Simple Harmonic Motion

Hooke's law: $F = -kx$ ([k] = N/m)

⇒ the – sign indicates that the direction of the force is opposite the displacement

Frequency: $f = 1/T$ ([f] = Hz)

Period: $T = 1/f$ ([T] = s)

Simple Harmonic Motion:

⇒ for an object oscillating in simple harmonic motion:

$$x = A\cos\omega t \qquad x_{\max} = A$$
$$v = -A\omega\sin\omega t \qquad v_{\max} = A\omega$$
$$a = -A\omega^2\cos\omega t \qquad a_{\max} = A\omega^2$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

Note: v = 0 at x = $\pm$A; v = v_{max} at x = 0
a = 0 when x = 0; a=a_{max} at x = $\pm$A

⇒ for a mass m oscillating on a spring with spring constant k:

$$\omega = \sqrt{\frac{k}{m}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad T = 2\pi\sqrt{\frac{m}{k}}$$

Elastic Potential Energy: $PE = \frac{1}{2}kx^2$

Conservation of Energy: $\frac{1}{2}mv_0^2 + mgh_0 + \frac{1}{2}kx_0^2 = \frac{1}{2}mv_f^2 + mgh_f + \frac{1}{2}kx_f^2$

Simple Pendulum:

⇒ for a simple pendulum (for small angles):

$$\omega = \sqrt{\frac{g}{L}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \qquad T = 2\pi\sqrt{\frac{L}{g}}$$