Simple Harmonic Motion Equations Worksheet

Level: A-Level / AP Physics 1 / IB HL | Difficulty: Advanced | Topic: Mechanics

Practice simple harmonic motion with 10 problems on period and frequency of pendulums and mass-spring systems, plus displacement, velocity, and energy in SHM.

Equations you will need

T = 2pi?(m/k)	Period of mass-spring system
T = 2pi?(L/g)	Period of simple pendulum
x = A cos(?t)	Displacement (starting at max)
v_max = ?A	Maximum velocity
a_max = ?^2A	Maximum acceleration
E = 1/2kA^2	Total energy in SHM
? = 2pi/T = 2pif	Angular frequency

Symbol key

Symbol	Quantity	Unit
T	period	s
f	frequency	Hz
m	mass	kg
k	spring constant	N/m
L	pendulum length	m
A	amplitude	m
?	angular frequency	rad/s
x	displacement	m

Practice problems

1. A 0.5 kg mass on a spring with k = 200 N/m. Find the period.

2. Find the period of a 1.5 m pendulum. (g = 9.8 m/s^2)

3. A spring oscillates at 2 Hz with amplitude 0.05 m. Find max velocity.

4. Find the spring constant if a 2 kg mass oscillates with period 0.6 s.

5. A pendulum has period 2 s on Earth. Find its period on the Moon (g_M = 1.62 m/s^2).

6. Mass-spring system: m = 1 kg, k = 100 N/m, A = 0.1 m. Find total energy.

7. Find max acceleration for a 0.05 m amplitude oscillation at 5 Hz.

8. A mass on a spring has period 0.4 s. Find ?.

9. A 0.2 kg mass on a spring oscillates with v_max = 1.2 m/s and A = 0.06 m. Find k.

10. Pendulum length needed for period of exactly 1 s? (g = 9.8 m/s^2)

Answer key

Full worked solutions for each problem.

1. T = 2pi?(0.5/200) = 0.314 s
2. T = 2pi?(1.5/9.8) = 2.46 s
3. ? = 4pi; v_max = (4pi)(0.05) = 0.628 m/s
4. k = m(2pi/T)^2 = 2(2pi/0.6)^2 = 219 N/m
5. T_M/T_E = ?(g_E/g_M); T_M = 2 x ?(9.8/1.62) = 4.92 s
6. E = 1/2kA^2 = 1/2(100)(0.01) = 0.5 J
7. ? = 10pi; a_max = (10pi)^2(0.05) = 49.3 m/s^2
8. ? = 2pi/0.4 = 15.7 rad/s
9. ? = v_max/A = 20; k = m?^2 = 0.2(400) = 80 N/m
10. L = g(T/2pi)^2 = 9.8(1/2pi)^2 = 0.248 m