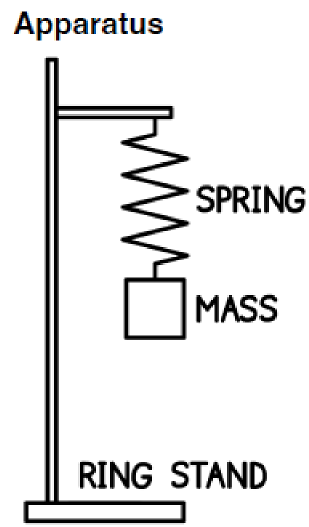
Hooke's Law Lab

Objective Determine the spring constant of a spring **Equipment** spring or rubber band ring stand ruler or meter stick hooked weights



Experimental Method

1) Construct the apparatus above.

2) Hang a mass on the spring and allow the mass to come to rest. Measure the stretched length of the spring.

3) Complete the table by measuring the spring length for ten different masses.

Mass (kg)	Spring Length (m)

Analysis

1. Plot the spring length (on the vertical axis) as a function of the mass (on the horizontal axis). Include a best fit line.

2. Determine the $slope = \frac{rise}{run}$ of the line of best fit. Clearly mark the points on the line that you used to calculate the slope (e.g. with an $\times$). Be sure to include units.

3. Determine the equation of your best fit line $\left(y = \frac{rise}{run}x + y_{int}\right)$. Write the equation with appropriate variables for x and y.

4. Solve the equation for *m, mass*.

5. What physical quantity does the y-intercept represent?

6. Use the slope of the best fit line to determine the spring constant of the spring. *Hint:* $k = \frac{1}{slope}$.

Discussion

1. **Did your results show a straight-line relationship between mass and spring length?** Use your graph to explain whether the spring followed Hooke's Law.

2. **What does the slope of your best-fit line tell you about the spring?** Explain what the slope says about how much the spring stretches when you add more mass.

3. **What does the y-intercept on your graph represent in this experiment?** Why is the spring not at zero length when no mass is attached?

4. **Is your spring considered "stiff" or "stretchy"?** Use your calculated spring constant $k$to justify your answer.

5. **What are two things that could have made your measurements less accurate?** For each one, explain whether it would make your calculated $k$value too big or too small, and why.

6. **Did every point lie perfectly on your best-fit line?** Explain why real experimental data is rarely perfect even when the physics law is correct.

7. **If you could redo the experiment, what change would most improve accuracy?** Explain how your change would reduce measurement error.

8. **What would happen if you continued adding more and more mass to the spring?** Would the extension keep increasing in a straight-line pattern forever? Explain using the idea of the spring's *elastic limit*.

More Hooke's Law

1. A vertical spring system holds a **0.40 kg** mass. Spring A ($k = 320$ N/m) and Spring B ($k = 480$ N/m) are in **parallel** (both attached to the same support). How much does each spring stretch in equilibrium?

2. Two springs in **series** support a **1.2 kg** mass in a vertical arrangement: $k_1 = 150$ N/m, natural length $= 18$ cm, $k_2 = 250$ N/m, natural length $= 22$ cm. How much is each spring stretched in equilibrium, and what is the final total length?

3. A **0.85 kg** mass hangs between **two springs (one above and one below)**: Top spring: $k = 420$ N/m, Bottom spring: $k = 330$ N/m. Both springs stretch from equilibrium until forces balance. Determine the extension of each spring.

4. A **0.60 kg** mass sits on a **horizontal frictionless** surface between two different springs attached to walls: Left: $k_1 = 160$ N/m, Right: $k_2 = 340$ N/m. The mass is displaced **9.0 cm left** from its equilibrium and released. At that instant, how much is **each spring** stretched or compressed?

5. A **4.5 kg** block on a frictionless surface is attached to **two springs in parallel**: $k_1 = 200$ N/m, $k_2 = 150$ N/m. The block is pushed **7.0 cm right** and released. Find the acceleration at the instant of release.

6. A **7.0 kg** block is attached to **two springs in series**: $k_1 = 260$ N/m, $k_2 = 390$ N/m. The block is pulled **12 cm from equilibrium** and released on a **horizontal surface with friction** $\mu = 0.22$. Determine whether the block starts moving, and if so, find the acceleration at release.

7. A **5.2 kg** block sits between **two different springs** (each attached to a wall): $k_1 = 300$ N/m on the left, $k_2 = 500$ N/m on the right. The block is pushed **10 cm toward the left** and released on a **rough surface (**$\mu = 0.18$**)**. Find the net force and the acceleration at the instant of release.

8. A **2.8 kg** block is attached to **three springs**: Left side: spring $k_1 = 120$ N/m, Right side: springs $k_2 = 200$ N/mand $k_3 = 450$ N/m**in parallel**. The block is pulled **14 cm right** on a **surface with friction** $\mu = 0.25$and released. Find the acceleration at the instant of release.