Physics 122

Learning Opportunities

Periodic Motion

An object is in periodic motion when its motion repeats with a defined cycle. Common examples are the movement of springs and pendulums.

The most important features of periodic motion are that the object has a stable equilibrium position, and a restoring force that is directed toward that position.

- For springs, there is a position at which they are at rest, but when they are either stretched or compressed, there is a restoring force that is always pointed in the direction of the equilibrium position.
- Pendulums are stable when they hang straight down. If a pendulum is pulled away from this equilibrium position, it swings back and forth as it is acted on by tension force and gravity.

An object that is experiencing periodic motion in one dimension will move back and forth through the origin. It will move the same distance away from the origin in either direction.

The time required for the object to move through one cycle is called the "period" (T). The unit for period is the second. $T = \frac{\Delta t}{N}$

The inverse of the period is called the "frequency" (f). The frequency is the number of cycles that take place per second. The unit for frequency is s^{-1} = Hz. $f = \frac{N}{\Delta t}$

Mass hanging from a spring

$T = 2\pi\sqrt{\frac{m}{k}}$

T – period (s)

m – mass (kg)

k – spring constant $\left(\frac{N}{m}\right)$ also called the force constant of the spring

See the *Periodic Motion - springs* sample problem.

Practice Problems

1. A 0.525kg mass oscillates at the end of a spring with a force constant of 85.0 N/m. What is the period of the oscillation?
2. A 0.275kg ball hangs from an elastic that is stretched and released. You count 15 complete oscillations in 12s. What is the spring constant?

3. A 0.250kg mass is oscillating on the end of a spring constant of 154 N/m. What is the period of the motion?

Simple Harmonic Motion

Simple Harmonic Motion is a special case of periodic motion.

In simple harmonic motion, the displacement of an object can be described using a sine wave. The sine function is ideal for describing periodic or cyclical situations, and simple harmonic motion has a cyclical behavior with respect to time.

Simple Pendulum

$T = 2\pi\sqrt{\frac{l}{g}}$

T – period of pendulum (s)

l – length of pendulum (m)

g – acceleration due to gravity ($+9.81\ m/s^2$)

As you can see from the formula, the only variable is the length of the pendulum. The mass on the end does not affect the period.

See the *Periodic Motion - pendulum* sample problem.

Practice Problems

1. What is the period of a pendulum with a length of 0.45m?
2. What is the length of a pendulum with a period of 4.0s?
3. If every swing of a clock pendulum causes the second hand to move an angle that represents half a second, what must the length of the pendulum be for the clock to keep accurate time?
4. If the period of a pendulum is 0.36s on Earth, what would its period be on the moon ($g = 1.62 m/s^2$)?