$$a(t) = \frac{\Delta v(t)}{\Delta t} = \frac{dv(t)}{dt} = \text{total derivative of } v(t) \text{ with respect to time, } t.$$

$$a(t) = \frac{d}{dt}\left(v(t)\right) = \frac{d}{dt}\left[v_o \sin\left(2\pi ft\right)\right] = 2\pi f\, v_o \cos\left(2\pi ft\right) = \omega v_o \cos\left(\omega t\right) \equiv a_o \cos\left(\omega t\right)$$

We see that: $\boxed{a_o = \omega v_o = 2\pi f\, v_o}$ but: $\boxed{v_o = -\omega x_o = -2\pi f\, x_o}$ $\therefore$ $\boxed{a_o = -\omega^2 x_o = -\left(2\pi f\right)^2 x_o}$

i.e. the acceleration amplitude, A_o = max acceleration is related to the displacement amplitude, X_o by this formula for ***harmonic*** motion.

Instantaneous Horizontal Accel. of the Moving Mass: $\boxed{a(t) = a_o \cos\left(2\pi ft\right) = a_o \cos\left(\omega t\right)}$ $\left(m/s^2\right)$

(meters/sec^2) acceleration amplitude (m/s^2) frequency of oscillation (cycles per second = Hertz)

The time dependence of the longitudinal position, $x(t)$ (*i.e.* displacement of the mass from its equilibrium position) *vs.* time, t and longitudinal speed of the mass, $v(t)$ *vs.* time, t and longitudinal acceleration $a(t)$ vs. time, t are shown in the figure below; note that each has been normalized to their respective amplitudes (note also the phase relation between $x(t)$, $v(t)$ and $a(t)$):