Lab 1
Harmonic Oscillator

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Feedback on Quiz #1

- Presentation of Data (for grading clarity)
  - Make your information **easy to read and interpret**.
  - Use **clear labels** on all data tables, graphs, and calculated values.
  - **Reduce clutter** by including only the required information.
  - Be sure to include **both the data and the graphs**.
  - When reporting a calculated value, include the **uncertainty** and clearly label both the value and its uncertainty.
- *My goal is to give you the tools you need to analyze data, teach you how to use those tools, and help you learn to present results clearly.*

Harmonic Oscillator

- Fundamental concept in physics
  - Simple harmonic oscillator
    - Mass-spring system
    - Simple pendulum
    - LC circuits
    - Vibration of atoms in a crystal lattice
  - Damped harmonic oscillator
    - Car shock absorbers
    - Seismograph
  - Driven harmonic oscillator
    - Child on a swing
    - Microwave cavity or laser resonator

Spring-Mass System

- $\vec{F_s} = -\vec{k}\{x\}$
- $\vec{F_s}$ is the spring force. It is a restoring force in the opposite direction from the displacement
- $\vec{k}$ is the spring constant. It relates the force to the displacement.
- x is the displacement
- If we plot F vs. x, we can obtain k from the **slope of the graph.**

More than 1 spring

- If we have more than 1 spring, they can be arranged in either a **series** or **parallel** configuration
- If we know the spring constants for the individual springs, we can calculate the equivalent spring constant, k_{eq}, for the system
  - Parallel: $k_{eq} = k_1 + k_2$
  - Series: $\frac{1}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2}$
- We can graph the data from a series or parallel configuration to find k_{eq} **experimentally** and compare to the **theoretical** or calculated value using the equations above

Dynamic Behavior

- If we displace the mass from its equilibrium position, it will **oscillate** around the equilibrium position
- We can measure the time the oscillations take and use that to calculate the spring constant:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

- If we measure the period for several different masses and plot the **period squared** vs. the **mass**, we can use the **slope** of the line to determine the spring constant:

$$T^2 = 2\pi\frac{m}{k}, \quad slope = \frac{2\pi}{k}$$