Spring Force Activity

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1 Experimental Setup

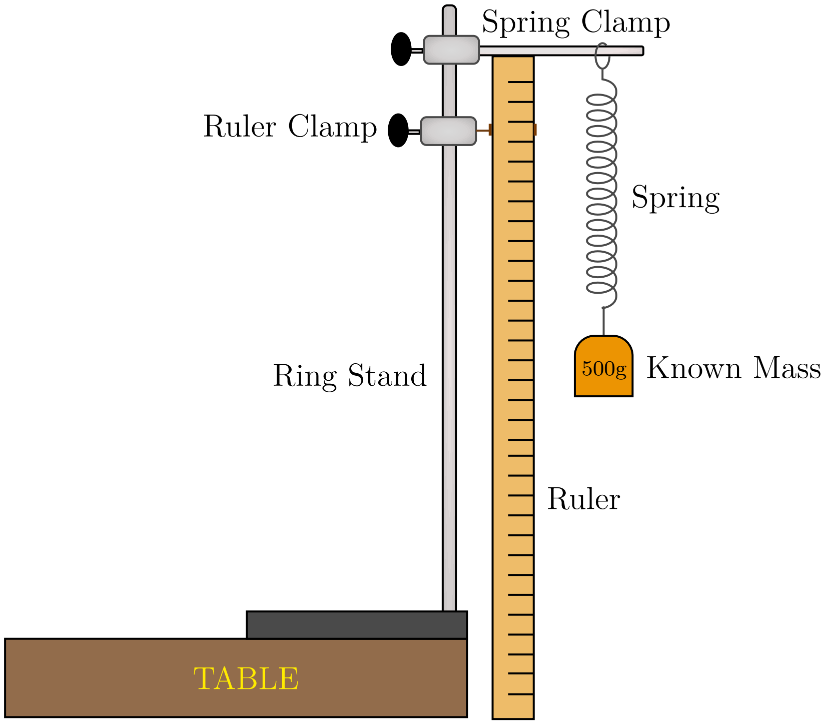


Figure 1: Setup Diagram

The figure above displays the setup used for the activity. To calculate displacement, first the length of the springs at equilibrium were measured and noted. Next, when masses were added to the springs, the length of the springs were measured with the ruler where only the length of the coil was measured and not including the rings. Lastly, to calculate displacement, the spring length at equilibrium was subtracted from the stretched spring length.

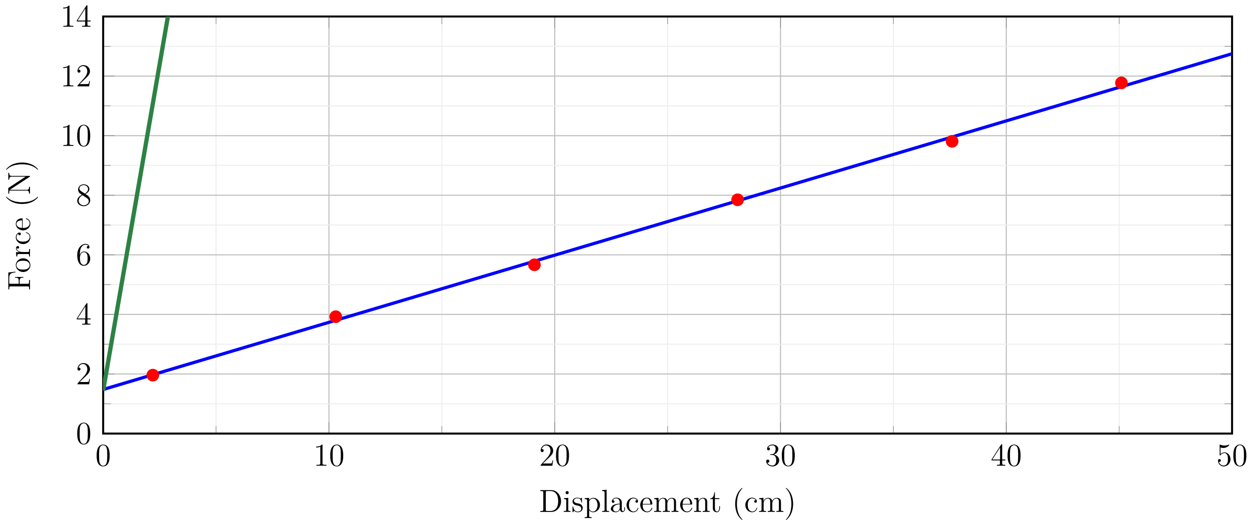
2 Observations

Table 1: Force and Displacement Data for Two Springs

Mass (kg)	**Force (N)**	**Spring A Displacement (cm)**	**Spring B Displacement (cm)**
0.20	1.96	2.20	0.270
0.40	3.92	10.3	0.450
0.60	5.67	19.1	0.920
0.80	7.85	28.1	1.43
1.0	9.81	37.6	1.91
1.2	11.8	45.1	2.40

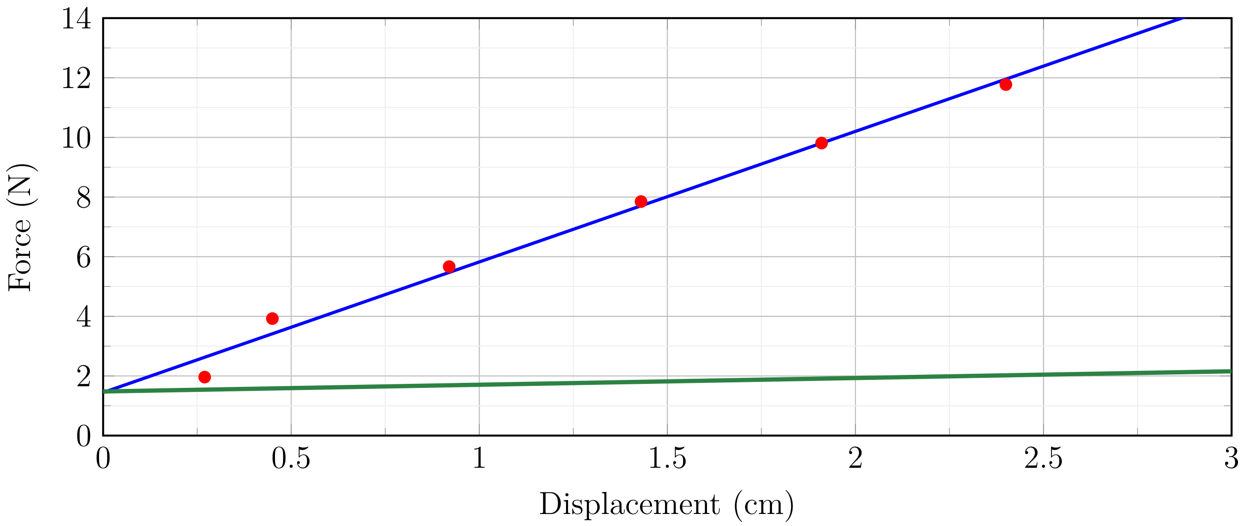
3 Analysis

Figure 2: Force Vs. Displacement for Spring A*



⋆ *Blue line represents Spring A and green line represents Spring B*

Figure 3: Force Vs. Displacement for Spring B*



⋆ *Blue line represents Spring B and green line represents Spring A*

1. Calculating Slope of Each Graph:

(a) Spring A

The trendline's equation for Spring A is: $\boldsymbol{y = 0.225x + 1.48}$

$\therefore$ The slope of the trendline is 0.225.

(b) Spring B

The trendline's equation for Spring B is: $\boldsymbol{y = 4.38x + 1.44}$

$\therefore$ The slope of the trendline is 4.38.

2. **Relationship Between Force and Displacement:**

   There is a linear relationship between force and displacement, where force is directly proportional to displacement ($F \propto \Delta d$).

3. **Physical Quantity the Slope Represents:**

   The slope represents the spring constant, which physically determines the stiffness of the spring. The two springs have different slope values because each spring has a different spring constant, where a higher slope value represents a stiffer spring. This holds true because Spring B has a larger slope than Spring A, meaning it should be more stiff, evident through Spring B's smaller displacement values than Spring A.

4. **Equation of Line from Proportionality Statement:**

   Let k represent the slope of the line.

   Let x represent the displacement (Δd) of the spring from equilibrium.

$$F \propto x$$

$$\boldsymbol{F = kx}$$

5. **Properties of an "Ideal Spring":**

   The properties of an ideal spring are that it is frictionless and massless. Additionally, an ideal spring should obey Hooke's Law which states that the force exerted by the spring is proportional to the displacement of the spring from its relaxed position. The springs used in class for the activity are not examples of ideal springs as they have mass and friction to some degree. Also, the springs do not perfectly obey Hooke's Law as the data points are not perfectly linear or have the y-intercept of the trendline at $y = 0$. Ideal springs exist in theory to simplify calculations while providing acceptable accuracy for practical problems.