

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

$T = 2\pi\sqrt{m/k}$	Period of mass-spring system
$T = 2\pi\sqrt{L/g}$	Period of simple pendulum
$x = A \cos(\omega t)$	Displacement (starting at max)
$v_{\max} = \omega A$	Maximum velocity
$a_{\max} = \omega^2 A$	Maximum acceleration
$E = \frac{1}{2}kA^2$	Total energy in SHM
$\omega = 2\pi/T = 2\pi f$	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
ω	angular frequency	rad/s
x	displacement	m

Practice problems

1. A 0.5 kg mass on a spring with $k = 200 \text{ N/m}$. Find the period.
2. Find the period of a 1.5 m pendulum. ($g = 9.8 \text{ m/s}^2$)
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 ($g_M = 1.62 \text{ m/s}^2$).
6. Mass-spring system: $m = 1 \text{ kg}$, $k = 100 \text{ N/m}$, $A = 0.1 \text{ m}$. 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 $v_{\text{max}} = 1.2 \text{ m/s}$ and $A = 0.06 \text{ m}$. Find k .
10. Pendulum length needed for period of exactly 1 s? ($g = 9.8 \text{ m/s}^2$)

Answer key

Full worked solutions for each problem.

1. $T = 2\pi\sqrt{0.5/200} = 0.314 \text{ s}$
2. $T = 2\pi\sqrt{1.5/9.8} = 2.46 \text{ s}$
3. $\omega = 4\pi$; $v_{\text{max}} = (4\pi)(0.05) = 0.628 \text{ m/s}$
4. $k = m(2\pi/T)^2 = 2(2\pi/0.6)^2 = 219 \text{ N/m}$
5. $T_M/T_E = \sqrt{g_E/g_M}$; $T_M = 2 \times \sqrt{9.8/1.62} = 4.92 \text{ s}$
6. $E = 1/2kA^2 = 1/2(100)(0.01) = 0.5 \text{ J}$
7. $\omega = 10\pi$; $a_{\text{max}} = (10\pi)^2(0.05) = 49.3 \text{ m/s}^2$
8. $\omega = 2\pi/0.4 = 15.7 \text{ rad/s}$
9. $\omega = v_{\text{max}}/A = 20$; $k = m\omega^2 = 0.2(400) = 80 \text{ N/m}$
10. $L = g(T/2\pi)^2 = 9.8(1/2\pi)^2 = 0.248 \text{ m}$