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PHYSICS IA

Topic: Hooke’s Law

Question: Does Hooke’s’ Law apply to elastic bands?

Dependent Variable: The force on the rubber band

Independent Variable: The extension of the rubber band

Introduction:

This is an experiment to see if elastic bands follow the principles of Hooke’s law. Hooke’s Law is concept that was proposed by physicist Robert Hooke that states that for relatively small deformations in an object the length of its extension is proportionate to the deforming force. This experiment is commonly proven with common springs. A force mass is attached to the spring and extends the spring in a manner that is proportional to its mass. The equation to prove the effect of Hooke’s law is :

$$F = -kx$$

Where F represents the force exerted on the object, k is a constant value and x is the displacement.

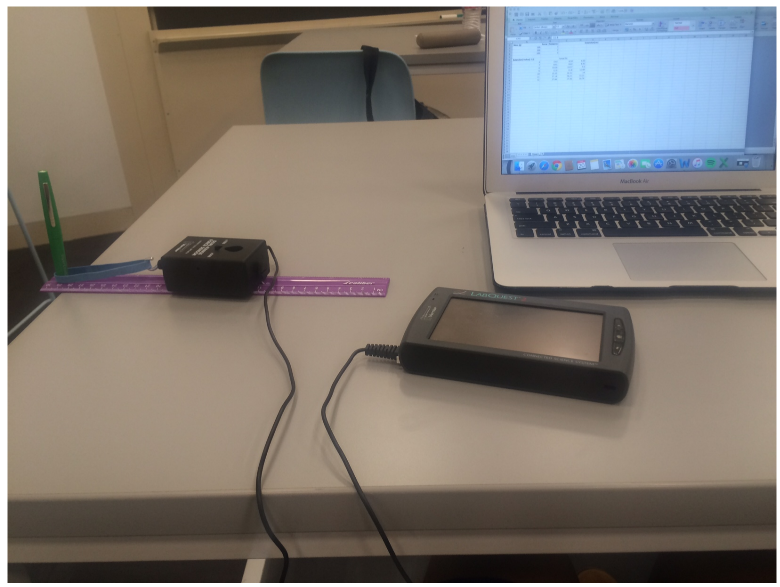
This experiment is going to inquire as to whether elastic bands act like springs and when the elastic limit of the bands are reached. Elastic bands are an essential part of everyday casual life for people across all age brackets. I am particularly interested in this concept because I am curious to the functionality of rubber bands as they are commonly used and multi functional.

Materials:

- A force meter
- Elastic bands 0.75 cm thick and 5.5 cm diameter
- Laptop
- Logger lite software
- Ruler
- Pen

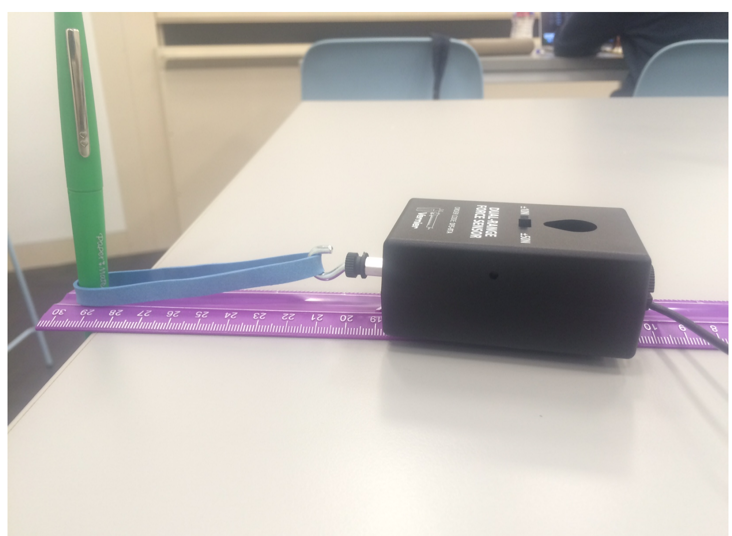
Procedure:

My set up used a pen at the end of a desk with a 30 cm ruler below; I attached the rubber band to the pen and attached the other side of the rubber band to the force meter.



A visual representation of my set up

1. I marked the part of the ruler where the rubber band and the pen start on the ruler calibration in order to make accurate calculation.

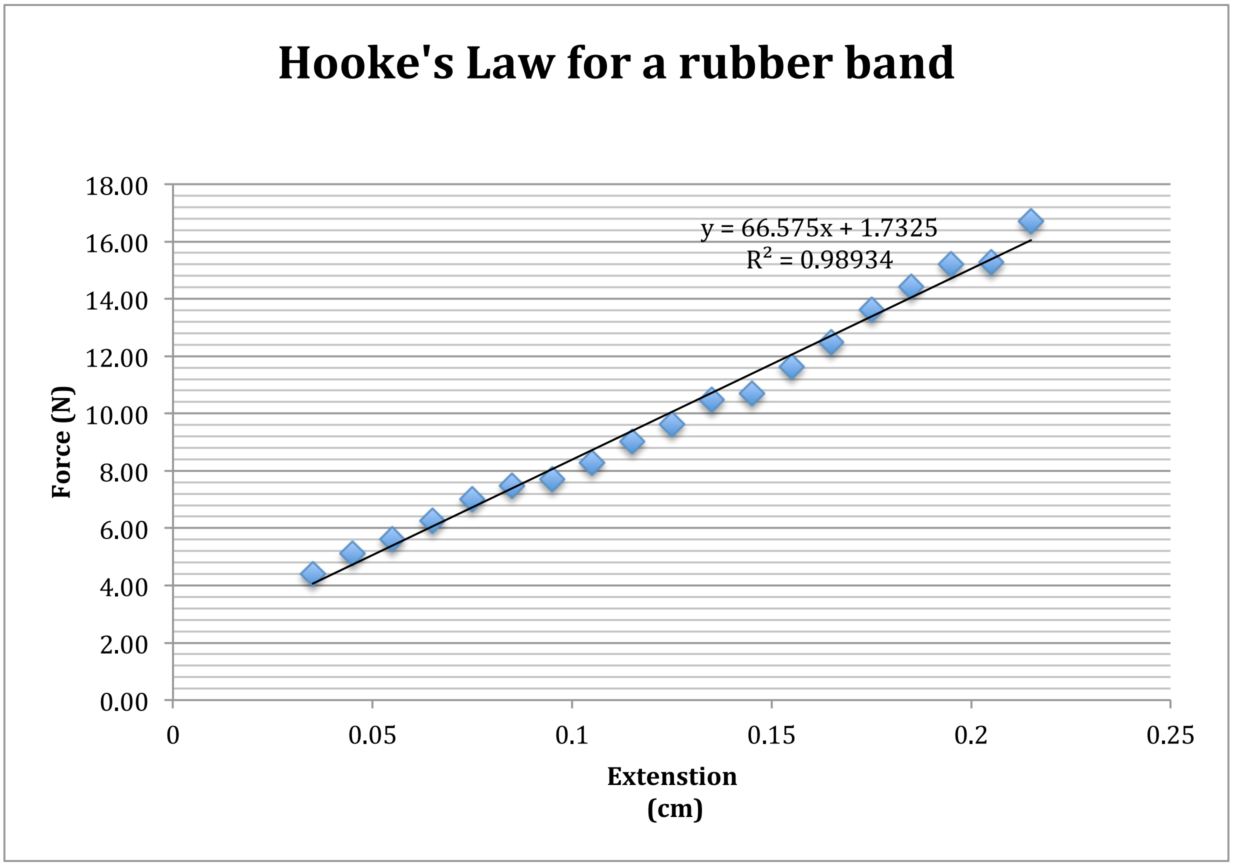


2. To reduce uncertainty I take note of the default force value on the force meter (0.23 Newton)
3. I extend the force meter to the nearest centimeter on the ruler and document the value shown on the force meter in Newton's.
4. I continue to do this until I reach the end of the ruler with 12 values recorded.
5. I repeat the experiment once again to reduce random error.
6. I calculated the average of the values obtained

Data and Calculation

Extension (m)	Force (N)		Average (N)
	-0.23 N		
0.035	4.51	4.28	4.40
0.045	5.23	5.00	5.12
0.055	5.72	5.49	5.61
0.065	6.38	6.15	6.27
0.075	7.12	6.89	7.01
0.085	7.60	7.37	7.49
0.095	7.81	7.58	7.70
0.105	8.40	8.17	8.29
0.115	9.14	8.91	9.03
0.125	9.74	9.51	9.63
0.135	10.60	10.37	10.49
0.145	10.82	10.59	10.71
0.155	11.74	11.51	11.63
0.165	12.59	12.36	12.48
0.175	13.73	13.50	13.62
0.185	14.54	14.31	14.43
0.195	15.33	15.10	15.22
0.205	15.40	15.17	15.29
0.215	16.82	16.59	16.71

Plotting the value of the extension against the value average force exerted on the rubber band the following graph was obtained:



In the equation:

$$y = 66.575x + 1.7325$$

66.575 is the calculated gradient which should be equivalent to k as the constant in the equation

$F = -kx$.

To prove the accuracy of the results I will pick two points on the graph

Extension: 0.0650 and 0.1550

$$F = -kx$$

F= 6.27

x= 6.50cm

$$6.27 = -k \times 0.0650$$

$$-k = \left|\frac{6.27}{0.0650}\right|$$

$$= 96.462$$

for F= 11.63

x= 0.1550

$$11.63 = -k \times 15.50$$

$$-k = \left|\frac{11.63}{0.1550}\right|$$

$$= 75.032$$

The negative value on k in the equation is not reflected on the calculation because the negative value only affects the vector quantity and not the scalar quantity, which is what is being calculated.

$$Average = \frac{(96.462 + 75.032)}{2}$$

Theoretical k = 85.747

Calculated k = 66.575

To calculate the percentage uncertainty of this procedure;

$$\frac{85.747 - 66.575}{66.575} \times 100$$

$$= 28.798\ \%$$

R in the graph indicates the degree of linearity of the graph with 1 being the most linear degree. The degree of the graph above is 0.98934 meaning it is highly linear.