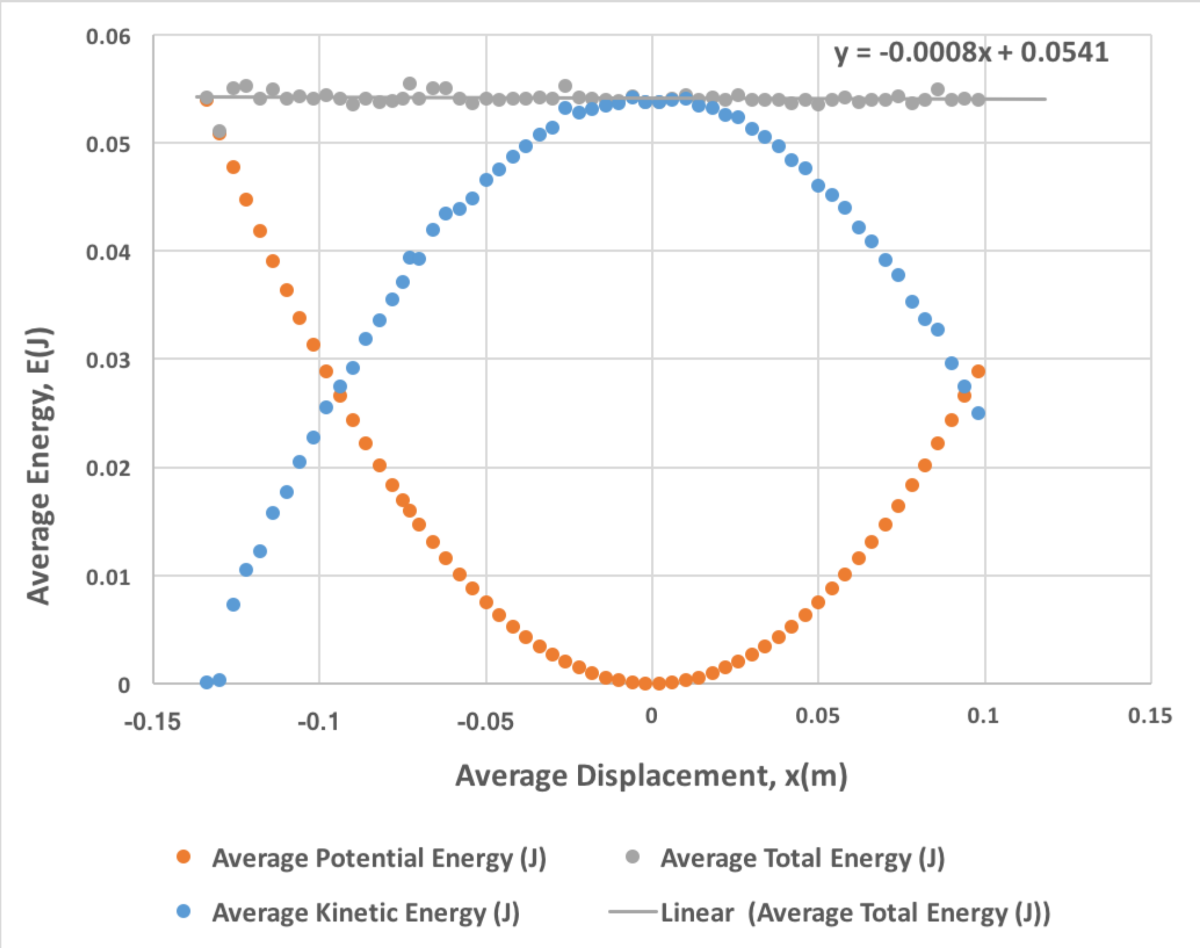

Figure 3.2 Kinetic, potential, and total energy of a glider attached to springs compared to displacement. The best fit line of the total energy is $E_{total} = (-0.0008 \pm 0.0003)x + (0.054 \pm 0.002)$, in units of J.

the spring constant by hanging various masses from the spring and measuring the displacement. We pulled the glider to the right and released it from rest for one-half oscillation; the tips of the photocomb passed through a photogate and allowed us to measure the displacement of the glider over time. After measuring the distance between each photogate tooth, we differentiated the displacement with respect to time to obtain the velocity at each point in time. With the spring constant, glider mass, velocity, and displacement, we plotted potential, kinetic, and total energy of the system with respect to average displacement. The graph shows the total energy of the system decreasing only very slightly, which we can attribute to any remaining friction in the system. We proved that energy is conserved in a closed system.