REC

The amplitude and frequency of an object executing simple harmonic motion are 0.01m and 12Hz respectively. What is the velocity of the object at displacement 0.005m? What is the maximum velocity and acceleration of the object?

a

$$V = \omega\sqrt{A^2 - x^2}$$

$$= 2 \times 3.14 \times 12 \times \sqrt{(0.01)^2 - (0.005)^2}$$

$$= 0.653\,ms^{-1}$$

$a = 0.01m$

$f = 12Hz$

$x = 0.005m$

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

$\omega = 2\pi f$

$= 2 \times 3.14 \times 12$

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$$V_{max} = \omega A$$
$$= (2 \times 3.1416 \times 12) \times 0.01$$
$$= 0.7536\ ms^{-1}$$
$$a_{max} = -\omega^2 A =$$

$a = 0.01m$

$f = 12Hz$

$x = 0.005m$

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

$\omega = 2\pi f$

$= 2 \times 3.14 \times 12$

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REC

A train of simple harmonic waves is travelling in a gas along the positive direction of the X-axis with amplitude equal to 2 cm, velocity 300m/s and frequency 400Hz. Calculate the displacement at a distance of 4cm from the origin after an interval of 5seconds.

$$y = a\sin\frac{2\pi}{\lambda}(vt - x)$$

$$= 0.02\sin\frac{2\pi}{0.75}(300\times 5 - 0.04)$$

$$= 0.02\sin(12566.06)$$

$$= -0.0111\,m$$

$v = f\lambda$

$\lambda = \frac{v}{f}$

$= \frac{300}{400}$

$= 0.75\,m$

$a = 2\,cm$

$= 0.02\,m$

$v = 300\,m/s$

$f = 400\,Hz$

$x = 0.04\,m$

$t = 5\,sec$

$y = ?$

REC

$$= \sqrt{4+9+12\cos(-\pi/6)}$$

$\cos(-\theta) = \cos\theta$

i) resultant amplitude

ii) Phase constant

iii) Resultant equation

$$= \sqrt{4+9+12\cos(\pi/6)}$$

$$= 4.83\,m$$

$a_1 = 2$

$a_2 = 3$

$\varphi_1 = \pi/6$

$\varphi_2 = \pi/3$

$$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos(\varphi_1 - \varphi_2)}$$

$$= \sqrt{4+9+12\cos\left(\frac{\pi}{6} - \frac{\pi}{3}\right)}$$

$$\frac{\pi}{6} - \frac{\pi}{3} = \frac{-\pi}{6}$$

REC

i) resultant amplitude
ii) Phase constant
iii) Resultant equation

$$\phi = \tan^{-1}\left(\frac{a_1 \sin\phi_1 + a_2 \sin\phi_2}{a_1 \cos\phi_1 + a_2 \cos\phi_2}\right)$$

$$= \tan^{-1}\left(\frac{2\sin\frac{\pi}{6} + 3\sin\frac{\pi}{3}}{2\cos\frac{\pi}{6} + 3\cos\frac{\pi}{3}}\right)$$

$$= \tan^{-1}(1.113) = 48^\circ$$

$a_1 = 2$

$a_2 = 3$

$\phi_1 = \pi/6$

$\phi_2 = \pi/3$

REC

$$(\omega t+\phi) = (\omega t + 48^\circ)$$

$$= \tan^{-1}\left(\frac{2\sin\frac{\pi}{6} + 3\sin\frac{\pi}{3}}{2\cos\frac{\pi}{6} + 3\cos\frac{\pi}{3}}\right)$$

$$\phi_1 = \pi/6$$

$$= \tan^{-1}(1.113) = 48^\circ$$

$$\phi_2 = \pi/3$$

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REC

$(\omega t + \phi) = (\omega t + 48^\circ)$

$y = A\sin(\omega t + \phi)$

$\boxed{y = 4.83\sin(\omega t + 48^\circ)}$

$=$ $-$

$2\cos\frac{\pi}{6} + 3\cos\frac{\pi}{3}$

$= \tan^{-1}(1.113) = 48^\circ$

REC

A body of mass 0.5kg is suspended from a spring of negligible mass and it stretches the spring by 0.07m for a displacement of 0.03m it has a downward velocity 0.4m/s. Calculate
(i) the time period
(ii) the frequency

$$= \frac{0.5 \times 9.8}{0.07}$$

$$= 70\ N/m$$

$$T = 2\pi\sqrt{\frac{m}{K}}$$

$$= 2\pi \times \sqrt{\frac{0.5}{70}}$$

$$= 0.531\ s$$

$$f = \frac{1}{T}$$

$$= \frac{1}{0.531} = 1.88\cancel{8}135^{-1} \mid Hz$$

(ii) $f = \frac{1}{T}$

$$= \frac{1}{0.531} = 1.8843\ Hz$$

REC

A body of mass 0.5kg is suspended from a spring of negligible mass and it stretches the spring by 0.07m for a displacement of 0.03m it has a downward velocity 0.4m/s. Calculate
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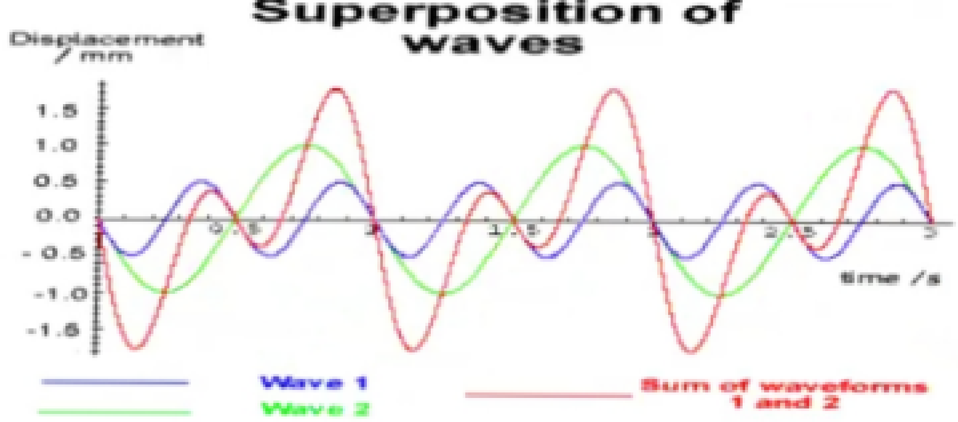
$$f = \frac{1}{T}$$

$$= \frac{1}{0.531} = 1.88135\ s^{-1} \mid Hz$$

$$\omega = 2\pi f$$

$$\omega = \frac{2\pi}{T} = \frac{2 \times 3.1416}{0.531}$$

Shuva Saha's screen



To understand superposition, we consider two waves passing through a point in a medium. Let y_1 be the displacement of a particle at that point due to the first wave in the absence of second wave and y_2 be the displacement at that point due to the second wave in the absence of the first wave. The resultant displacement (R) at that point when both the waves act simultaneously is

$$R = y_1 \pm y_2$$

5. In case of a stationary wave each particle attains its stationary position twice during one complete vibration.
6. The equation of a stationary wave is,

$$y = A\sin\frac{2\pi}{\lambda}(vt)$$

Equation of a standing wave

The phenomenon can be demonstrated mathematically by deriving the equation for the sum of two oppositely moving waves:

A harmonic wave traveling to the right along the x-axis is described by the equation

$$y_1 = a\sin\frac{2\pi}{\lambda}(vt - x) \qquad \text{----------(1)}$$