

Answer on Question #67799 – Physics – Mechanics | Relativity

SHO (Simple Harmonic Oscillators) consists of a spring with constant $k = 10 \text{ N/m}$ and mass $m = 0.1 \text{ kg}$. Find the frequency of oscillations, angular frequency of oscillations, and find the solution for the SHO

for initial conditions given by at $t = 0, x(0) = 0.01 \text{ m}$, and $v(0) = 5 \text{ m/sec}$.

Solution.

Angular frequency of oscillations:

$$\omega_0 = \sqrt{\frac{k}{m}} = \frac{10}{0.1} = 10 \text{ rad s}^{-1};$$

Frequency of oscillations:

$$\nu = \frac{\omega_0}{2\pi} = \frac{5}{\pi} \approx 1.59 \text{ Hz};$$

General solution for the SHO:

$$x(t) = x_m \cos(\omega_0 t + \varphi);$$

The solution for the SHO for initial conditions:

$$\begin{cases} x(0) = x_m \cos \varphi & \frac{v(0)}{x(0)} = -\omega_0 \tan \varphi; \frac{5}{0.01} = -10 \tan \varphi; \tan \varphi = -50; \\ v(0) = -\omega_0 x_m \sin \varphi; \end{cases}$$

$$\varphi = -\tan^{-1} 50 \approx -1.55;$$

$$\cos \varphi = \frac{1}{\sqrt{1 + (\tan \varphi)^2}} = \frac{1}{\sqrt{1 + 2500}} \approx 0.02; \quad x_m = \frac{x(0)}{\cos \varphi} = \frac{0.01}{0.02} = 0.5 \text{ m};$$

$$x(t) = 0.5 \cos(10 t - 1.55);$$

Answer:

$$\nu = \frac{5}{\pi} \approx 1.59 \text{ Hz}; \quad \omega_0 = 10 \text{ rad s}^{-1}; \quad x(t) = 0.5 \cos(10 t - 1.55).$$

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