MASS-SPRING OSCILLATOR

Period, force, phase relationships, and energy exchange

Name: _____	Period: _____	Date: _____

INVESTIGATION QUESTION **How do mass, spring constant, and amplitude affect simple harmonic motion?**

TIME 30 minutes	SIMULATION BuildPhysics > Mass-spring oscillator	UNIT 7 Oscillations

Learning targets

- Test how oscillator mass affects the period.
- Connect spring force and acceleration to displacement.
- Compare kinetic and spring potential energy during a cycle.

Model before you measure

The preset uses a horizontal spring with gravity turned off. Displacement x is measured from equilibrium.	$F_s = -kx$ $a = -(k/m)x$ $T = 2\pi\sqrt{(m/k)}$

Important: The baseline preset uses m = 1.0 kg and k = 8.0 N/m. Reset before every trial and time several complete cycles.

Pre-lab prediction | 4 minutes

1. If oscillator mass quadruples, by what factor should the period change?

_____

2. At maximum displacement, predict the velocity, acceleration magnitude, and spring energy.

_____

3. Predict whether changing amplitude changes the ideal period.

_____

PART A Change oscillator mass

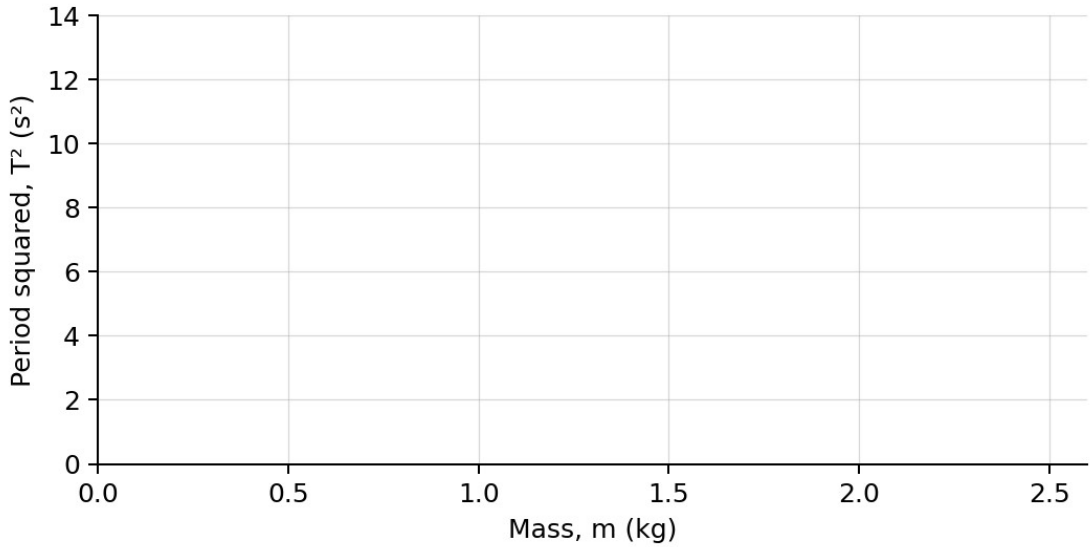
Setup | 3 minutes

- ☐ Load Mass-spring oscillator. Confirm gravity is off and record the spring constant k.
- ☐ Use the same initial extension from equilibrium in every Part A trial.
- ☐ Set each listed mass, reset, and run five complete cycles.
- ☐ Record total time, calculate T and T^2, and observe the x, v_x, and a_x graphs.

Consistent amplitude: After changing mass, return the oscillator to the same starting displacement before resetting and running.

Data table | 10 minutes

Mass m (kg)	Time for 5 cycles (s)	Measured T (s)	T^2 (s^2)	Predicted T (s)	Maximum speed (m/s)
0.50					
1.00					
1.50					
2.00					
2.50					



4. Plot T^2 versus mass. Draw a best-fit line.

PART B Change starting amplitude

Amplitude and energy test | 7 minutes

Fixed inputs: Use m = 1.0 kg and k = 8.0 N/m. Change only the initial displacement magnitude A.

Amplitude A (m)	Measured period T (s)	Maximum speed (m/s)	Maximum spring energy (J)	Maximum kinetic energy (J)
0.50				
0.75				
1.00				
1.25				

Analysis | 7 minutes

5. What should the slope of the T^2-versus-m graph equal? Compare with $4\pi^2/k$.

6. How did increasing mass affect period and maximum speed at fixed amplitude?

7. How did changing amplitude affect period, maximum speed, and total energy?

8. Describe the phase relationships among x, v_x, a_x, spring force, kinetic energy, and spring energy.

Claim-Evidence-Reasoning conclusion

Evaluate this claim: At equilibrium, the oscillator has zero net force because its speed is greatest.

CLAIM	Accept, reject, or revise the statement.
EVIDENCE	Cite at least two measured trials or graph features.
REASONING	Use the force, acceleration, velocity, and energy graphs at equilibrium and turning points.

Exit ticket

A spring constant is increased from k to 4k while mass stays fixed. Predict the new period relative to the original.