Simple Harmonic Motion

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DEFINITION

Simple Harmonic Motion- oscillatory motion under a restoring force proportional to the amount of displacement from equilibrium.

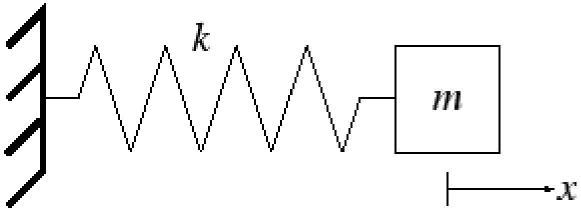
SPring Mass System/pendulum:

Pendulum- A pendulum is a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting, equilibrium position, it is subject to a restoring force due to gravity that will accelerate it back toward the equilibrium position.

Spring Mass system- When a spring is stretched or compressed, kinetic energy of the mass gets converted into potential energy of the spring. By conservation of energy, when the spring reaches its maximum potential energy, the kinetic energy of the mass is zero.

Spring Mass System/ Pendulum Examples

Spring Mass System

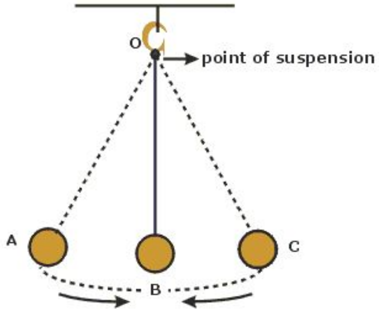


k= spring constant

m= mass

x= distance

Pendulum



x= distance

a= acceleration

g= gravity

l= length of string

Basic concepts

Sinusoidal motion

PE is greatest at the amplitude, 0 at equilibrium

KE is greatest at equilibrium, 0 at amplitude

Conservation of energy

EQUATIONS

Pendulum- T=1/f=2π□(L/g) where T is the period, f is the frequency, L is the length of the wire, and g is the mass of the weight

Spring mass- $T=1/f=2\pi\sqrt{(m/k)}$ where T is the period, f is frequency, m is mass, and k is the spring constant which is specific to the spring

Hooke´s law- $F_{spring}=-kx$ where x is distance. Used to find the spring constant k

Equations (contd.)

Position- $x(t)=A\cos(\omega t)$ where A is amplitude, ω is angular frequency, and t is time

Velocity- $v(t)=-A\omega\sin(\omega t)$

Acceleration- $a(t)=-A\omega^2\cos(\omega t)$

Remember: don't confuse frequency (f) with angular frequency

$\omega = 2\pi f$

Common Mistakes

1. The heavier a pendulum, the shorter its period.

Actually, the period of a pendulum is dependent only on the length of the pendulum and the gravitational field strength.

2. The period of oscillation depends on the amplitude.

Actually, the period of a spring is dependent only on the mass and spring constant and the period of a pendulum is dependent only on the length of the pendulum and the strength of gravity.

3. Lastly, gravity is the restoring force for a spring mass system

Actually, the spring force is the restoring force for this system.

Example Problem: (Spring Mass System)

A 6.oN weight is hung from a spring. The weight stretches the spring . 03m. Calculate the spring constant k.

Ans: 200 N/M

mg=kx

Example Problem: (Simple Pendulum)

You find yourself on a strange planet armed only with a simple pendulum. The mass of the pendulum hangs on a .45m long string and will swing through a full oscillation in 1.7s once set in motion. Use this info to find the acceleration due to gravity on this planet.

$$T=2\pi\sqrt{L/g}$$

Ans: 6.14 m/s

Do Now: Pendulum (right side)/ Spring Mass (left side)

1. Find the frequency of a pendulum if the length of the wire is 16 meters *Ans: .12 cycle/s*

2. A 17.0 g mass on a 35 N/m spring is pulled 20 cm from equilibrium and released. What is the position of the mass at time t = 1.2s?

Ans: -0.101 m or -10.1 cm