# Vibrations and Waves

Waves are propagation of energy from one place to another.

By definition, simple harmonic motion is:

$$a = -\frac{k}{m}x$$

$$a_{max} \ \ from \ \ \frac{kA}{m} to + \frac{kA}{m}$$

The starting position of a wave tells you whether its a sin or cosine term. $\cos\theta = 1$ and $\sin\theta = 0$.

**Amplitude (A): object oscillates between** $x = -A$ and $x = +A$.
**Period (T)**: time for one cycle: from $x = A$ to $x = -A$ and back to $x = A$.
**Frequency (f)**: the number of complete cycles of vibrations per unit of time.

$$f = \frac{1}{T}$$

By definition, frequency is 1 over the number of periods typically in seconds.

# Velocity as a Function of Position

The maximum velocity from the max acceleration:

$$v = \pm\sqrt{\frac{k}{m}(A^2 - x^2)}$$

# Simple Harmonic Motion

For uniform circular motion, similarities can be to other wave functions.

$$v = C\sqrt{A^2 - x^2}$$

# Period, Frequency, and Angular Frequency

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

where $k$ is the spring constant.

More simply,

$$v = f\lambda$$

where $\lambda$ is the wavelength.

$$\omega = 2\pi f$$

$$a = -\omega^2 x$$

# Motion of a Pendulum

A swinging pendulum exhibits simple harmonic motion.

$$F = -(\frac{mg}{L}s)$$

To calculate the period of a pendulum:

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

These type of motion is mass independent, which explains why we have no mass variable.

# Maxwell's Predictions

1. Electric field lines originate on positive charges and terminate on negative charges
2. Magnetic field lines always form closed loops
3. A varying magnetic field induces an emf and so an electric field
4. Magnetic field are generated by moving charges or currents

Hertz would later confirm these prediction by building and LC circuit.

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$$

gives us the speed of lights at

$$c = 2.99792 \times 10^8 m/s$$

in which

$$\frac{E}{B} = c$$

The intensity of the electromagnetic waves is

$$I = \frac{E_{max}^2}{2\mu_0 c} = \frac{c}{2\mu_0}B_{max}^2$$