Stefano Fochesatto PHYS 212 Lab#1

Uncertainty:

1. Find dx for the following equation.

$$x = \frac{2M_{p+b}}{m_b}\sqrt{y\Delta h}$$

- First find partial derivative for every variable.

$$\frac{\partial x}{\partial y} = \frac{M_{p+b}}{m_b}(\Delta h)^{1/2}(y)^{-1/2} \qquad \frac{\partial x}{\partial M_{p+b}} = \frac{2}{m_b}(\Delta h)^{1/2}(y)^{1/2}$$

$$\frac{\partial x}{\partial \Delta h} = \frac{M_{p+b}}{m_b}(\Delta h)^{-1/2}(y)^{1/2} \qquad \frac{\partial x}{\partial m_b} = \frac{-2M_{p+b}}{m_b^2}(\Delta h)^{1/2}(y)^{1/2}$$

- Apply Uncertainty formula.

$$dx = \left(\left(\frac{\partial x}{\partial y}\, y\right)^2 + \left(\frac{\partial x}{\partial \Delta h}\, \Delta h\right)^2 + \left(\frac{\partial x}{\partial M_{p+b}}\, M_{p+b}\right)^2 + \left(\frac{\partial x}{\partial m_b}\, m_b\right)^2\right)^{1/2}$$

2. Find ∂L for the following equation with C_w having negligable uncertainty.

$$L_f = \frac{c_w m_h + C_d}{m_{ice}}\left(T_h - T_f\right) + c_w\left(T_{ice} - T_f\right)$$

- Find the necissary partial derivatives.

$$\frac{\partial L}{\partial m_h} = \frac{C_w + C_d}{m_{ice}}\left(T_h - T_f\right) \qquad \frac{\partial L}{\partial m_{ice}} = \frac{-C_w m_h + C_d}{m_{ice}^2}\left(T_h - T_f\right)$$

$$\frac{\partial L}{\partial C_d} = \frac{C_w m_h + 1}{m_{ice}}\left(T_h - T_f\right) \qquad \frac{\partial L}{\partial T_h} = \frac{C_w m_h + C_d}{m_{ice}}$$

$$\frac{\partial L}{\partial T_f} = -\frac{C_w m_h + C_d}{m_{ice}} - C_w \qquad \frac{\partial L}{\partial T_{ice}} = C_w$$

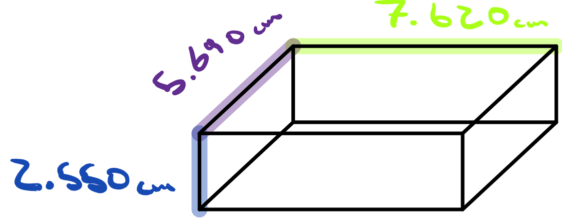
- Apply uncertainty formula.

$$\partial L = \left(\left(\frac{\partial L}{\partial m_h} m_h\right)^2 + \left(\frac{\partial L}{\partial C_d} C_d\right)^2 + \left(\frac{\partial L}{\partial T_f} T_f\right)^2 + \left(\frac{\partial L}{\partial m_{ice}} m_{ice}\right)^2 + \left(\frac{\partial L}{\partial T_h} T_h\right)^2 + \left(\frac{\partial L}{\partial T_{ice}} T_{ice}\right)^2\right)^{1/2}$$

Part 2: Calipers.

3. Measure the outer dimensions of the 1-2-3 block with calipers.

Measurements:



Note that for all measurements $\partial x = .0005$ cm.

4. Convert your measurements and uncertainty to inches and compare to the expected values.

	Measured	Converted	Expected
length	7.620 cm	3.000 in	3 in
width	5.690 cm	2.240 in	2 in
height	2.550 cm	1.003 in	1 in
∂x	.0005 cm	.00019 in	.0002 in

Just from looking at the table both the length and height fit inside the tolerance. However the width doesn't at all.

percent error calculation for width

$$12\% = \frac{|2.240 - 2.000|}{2.000} \cdot 100$$

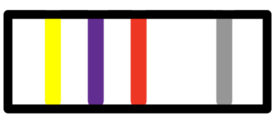
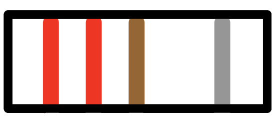
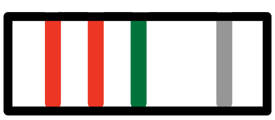
Part 3: DMM

5.) Measure the voltages of the batteries and compare it to the accepted values.

	Measured Values	Accepted Values
Large Battery	4.47 volts	6 volts
Small Battery	1.36 volts	1.5 volts
dx	.05 volts	

With our given tolerance of .05 volts neither battery reaches the accepted value. The batteries are dead.

6.) Measure each resistor. Are the measurements within the tolerance of the accepted value.

	Measured	Accepted
Resistor #1 	$4.12 \times 10^3 \, \Omega$ $\pm .05 \times 10^3 \, \Omega$	$4700 \, \Omega$ $\pm 470 \, \Omega$
Resistor #2 	$200 \, \Omega$ $\pm .05 \, \Omega$	$220 \, \Omega$ $\pm 22 \, \Omega$
Resistor #3 	$2.36 \times 10^6 \, \Omega$ $\pm .05 \times 10^6 \, \Omega$	$2{,}200{,}000 \, \Omega$ $\pm 220{,}000 \, \Omega$

At a quick glance we can see that resistors 2 and 3 fall within the manufacture tolerance. However resistor 1 does not fall into the manufacture tolerance

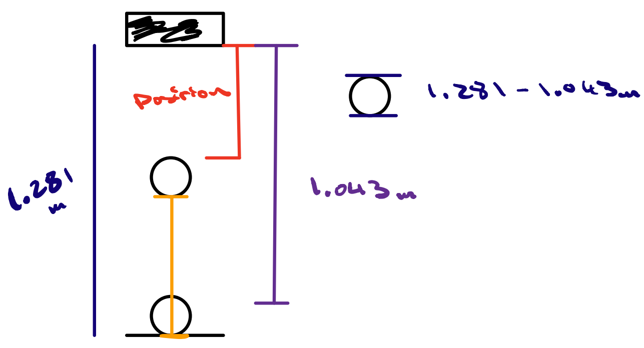
$$12.3\% = \frac{|4120 - 4700|}{4700} \times 100$$

Part 4: Lab quest + Basketball.

7. Measure the mass of the basket ball.

Mass of B-ball = 589.70 g ± .05 g

8. Experiment Results.

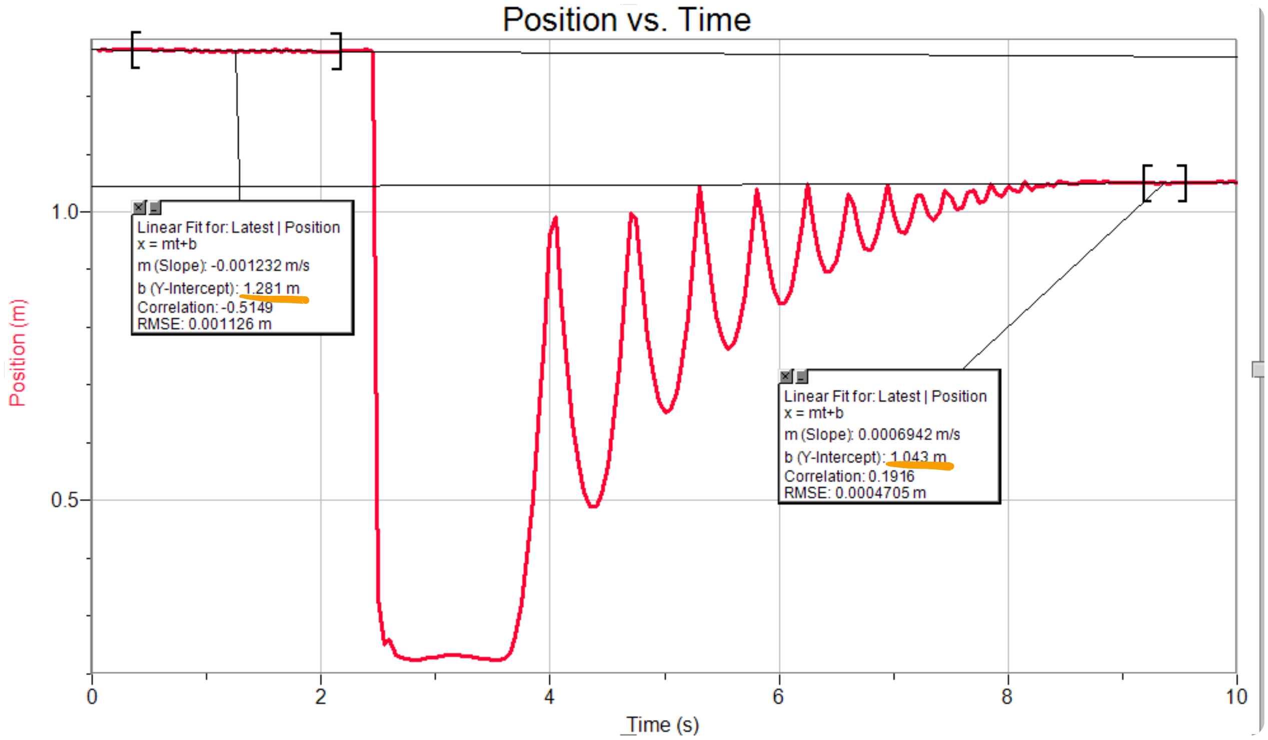


First Note that the expiriment data for positions results in a non-zero potential energy at the end of the expiriment.

= 1.281 - (Position + (1.281 - 1.043))

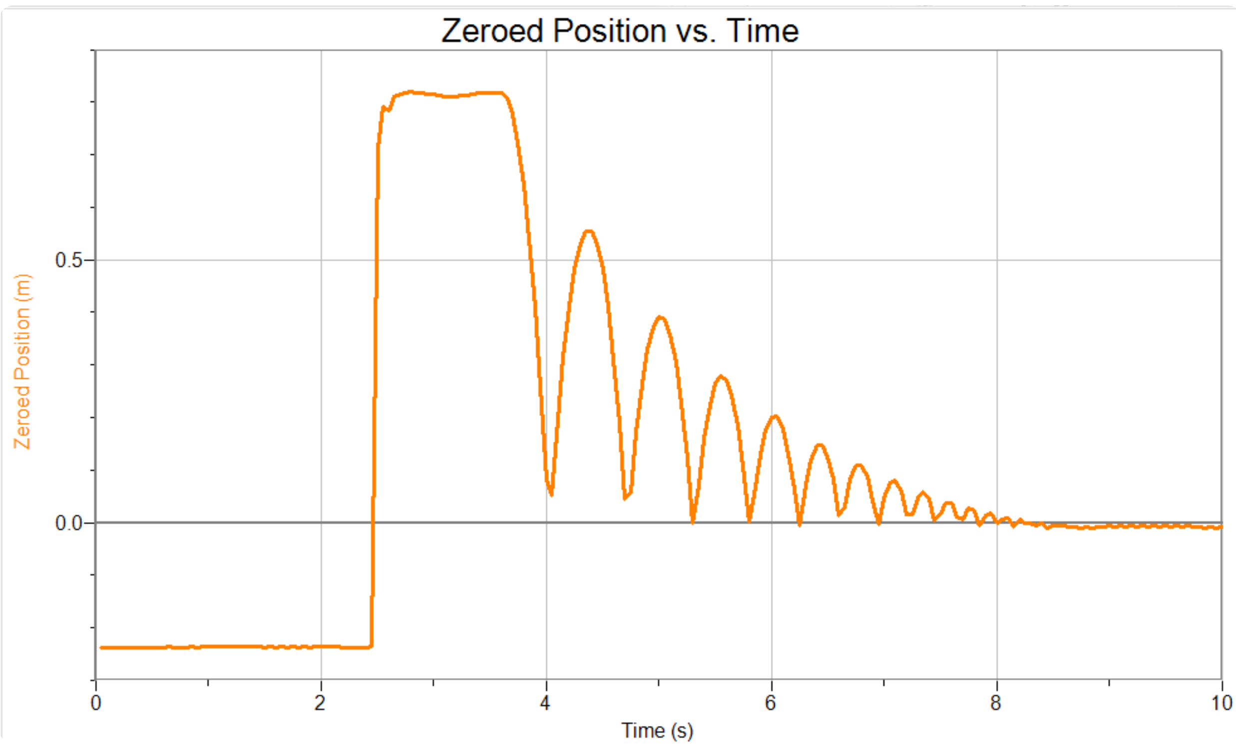
We measured Position, however we want the orange Position in order to zero the potential energy.

The following is the position vs time data, using linear fit data to find the values needed to find zeroed position

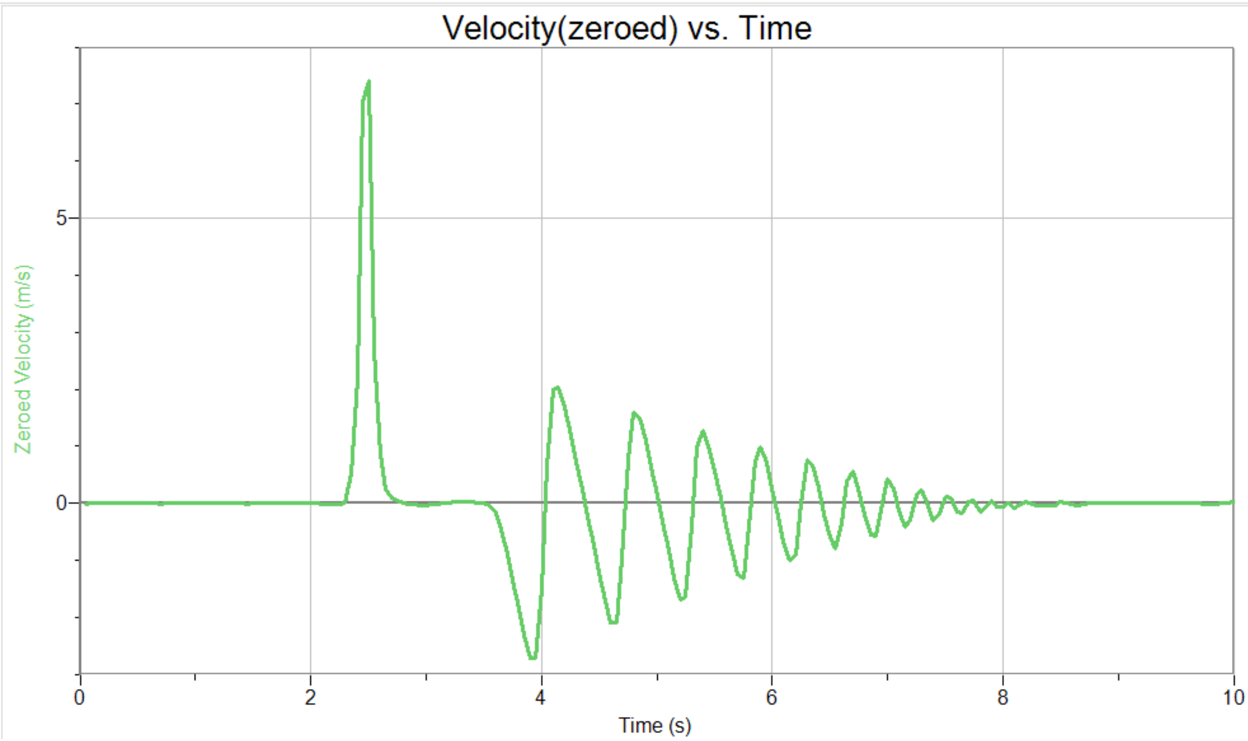


Using these values and the diagram from above to calculate.

Zeroed Position = 1.281-(Position+(1.281-1.043))



Calculating the velocity by differentiating the zeroed position.

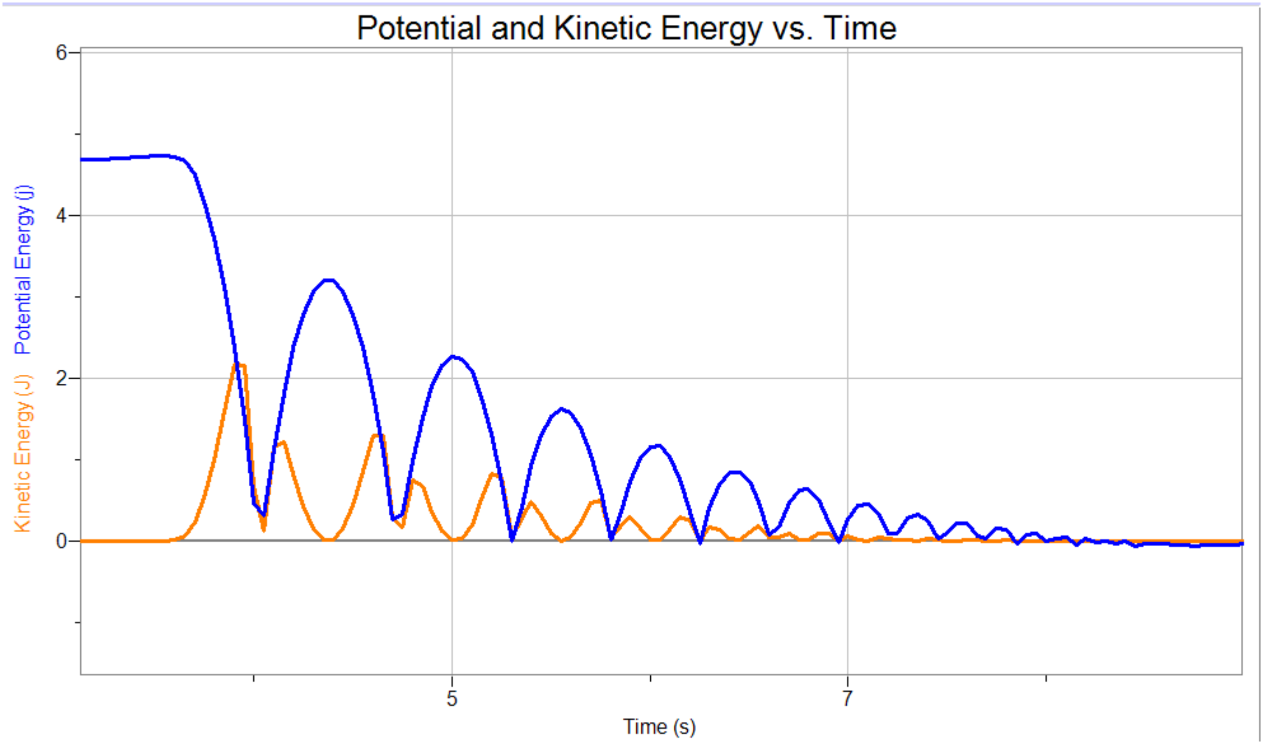


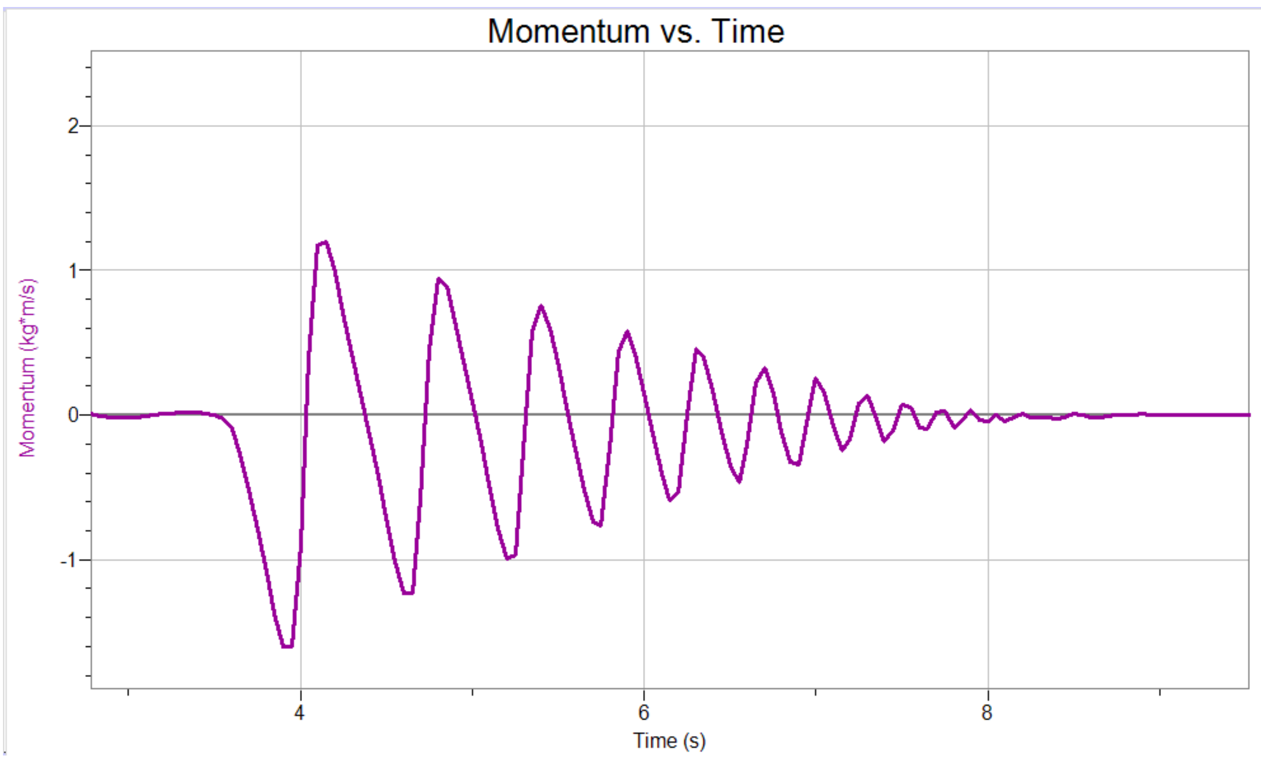
Finally with our velocity and position we can calculate potential energy, kinetic energy and momentum.

$$KE = \frac{1}{2} m v^2,$$

$$PE = mgh,$$

$$\text{Momentum} = mV.$$





Discussion:

The energy graph is exactly what we should expect. We see PE achieve a maximum where KE is a minimum. Slowly the total energy is decreasing since energy is being lost on the bounce. The momentum is also exactly what we should expect given the parabolic nature of the velocity.