Writing style for reporting the results of a physics experiment

This document gives you a basic idea of the writing style that is expected. The subject of this report is very simple (stretching a spring). The ph315 lab is more complicated than this. Every experiment is different, so every lab report is different. Do not treat this example report as a cookie-cutter template. Check the grading rubric for the PH315 lab for a detailed list of what you are expected to include in your own report.

Establishing a quantitative model for the displacement of a spring

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Introduction

The goal of this experiment is to find a quantitative model that accurately predicts how much a spring will stretch when it is pulled by a known force.

Procedure:

The spring of interest was hung vertically with a mass hanger attached to the lower end of the spring. A mass m, ranging from 1 g to 140 g was added to the mass hanger (see Figure 1). As the mass increased, the downward force on the end of the spring increased a known amount

$$F_{\text{down}} = mg,$$

where $g = 9.8\ \text{ms}^{-2}$ is the gravitational acceleration constant. The change in location of the end of the spring, Δy, was measured after the mass came to rest.

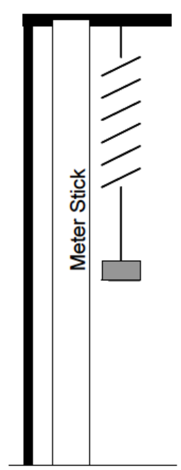

Figure 1. Schematic of the procedure.

There is some uncertainty in the measured variables. Displacement was measured using a meter stick. When reading the meter stick, effort was made to sight the measurement directly, so that a horizontal line would connect the bottom of the mass hanger to the reading on the meter stick. We tried to keep the mass hanger perfectly flat. We estimate that the uncertainty in y-position is approximately 0.05 cm. The mass values were labeled. We did not have a method for calibrating/verifying the mass, therefore, the uncertainty in *m* is unknown.

Results

Table 1 summarizes the 44 measurements that we made. The trial-to-trial variation was minimal (about 0.05 cm), which is consistent with our estimated uncertainty for the displacement measurement technique.

Table 1

Position	Mass (g)	Location of the Mass Hanger Reference in cm ±0.05cm			
		Trial 1	Trial2	Trial 3	Trial 4
Reference	0	69.55	69.50	69.50	69.50
1	1	69.27	69.19	69.18	69.17
2	3	68.61	68.50	68.53	68.52
3	5	67.95	67.87	67.88	67.86
4	10	66.42	66.20	66.21	66.20
5	20	62.90	62.89	62.90	62.93
6	40	56.32	56.22	56.30	56.23
7	60	49.65	49.60	49.61	49.6
8	80	42.97	42.97	42.95	42.95
9	100	36.32	36.30	36.32	36.32
10	120	29.63	29.70	29.72	29.72
11	140	23.07	23.05	23.10	23.12

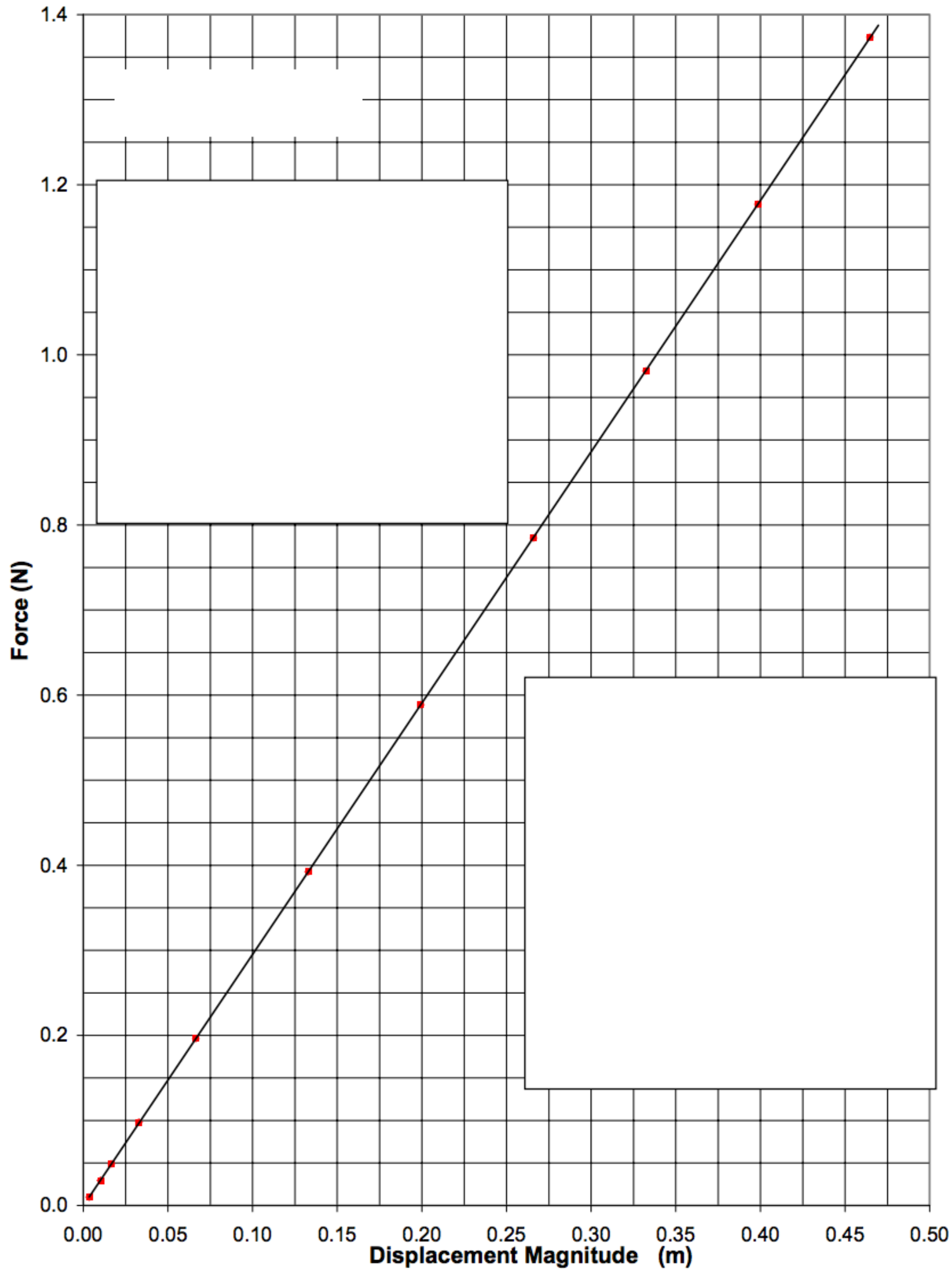

Figure 2. A plot of the downward force on the spring (mg) as a function of the displacement of the spring, Δy.

Figure 2 shows a graph of mg vs. Δy. We found that the experimental results can be fit with a straight line

$$mg = k|\Delta y|. \qquad (1)$$

The only fitting parameter is the constant of proportionality, k. We get the best fit (smallest sum of squared residuals) when we set $k = 2.95$ N/m. Each experimental data point is within 0.01 N of the fit line (see Figure 2). The sum of these squared residual is 2×10^{-4} N^2. We considered fitting the data with other functional forms (such as a 2^{nd} order polynomial or exponential), but these functions did not reduce the sum of squared residuals.

We estimate the standard uncertainty in k is approximately 0.02 N/m. We made this uncertainty estimate based on the root mean squared residual value (0.01 N) and the range of vertical displacements (0.5 m).

While the uncertainty in the mass values is unknown, the excellent fit between Eqn. 1 and the experimental data suggests that the nominal mass values are actually very accurate.

Conclusion

A linear relationship between force and displacement describes our experimental system very well. This linear relationship was valid for $\Delta y = 0$ to 0.5 m. We did not test displacements above 0.5 m. We conclude that this simple quantitative model (Equation 1) can accurately predict how much this spring will stretch when it is loaded with a known force.