Examples of Periodic Motion

$$\boxed{x(t) = A\sin(\omega t + \phi)}$$

A: amplitude: $\Delta x_{\max}$

ω: angular velocity: $\omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}} = 2\pi f$

ϕ: phase shift: $\Delta x(t=0) = x_0 = A\sin\phi$

When $\Delta x = A$, $\phi = \frac{\pi}{2}$

When $\Delta x = 0$, $\phi = 0, \pi$

Should be $\phi = \pi$ because negative motion

$v = A\omega\cos(\omega t + \phi)$

$a = A\omega^2\left[-\sin(\omega t + \phi)\right]$

$v_{\max} = A\omega(1)$

$a_{\max} = A\omega^2(1)$

$$E_{\text{tot}} = \frac{1}{2}mv^2 + \frac{1}{2}k\Delta x^2$$

$$= \frac{1}{2}m\left[A\omega\cos(\omega t + \phi)\right]^2 + \frac{1}{2}k\left[A\sin(\omega t + \phi)\right]^2$$

$$\frac{1}{2}A^2\left[m\omega^2\cos^2(\omega t + \phi) + k\sin^2(\omega t + \phi)\right]$$

$E =$constant IF $m\omega^2 = k$, true

$$\boxed{E_{\text{tot}} = \frac{1}{2}kA^2 = \frac{1}{2}m\omega^2A^2 = \frac{1}{2}m\left(v_{\max}\right)^2}$$