Introduction

The objective of this lab was the measure the position of an oscillating mass to use the position of a oscillating system over a period of time to calculate the kinetic and potential energy and determine if the total mechanical energy was conserved.

Theory

According to the formula for total mechanical energy, $E_T = K + U$. To prove that total mechanical energy was conserved, it must be proved that $E_k = E_u$ through the entire oscillation.

$F_y = m_{ay}$

$= -k(y-y_{i)}$

$A_y = v_y * d_{vy}/d_y$

$F_y = m(v_y * d_{vy}/d_y)$

$F_y = m * v_y * d_{vy}/d_y$

$\cancel{m}a_y = \cancel{m} * v_y * d_{vy}/d_y$

$\int a\, y = \int vy * dvy/dy$

$= v_y$

$E_T = K + U$

$= \frac{1}{2} (mv^2) + \frac{1}{2} (kx^2)$

$E_T = \frac{1}{2} (mv^2) + \frac{1}{2} k(y_2-y_1)^2$

Velocity can be determined through slope of a position time graph, or the derivative of the equation of a position time graph.

Procedure

All experiments were carried out in the springs lab section of the PHET Colorado website.

1. Place the orange mass onto the spring and allow to rest at equilibrium. Then, use the ruler to measure a certain distance away from the bottom of the weight at rest. This distance will be the amplitude. Finally, ensure there is no damping and keep the gravity value at 9.8 m/s^2.
2. Measure the position of the weight as it oscillates, and graph it.

Results

Q1.

Mass = 50 g

Amplitude = 20 cm (0.2m)

t	x (m)	Pos uncert	t	x (m)	Pos uncert
0	0.2	0.5	1.5	0.11	0.5
0.1	0.14	0.5	1.6	0.2	0.5
0.2	0	0.5	1.7	0.16	0.5
0.3	-0.14	0.5	1.8	0	0.5
0.4	-0.19	0.5	1.9	-0.1	0.5
0.5	-0.14	0.5	2	-0.2	0.5
0.6	0	0.5	2.1	-0.17	0.5
0.7	0.13	0.5	2.2	-0.04	0.5
0.8	0.2	0.5	2.3	0.1	0.5
0.9	0.16	0.5	2.4	0.19	0.5
1	0.02	0.5	2.5	0.17	0.5
1.1	-0.12	0.5	2.6	0.05	0.5
1.2	-0.2	0.5	2.7	-0.09	0.5
1.3	-0.16	0.5	2.8	-0.19	0.5
1.4	-0.02	0.5	2.9	-0.17	0.5
			3	-0.07	0.5

Table 1: *Data table of time and position of system*

Q2.

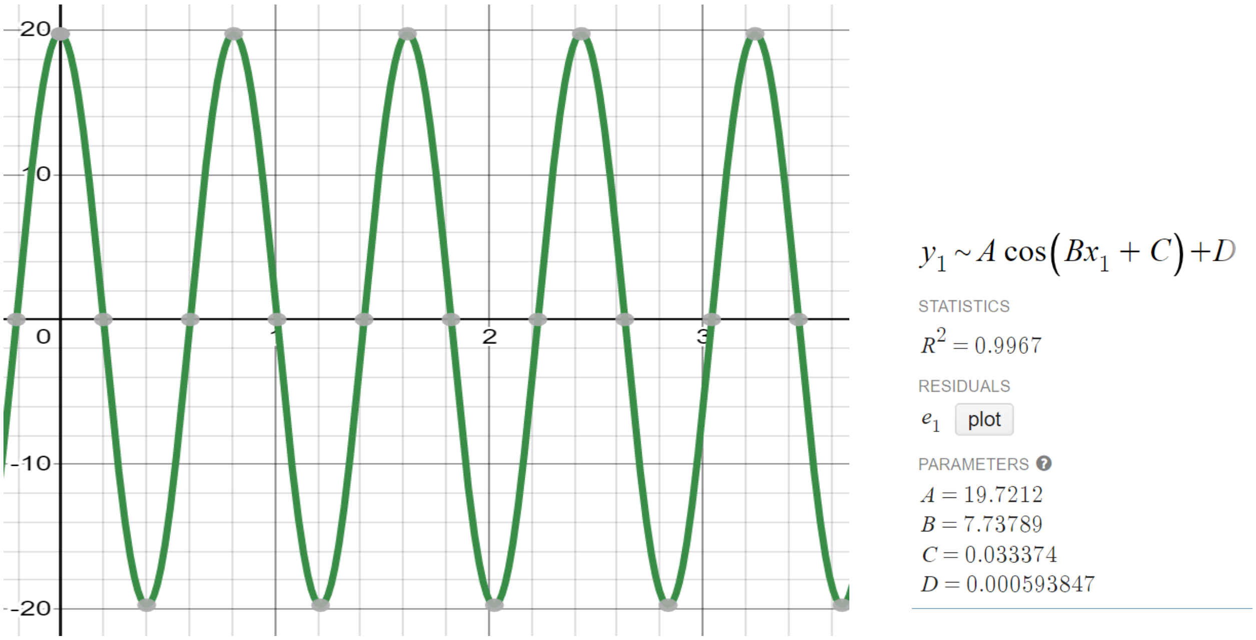

Figure 1: *Graph of position (y) over time (x), with calculated A, B, C, D values*

Y=Acos(Bx+C) +D, where A is the amplitude, B is the angular frequency, C is the phase shift, and D is the vertical shift. Parameter B provides frequency, as it can be calculated from the formula $w=2\pi f$.

Using the formula $2\pi f = \sqrt{\frac{k}{m}}$, the spring constant can be calculated.

$$B = w = 2\pi f = 7.73789 = \sqrt{\frac{k}{m}}$$

$$7.73789^2 = \frac{k}{m}$$

$$m(7.73789^2) = k$$

$$(0.05)(7.73789^2) = k$$

$$K = 2.99374$$

$$K = 3.0 \text{ N}$$

The spring constant is 3.0 N.

Q3.

Mechanical potential energy of a system is: $\frac{1}{2}kx^2$

$U = (0.5)(k)(A^2)\cos^2(Bx-C)$

$= (0.5)(3)(0.2^2)*\cos^2((7.738)x-0.03338)$

$= 0.06*\cos^2((7.738)x-0.03338)$

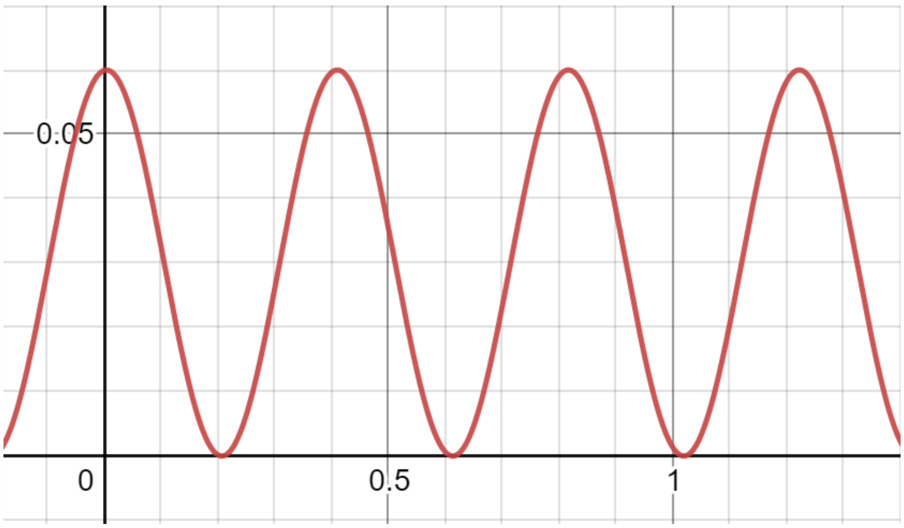

Figure 2: *Graph of mechanical energy (y) over time (x)*

Q4.

Kinetic Energy of a system is: $\frac{1}{2}(mv^2)$

Velocity equation can be found by finding the derivative of position equation

$V(t) = dx/dt$

$= A\cos^2(Bx-C)+D$

$V(t) = BA\sin(Bx-C)$

$= (7.738)(0.2)*\sin(7.738x-0.03338)$

$v = 1.5476*\sin(7.738x-0.03338)$

$K = \frac{1}{2}(mv^2)$

$= \frac{1}{2}(0.05)(1.5476\sin(7.738x-0.03338))^2$

$= ½ (0.05)(1.5476^2)*\sin(7.738x-0.03338)^2$

$K = 0.05987*\sin(7.738x-0.03338)^2$

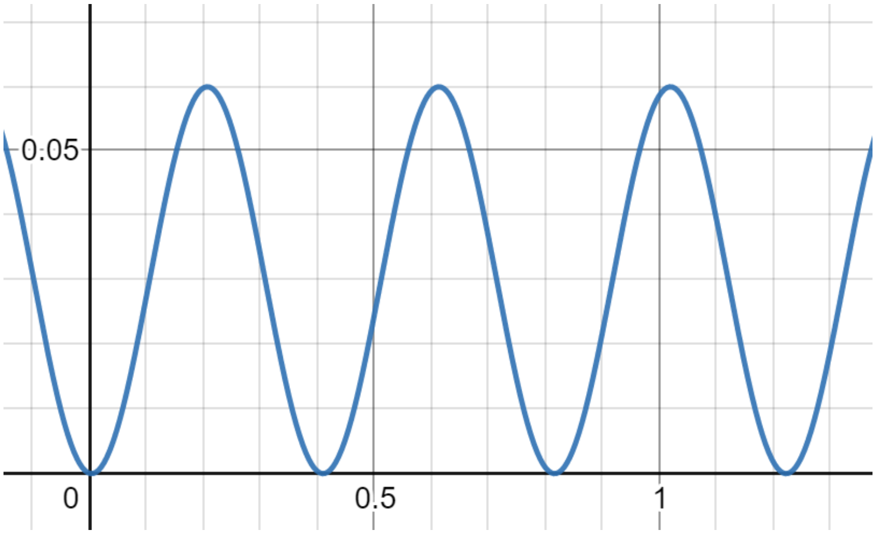

Figure 3*: Graph of kinetic energy (y) over time (x)*

Q5.

The overall total mechanical energy stays equal throughout the system oscillation.

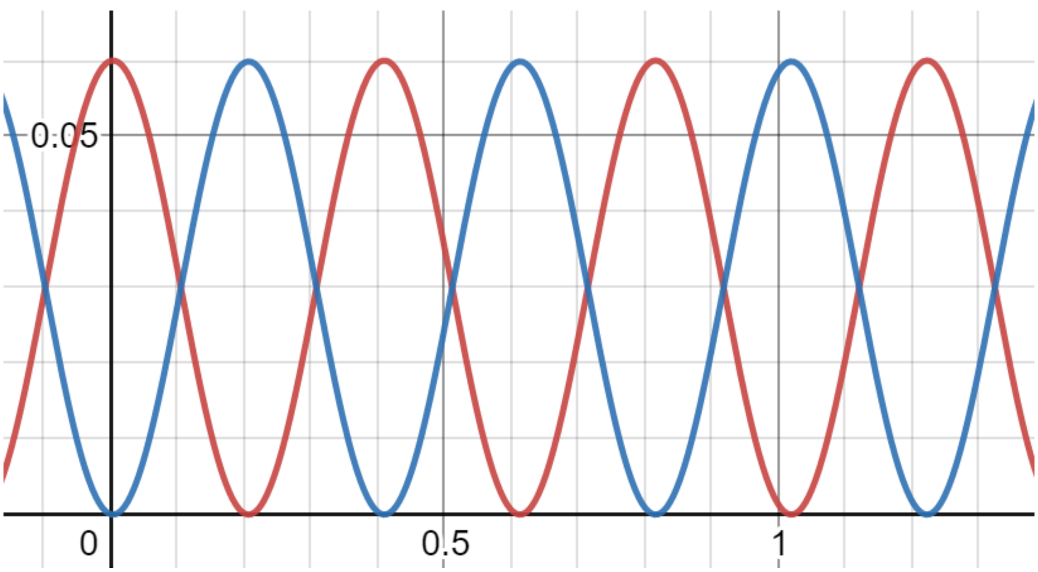

Figure 4: *Graph of kinetic and potential energy.*

In fact, it appears that when the potential energy of the system is at maximum, the kinetic energy is at a minimum, and vice versa.

Discussion and Conclusion:

In conclusion, if there is no damping effect on a system, the total energy of the system will stay consistent, as the total energy of the system will alternate between maximum potential energy and minimum kinetic energy, and maximum kinetic energy and minimum potential energy.

The value of A is