# Foundations of Physics: Waves & Sound

*Week 6 & 8 Content*

Name: _____

Date: _____

## 1 Simple Harmonic Motion

Definition: Periodic motion via a restoring force whose magnitude is proportional to the displacement of the object.[1]

If I have a mass and spring system, and I displace it an amount $x$, then the restoring force $F$ is given by the following,

$$F = -kx, \tag{1}$$

where $k$ is denoted as the spring constant.

The value of $k$ can be found experimentally via the following linearisation,

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

We also have the following equation for SHM,

$$x(t) = A\cos(\omega t) \tag{3}$$

Which can then be differentiated into,

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

And,

$$\begin{aligned} a(t) &= -A\omega^2\cos(\omega t) \\ &= -\omega^2 x(t) \end{aligned}$$

By considering the total energy of the system, we arrive at the expression $E = E_K(v) + U(x)$. We see that the kinetic energy is proportional to the velocity, and the potential energy is proportional to the displacement. It is evident that when the displacement is 0 (i.e., the mass is at the equilibrium point), the total energy is purely kinetic: $E = E_K(v)$.

[1] It is noted that simple harmonic motion is mostly a theoretic model as the existence of friction and dissipation of energy dampens the system until no motion is present.