48298

$x = a\cos(\omega t+\alpha)$

$\Rightarrow \dot{x} = -a\omega \sin(\omega t+\alpha)$

$\Rightarrow \ddot{x} = -a\omega^2 \cos(\omega t+\alpha)$

$\Rightarrow \ddot{x} = -\omega^2 a\cos(\omega t+\alpha)$

$\Rightarrow \ddot{x} = -\omega^2 x.$

accel is proportional to x but in the opposite direction it will perform SHM about the point x

To find ω and α:

Find α. $t=0$, $x=\frac{3a}{5}$.

$\Rightarrow \frac{3a}{5} = a\cos(0+\alpha)$

$\Rightarrow \frac{3}{5} = \cos\alpha$

$\Rightarrow \alpha = \cos^{-1}\left(\frac{3}{5}\right) = .927$ rads.

Find ω $v=-2a$, when $x=\frac{3a}{5}$ and amp $=a$

$v^2 = \omega^2(A^2-x^2)$.

$(-2a)^2 = \omega^2\left(a^2-\left(\frac{3a}{5}\right)^2\right)$

$4a^2 = \omega^2\left(a^2-\frac{9a^2}{25}\right)$

$\Rightarrow 4a^2 = \omega^2\left(\frac{16a^2}{25}\right)$

$\Rightarrow 4 = \omega^2\frac{16}{25}$

$\Rightarrow \frac{25}{4} = \omega^2 \Rightarrow \boxed{\omega = \frac{5}{2}}$

To find the time to reach the mean position ($x=0$)

$x=0$ [use cos solution, time measured from initial position)

$0 = a\cos(\omega t+\alpha)$

$\Rightarrow 0 = a\cos(\omega t+\alpha)$

$\Rightarrow 0 = \cos(\omega t+\alpha)$

$\Rightarrow \frac{\pi}{2} = \omega t+\alpha.$

$\Rightarrow \frac{\frac{\pi}{2}-\alpha}{\omega} = t$

$\Rightarrow \frac{\frac{\pi}{2}-.927}{2.5} = t.$

$\Rightarrow \boxed{.258 = t}$

Alternative way to find ω: $x = a\cos(\omega t+\alpha)$

$\Rightarrow \dot{x}=v = -a\omega\sin(\omega t+\alpha)$

$t=0$, $v=-2a$ $\Rightarrow -2a = -a\omega\sin(\omega(0)+\alpha)$

$\Rightarrow +2 = \omega\sin(\alpha)$

$\Rightarrow 2 = \omega\left(\frac{4}{5}\right)$

$\Rightarrow \frac{10}{4} = \omega \Rightarrow \boxed{\omega = \frac{5}{2}}$