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Physics H – Room 421 – Period 1

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Graphing Experimental Data

Objectives:

- To graph experimental data
- To interpret the data
- To develop relationships between the variables

Safety:

- General Lab Safety

Equipment:

- Hook's Law Apparatus
- coil spring
- rubber bands
- masses
- paper clip

Hypothesis: Both the measurements taken for the elongation of the spring and the elongation of the rubber band will be related to superimposed mass in a direct linear relationship.

Procedure:

1. The apparatus was inspected and the spring was hung from the support by the author.
2. The mirrored scale was adjusted so that the position of the pointer was at zero when the only load on the spring was the platform.
3. Weights of various masses were placed on the scale, and the elongation of the spring was measured and recorded. (see Data section Table 1) Readings were taken by looking strait on at the pointer, to eliminate as much parallax error as possible.
4. The procedure was repeated for the rubber band and data was recorded (see Data section Table 2)

Data and Calculations:

Table 1

Data Recorded, elongation of Spring

Superimposed mass* (g)	Elongation (cm)
40	0.65
80	1.60
120	2.62
160	3.64
200	4.70
240	5.65

Table 2

Data Recorded, elongation of rubber band

Superimposed mass* (g)	Elongation (cm)
30	0.30
60	0.60
90	0.95
120	1.35
150	2.55
180	3.45

Mass of the platform: 5g

Calculations:

Analysis and Conclusions:

The relationship between the stretch of the spring and the applied mass in Graph 1 is linear. From Graph 1, three data points which are on the line of best fit which were not measured are as follows.

Superimposed mass* (g)	Elongation (cm)
170	3.80
220	5.20
270	6.40

$$Slope = \frac{rise}{run} \qquad Slope = \frac{6.4\text{cm} - (-.2\,cm)}{270\text{g} - 0\text{g}} = \frac{6.8\text{cm}}{270\text{g}} \approx .025\frac{g}{cm}$$

Therefore the equation for the elongation of the spring would be as follows:

$$y_{(\text{elongation in cm})} = .025\frac{g}{cm}x_{(\text{mass applied in g})} - .2\,cm$$

The elongation for the three selected masses, calculated by the derived equation, would then be as follows.

Superimposed mass* (g)	Elongation (cm)
170	4.05
220	5.30
270	6.55

These calculated elongations are slightly higher than those approximated by reading off the graph. This may be due to error and will be discussed later.

The relationship between the stretch of the rubber band and the applied mass in Graph 2 is exponential. From Graph 2, three data points which are on the curve of best fit which were not measured are as follows.

Superimposed mass* (g)	Elongation (cm)
110	1.30
140	2.20
170	3.10

An equation to predict the elongation of the rubber band for any mass applied to it would be as follows:

$$y(\text{elongation in cm}) = \frac{1\text{cm}}{10000\text{g}^2} x(\text{mass applied in g})^2$$

This equation was obtained by straightening the graph and estimating the slope of the resulting graph, and then squaring that slope. Using the derived equation to calculate elongation, the elongation for the three masses would be as follows.

Superimposed mass* (g)	Elongation (cm)
110	1.21
140	1.96
170	2.89

These values are slightly lower, which may be due to the estimation when deriving the equation, or the possible sources of error.

The error between the values obtained by using the derived equations don't exceed more than .3cm in either direction. This error is within acceptable limits because the limitations of the lab environment did not allow measurements to be more precise. There are many different possible sources for error in this experiment. The observer recording the observations may have been at an angle to horizontal while taking readings, which would have skewed the readings. Since horizontal was estimated by the observer, there was no precise way of knowing the right angle. Also, the weight of the platform (5g) may have been a source of error. The weight of the platform, if used in calculations, would have shifted the graphs over by 5g. Another possible source of error is the angle of the pointer. The pointed was observed to have slight variation in angle, depending on which way the platform was turned. This variation could have also changed readings.

In conclusion, the objectives of graphing experimental data, interpreting the data, and developing relationships between the data was met. The hypothesis was proven incorrect. Although the relationship between the elongation of the spring and the superimposed mass was linear, the relationship between the elongation of the rubber band and the superimposed mass was not. This shows that Hooke's Law does not apply to rubber, as in the case of the rubber band.