Name: ____________ Date: ____________ Period: ____________

LAB DAY 1: MASS-SPRING OSCILLATIONS

PURPOSE

Measure the period of oscillation for a spring-mass system at different masses. Use linearization to determine the spring constant k and verify the theoretical relationship between period and mass.

THEORY

PERIOD-MASS RELATIONSHIP

$$T = 2\pi\sqrt{\frac{m}{k}} \quad \Rightarrow \quad T^2 = \frac{4\pi^2}{k} \cdot m$$

Interpretation: A graph of T^2 vs m is linear with slope = $4\pi^2/k$, so $k = 4\pi^2/\text{slope}$.

EQUIPMENT

- Spring (hanging vertical)
- Masses: 50g, 100g, 150g, 200g, 250g, 300g
- Stopwatch or photogate timer
- Meter stick or ruler
- Ring stand & clamp

PROCEDURE

Setup: Mount spring vertically. Let system reach rest.

For each mass: Pull down gently (~1.5 cm), release. Time **10 complete oscillations**. Record to 0.01 s. Repeat 3 trials. Rest spring between trials.

Amplitude constraint: Keep amplitude < 2 cm (small-angle approx.).

⚠ **Safety & Technique:** Keep masses away from toes. Use gentle small amplitude. Do **not** stretch spring beyond elastic limit. If time measurement shows $T > 2$ s, recheck your count.

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DATA COLLECTION & PROCESSING

MEASUREMENTS (TIME FOR 10 OSCILLATIONS IN SECONDS)

Mass (kg)	Trial 1 (10T)	Trial 2 (10T)	Trial 3 (10T)	*T*_avg (s)	*T*² (s²)
0.050					
0.100					
0.150					
0.200					
0.250					
0.300					
0.350					

SAMPLE CALCULATION

Example: If 10T = 3.47 s, 3.52 s, 3.48 s for mass 0.300 kg:

$$T_{\text{avg}} = \frac{3.47 + 3.52 + 3.48}{3 \times 10} = \frac{10.47}{30} = 0.349 \text{ s}$$

$$T^2 = (0.349)^2 = 0.122 \text{ s}^2$$

Note: Divide sum by 3, then by 10 to get single-oscillation period.

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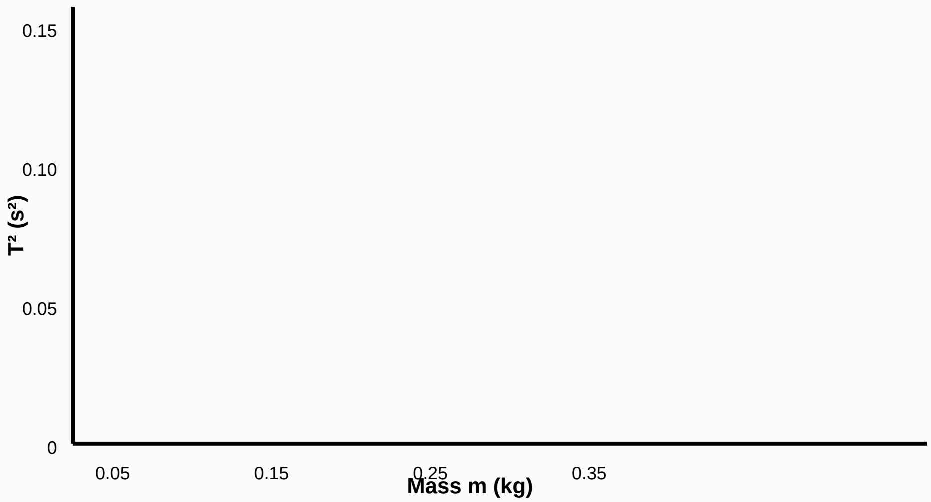
LINEARIZATION GRAPH

PLOT T^2 VS MASS

Instructions: Plot each (m, T^2) point from your data table. Draw the best-fit line that starts near the origin.



ANALYSIS

Q1 Calculate slope from your best-fit line

Select two points on your line. Slope = $\Delta T^2/\Delta m$

Slope = ______ s^2/kg

Q2 Extract spring constant k

Use: Slope = $4\pi^2/k$, so $k = 4\pi^2/\text{Slope}$

k = ______ N/m

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ANALYSIS & REFLECTION

Q3 Does your line pass through the origin (0, 0)?

If not, what physical effect might cause this offset?

Q4 Static spring constant verification

Hang a known mass (e.g., 200 g), measure stretch Δx. Use $k = mg/\Delta x$.

k_static = ______ N/m

Q5 Percent error

% Error = |k_dynamic − k_static| / k_static × 100%

Q6 Assumptions & Sources of Error

List 2–3 assumptions you made. Which are most likely violated?

Q7 Conceptual: If you doubled every mass, would the slope change?

Explain using the linearized equation.

Clean-up: Return all masses and equipment to station. Tomorrow we measure periods of pendulums using the same linearization technique!