Kaleb Burris
PHYS 211X
Lab 5: Conservation of Mechanical Energy , 2/28/2023, Partners: Maite Valentin-Lugo, Seth Waln

I was pretty sick when I filled in this lab. Forgive the terrible formatting and cheapskate images.

1.

$$E = K + U$$

Mechanical energy is the sum of the kinetic and potential energy in a system, so changing one will have a linear effect on the other.

$$U = \frac{1}{2}(k_1)(x - x_e)^2 + U_0$$

For springs, the potential energy is half of the spring constant times the displacement squared plus any initial potential energy.

$$K = \frac{1}{2}\left[M + \frac{1}{3}(m_1 + m_2)\right] v^2$$

Kinetic energy is based on the mass of the system and the velocity squared.

2. Force = mx+b

m (Slope): -7.965 N/m

b (Y-Intercept): 7.591 N

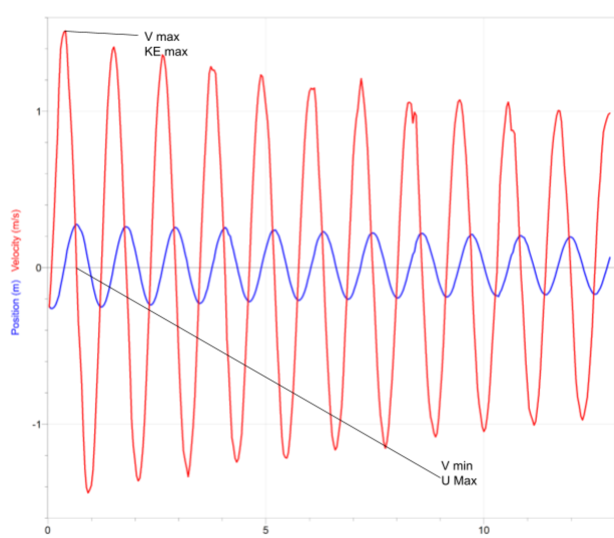
Correlation: -0.6982

RMSE: 0.07085 N

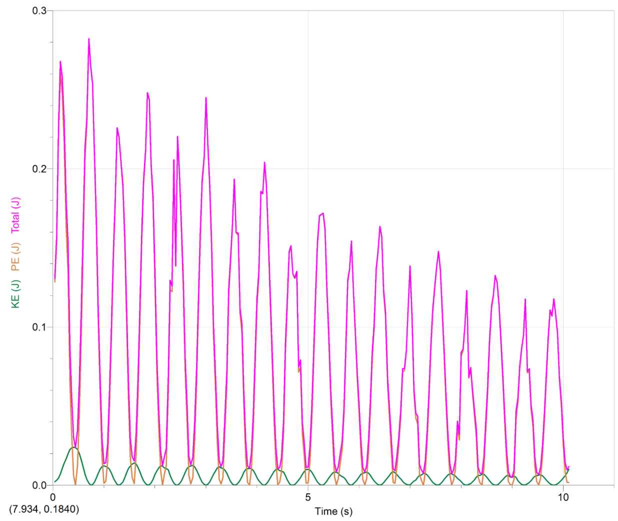
3. RMSE: 0.07085 N

4. The spring constant is the negative of the slope (from question 2). k = 7.965 N/m

5., 6.



7.



8. Manual Fit for: Latest | Total E = A*exp(-C*t)+B A: 0.1575 C: 0.09993 B: 0.009152

A is the initial energy

B is final energy in the system

C is energy loss due to friction

9. Logger pro says the RMSE is $\pm$ 0.07085 N. Given just how shaky my hands were, this uncertainty seems pretty low, although the algorithm for RMSE is relatively good at filtering outliers.

10. Linear Fit for: Latest | Force

Force = mx+b

m (Slope): -7.582 N/m

b (Y-Intercept): -0.05095 N

Correlation: -0.9978

RMSE: 0.05060 N

Linear Fit for: Latest | Force

Force = mx+b

m (Slope): -7.850 N/m

b (Y-Intercept): -0.1560 N

Correlation: -0.9969

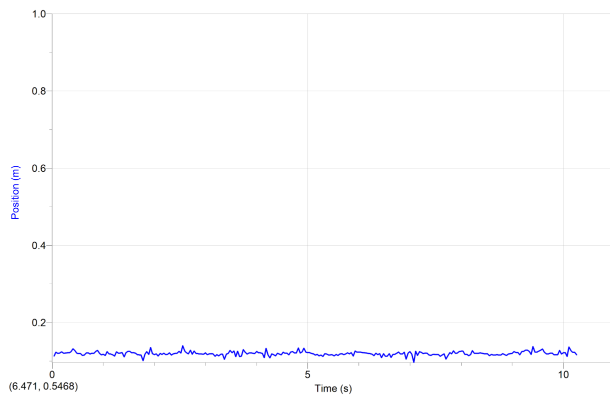
RMSE: 0.06398 N

Average relative uncertainty = $\boxed{0.00742}$

11.

$$Relative\ Uncertainty = \frac{\sqrt{((\frac{1}{3}(m_1+m_2)(\delta M))^2+((M+\frac{1}{3}(1+m_2)(\delta m_1))^2+((M+\frac{1}{3}(1+m_1)(\delta m_2))^2}}{M_t} = 0.0065$$

12.



13. Find the largest "blip", or random, sharp change in velocity, and divide that by the nearest maximum value.

14.

Relative uncertainty in Spring Constant	Relative uncertainty in Mass	Relative uncertainty in Displacement	Relative uncertainty in Velocity?
.0005N / 7.695N .000065	.05g\203.29g= ± 0.000246	0.005m/0.28m= 0.357	0.005 / 1.56 = 0.0032

Conclusions

1. The restoring force is in the opposite direction the spring is being stretched in. When you stretch the spring in the negative direction (compress it), the restoring force is much the same; in the opposite direction you're applying force to.

2. Yes, the derivative of a sinusoidal graph is a cosinusoidal graph, meaning it's 90 degrees out of sync. Both graphs were 90 degrees out of sync with each other.

3. The max amplitude of the U plot was much large than the K plot, however it functioned to be 90 degrees out of sync of the K plot, following $E = K + U$ correctly.

4. Over time they slowly lose amplitude, which is most likely cause by outside forces like friction and air resistance.

5. The mechanical energy here is being leeched out of the system as stated before.

6. 1: Energy lost as heat via friction, 2: Energy lost to the force of air resistance, 3: energy lost to vibrations in the springs, 4: Energy lost as it's imparted into the springs and down and out of the glider.

7. The K recording was much lower than the U recording. This is most likely due to inaccuracies in the sensor, issues in the software interpolating the points of data collected, kinetic energy being leeched from the system, and probably due to some unfamiliarity we had with the equipment and experiment. It took us about 10 minutes to figure out that rotating the motion sensor would fix the occurance of massive erroneous blips in the data.