Bazil-uddin-khan

24k-0559

BS-CS-1H

Q1). Ans:- $x = x_m \cos(\omega t + \phi)$

$\frac{dx}{dt} \Rightarrow v = -\omega x_m \; \cancel{\cos}\,\sin(\omega t + \phi)$

$V_{max} = +\omega x_m$

$\because t = 0$ $\quad v = -V_{max} \sin(\omega t + \phi)$

$4\times10^{-2} = -5\times10^{-2} \sin(\omega(0) + \phi)$

$\phi = \sin^{-1}\left(\frac{4\times10^{-2}}{5\times10^{-2}}\right) = \boxed{-0.93 \text{ radians} \quad \text{OR} \quad -53.13^{\circ} \text{degrees.}}$

Q2). Ans:- $X = 20\times10^{-2}$

(a). $US = \frac{1}{2} kA^2 \rightarrow$ $\quad \frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$2 = \frac{1}{2} k \times (20\times10^{-2})^2$ $\quad \frac{1}{2} \times 100 \times x^2 = \frac{1}{2} \times 2 \times \left(\frac{85}{100}\right)^2$

$\boxed{k = 100}$

$\boxed{x = 0.12m}$ or $\boxed{x = 12cm}$

Yes,
~~(b)~~. it will be ~~barde~~ be fore $x = 15cm$.

(b). it will come back before $x = 15cm$ at $X = 12cm$.

Q3). (a). $F = kx$ $\quad F = 20N,\ X = 0.2m$

Ans:- $20 = k(0.2)$

$\boxed{k = 100\ N/m}$

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(b). Ans:- $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \rightarrow f = \frac{1}{2\pi}\sqrt{\frac{100}{2.0}} \rightarrow \boxed{f = 1.13Hz}$

(c). Ans:- $V = \omega x_0$

$V = (2\pi \times 1.13 \times 0.2) \rightarrow \boxed{1.42 m/s}$

(d). Ans:-

$a = \omega^2 x_0$

$a = (2\pi \times 1.13)^2 \times 0.2 = \boxed{10.08 m/s^2}$

(e). Ans:- $T.E = \frac{1}{2} \times 100 \times (0.2)^2$

$T.E = 2J$

(f) Ans:- $E = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 \quad x = \frac{1}{3} x_m \rightarrow 2 = \frac{1}{2}(2)v^2 \times \frac{1}{2} \times (100)(0.2/3)^2$

$V = 1.33 m/s$

(g) Ans:- $a_{max} = (2\pi \times 1.13)^2 \times \left(\frac{0.2}{3}\right) = 3.33 m/s^2$

Q4). (a). Ans:- In parallel connected so every k will be equally distributed

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$3 = \frac{1}{2\pi}\sqrt{\frac{k}{1450}} \rightarrow \boxed{k = 5.2 \times 10^5} N/m$ so ∴ when $k_{eq} = \frac{5.2 \times 10^5}{4} = \boxed{1.29 \times 10^5 N/m}$

(b). Ans:- $F = \frac{1}{2\pi}\sqrt{\frac{5.2 \times 10^5}{(173 \times 5) + 1450}} = \boxed{2.68 Hz}$

Q5). In series:-

Ans:- $f = \frac{1}{2\pi}\sqrt{\frac{7580/2}{0.245}} = \boxed{19.8Hz}$

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Q6).

(a). $F = kx$

Ans:- $148 \sin(40°) = 120\,x$

$\boxed{x = 0.075m}$ for from equilibrium point $= 0.075 + 0.450 = \boxed{0.525m}$

(b).

Ans:- $\cancel{T = 2\pi\sqrt{\frac{m}{k}}}$

$T = 2\pi\sqrt{\frac{m}{k}} \rightarrow T = 2\pi\sqrt{\frac{14/9.81}{120}}$ $w = mg$ $\therefore m = w/g$

$\boxed{T = 0.6855}$

Q7). A |———| B $x_m = A$

$T = 1.5s$ $x = x_m \cos(\omega t + \phi)$

$t = 0.5s$ $x_2 = A\cos\left(\frac{2\pi}{T} \times t + \phi\right) \rightarrow x_2 = A\cos\left(\frac{2\pi}{1.5} \times 0.5 + \frac{\pi}{6}\right)$

$x_1 = A\cos\left(\frac{2\pi}{T} \times t\right) \rightarrow A\cos\left(\frac{2\pi \times 0.5}{1.5}\right) \hookrightarrow x_1 = -0.5A$ $\boxed{x_2 = -0.866A}$

$V_1 = -A \times \omega \sin(\omega t)$ $x_1 - x_2 \rightarrow$

$V_1 = -A \times \frac{2\pi}{1.5} \sin\left(\frac{2\pi}{1.5} \times 0.5\right)$ $-0.5A - (-0.866A) = 0.366A$

$V_1 = -3.63A$ $V_2 = -A\omega \sin(\omega t + \pi/6) \rightarrow -A \times \frac{2\pi}{1.5} \sin\left(\frac{2\pi}{1.5} \times 0.5 + \frac{\pi}{6}\right) = -\frac{2\pi A}{3}$

Q8). [Repeated] $\rightarrow$ [of Q7] so $\rightarrow V_1 - V_2 \rightarrow -1.53A$

Q9). (a) In simple harmonic motion the direction of velocity and position will be in the same direction when it is moving away from the equilibrium position.
For Example when moving toward equilibrium both have same direction when at +ve displacement.

(b). Ans:- Directions of Velocity and acceleration cannot be in the same direction. as they

(c). Ans:- Directions of displacement and acceleration cannot be in same direction due to $a = -w^2x$ they are always in opposite direction.

(d). Ans:- $T.E = K.E + P.E$

$$\frac{1}{2}kx_m^2 = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$$

If mass get doubled so it will not change Total energy as total energy remains conserved it will not change.

But K.E depends on mass if mass get doubles so K.E will vary as it is dependent on mass.

P.E donot depend on mass but it depends on displacement. so it will not get effected if mass changes

Q10). $x = 5\times10^{-2}\cos(2t + \pi/6)$

(a) At $t=0 \rightarrow x = 5\times10^{-2}\cos\left(2(0)+\pi/6\right) = 0.043m$

(b). $V = -wx_m \sin(2t+\pi/6) \rightarrow V = -5\times10^{-2}\times 2\sin\left(2(0)+\pi/6\right) \rightarrow -0.05m$

(c). $a = -w^2x_m\cos(2t+\pi/6) \rightarrow a = -(2)^2\times5\times10^{-2}\cos\left(2(0)+\pi/6\right) \rightarrow -0.17m$

(d). Amplitude $= 5\times10^{-2}$

$w = \frac{2\pi}{T} \rightarrow \cancel{2} = \frac{\cancel{2}\pi}{T} \rightarrow \boxed{T = 3.142s}$

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Q11) Ans:- $\omega' = \frac{2\pi}{T} = \frac{2\pi}{0.615} = 10.21\, rad/s$ mass = 2.2kg , k = 250N/m , T = 0.61s

$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

∵ As it is damped
$\omega' = 10.21$
$\omega = \sqrt{\frac{k}{m}} = \frac{\sqrt{250}}{\sqrt{2.2}} = 15.8$
so damped

banking constant $= \sqrt{4mk}$
$= \sqrt{4 \times 2.2 \times 250} = 46.9\, kg/s$

$(10.21)^2 = \frac{250}{2.2} - \frac{b^2}{4m^2}$

$\frac{b^2}{4(2.2)^2} = \frac{250}{2.2} - (10.21)^2 \rightarrow \boxed{b = 13.5}$

damping constant

System is underdamped as $b_c > b$

Q12). Ans:-

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ k = 580 , m = ?

mass of molecules $= \frac{1.67 \times 10^{-27}}{2} \rightarrow 8.35 \times 10^{-28}\, kg$

$f = \frac{1}{2\pi}\sqrt{\frac{580}{8.35 \times 10^{-28}}} \rightarrow \boxed{F = 2.33 \times 10^{14}\, Hz}$

Q13). (a). How high will be ~~...~~ $a = -\omega^2 x \rightarrow 9.8 = -(10.2)^2 x \rightarrow \boxed{x = 0.094m}$ $\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{185}{1.775}} = 10.2\, rad/s$

(b). $\omega = \sqrt{\frac{k}{m}} \rightarrow \sqrt{\frac{185}{1.775}} = \boxed{10.2\, rad/s}$

$m = 1.775\, kg \rightarrow x = x_m \cos\omega t \rightarrow -0.15 + 0.094 = -0.15\cos[10.2t] \rightarrow \boxed{t = 0.116s}$

~~...~~ $= \frac{-0.056}{-0.15} = \cos[10.2t]$

(c) $a_{max} = \omega^2 x \rightarrow$ ∵ $V_{max} = -\omega x_0 \rightarrow v(t) = -\omega x_0 \sin(\omega t)$.

$= (10.2)(0.15) = 1.53\, m/s$
$\times \sin(10.2 \times 0.116) =$

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(Q14).1(a).

$(t=0)$ $x(0) = -8.6\times10^{-2}$

$v(0) = -0.93$

$a(0) = 48 m/s^2$

$a = \omega^2 x$

$48 = (8.6\times10^{-2})\omega^2$

$\omega = 23.6$ rad/s

$\omega = 2\pi f \Rightarrow 23.6 = 2\pi f$

$f = 3.75Hz$

(b) $V = -\omega x_0 \sin(\omega t + \phi)$ at $t=0$

$X = X_0 \cos(\omega t + \phi) \rightarrow$ so To find phase $\frac{V(0)}{x(0)} = \frac{-\omega \cancel{x_0} \sin(\theta)}{\cancel{x_0} \cos(\theta)}$

$\frac{\cancel{-}0.93}{\cancel{-}23.6 \times -0.086} = \tan\phi \rightarrow \theta = -24.22^\circ$ or $\theta = -0.42$ rad

(c). $x(0) = x_m \cos(\omega t + \phi)$

$-8.6\times10^{-2} = x_m \cos(0 \cancel{+} 24.22^\circ)$

$\boxed{x_m = 0.0945 m \text{ or } 9.45 cm}$

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