Solutions

S1. Ans.(a)

$x = 5\sin\left(\pi t + \frac{\pi}{3}\right)m$

Amplitude = 5 m

$\omega = \pi$

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

$T = \frac{2\pi}{\pi} = 2\ s.$

S2. Ans.(a)

$T' = 2\pi\sqrt{\frac{\ell'}{g}}$ where $\ell' = \frac{\ell}{2}$

$T = 2\pi\sqrt{\frac{\ell}{g}}$

$T' = \frac{X}{2}T$

$2\pi\sqrt{\frac{\ell}{2g}} = \frac{X}{2}2\pi\sqrt{\frac{\ell}{g}}$

$\frac{1}{\sqrt{2}} = \frac{X}{2} \Rightarrow X = \sqrt{2}.$

S3. Ans.(a)

From x – t graph

A = 1 T = 8

$\Rightarrow \omega = \frac{2\pi}{T}$

$\Rightarrow \omega = \frac{\pi}{4}$

At $t = 2, x = 1$

$a = -\omega^2 x$

$\Rightarrow a = \frac{-\pi^2}{16} \times 1$

$\Rightarrow a = \frac{-\pi^2}{16}\ m/s^2$

S4. Ans.(d)

$n(T)_l = (n+1)T_s$

$(n)2\pi\sqrt{\frac{1.21}{g}} = (n+1)2\pi\sqrt{\frac{1}{g}}$

$(n)(1.1) = (n+1)$

$0.1(n) = 1$

$n = 10$

No. of oscillation of smaller one

= n + 1

= 10 + 1

= 11

S5. Ans.(a)

Frequency of K.E. = 2 × F

S6. Ans.(c)

$K = \frac{10}{5\times10^{-2}} = 200N/M$

$T = 2\pi\sqrt{\frac{m}{k}} = \frac{\pi}{5}$ sec

$T = 0.628$ sec

S7. Ans.(d)

Displacement (π) equation is

$x = A\sin(\omega t + \phi)$ ...(i)

$\frac{dx}{dt} = A\omega\cos(\omega t + \phi)$

$a = \frac{d^2x}{dt^2} = -\omega^2 A\sin(\omega t + \phi)$

$a = \omega^2 A\sin(\omega t + \phi + \pi)$ ...(ii)

From equation (i) and (ii) phase difference between displacement and acceleration is π

S8. Ans.(b)

$\sin\omega t$ and $\cos\omega t$ both are periodic function

S9. Ans.(b)

$y = A_0 + A\sin\omega t + B\cos\omega t$

This S.H.M can be reduced to

$y' = y - A_0 = A\sin\omega t + B\cos\omega t$

Hence, resultant amplitude

$R = \sqrt{A^2 + B^2 + 2AB\cos 90°}$

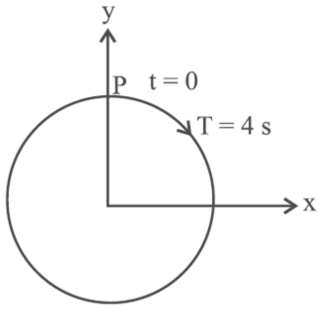
$= \sqrt{A^2 + B^2}$

S10. Ans.(d)

In one complete vibration the displacement of the particle is zero. So, average velocity in one complete vibration $= \frac{\text{Displacement}}{\text{Time interval}} = \frac{y_f - y_i}{T} = 0$

S11. Ans.(d)

At $t = 0, y$ displacement is maximum, so equation will be cosine function



T = 4s

$\omega = \frac{2\pi}{T} = \frac{2\pi}{4} = \frac{\pi}{2}\text{rad/s}$

$y = a\cos\omega t$

$y = 3\cos\frac{\pi}{2}t$

S12. Ans.(b)

$a = \omega^2 x \Rightarrow 20 = \omega^2 5$

$\omega = 2$

$T = \frac{2\pi}{\omega} = \pi$ sec

S13. Ans.(b)

Acceleration $= \omega^2 x$, velocity $= \omega\sqrt{A^2 - x^2}$

A = 3 cm

x = 2 cm

a = v

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

$2\omega = \sqrt{3^2 - 2^2} \Rightarrow 2\omega = \sqrt{5}$

$\omega = \frac{\sqrt{5}}{2} \Rightarrow \frac{2\pi}{T} = \frac{\sqrt{5}}{2}$

$T = \frac{4\pi}{\sqrt{5}}$

S14. Ans.(b)

$y_1 = a\sin\omega t$

$y_2 = b\cos\omega t = b\sin\left(\omega t + \frac{\pi}{2}\right)$

Since the frequencies for both S.H.M. are same, resultant motion will be S.H.M. Now

Amplitude $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$

Here $A_1 = a,\ A_2 = b,\ \phi = \frac{\pi}{2}$

So $A = \sqrt{a^2 + b^2}$

S15. Ans.(a)

For particle undergoing S.H.M.

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

So, $V_1 = \omega\sqrt{A^2 - x_1^2}$ & $V_2 = \omega\sqrt{A^2 - x_2^2}$

Solving these two equation, we get

$\omega = \sqrt{\frac{V_1^2 - V_2^2}{x_2^2 - x_1^2}} = \frac{2\pi}{T} \Rightarrow T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{V_1^2 - V_2^2}}$

S16. Ans.(a)

Two consecutive resonant frequencies for a string fixed at both ends will be

$\frac{nv}{2l}$ and $\frac{(n+1)v}{2l} \Rightarrow \frac{(n+1)v}{2l} - \frac{nv}{2l} = 420 - 315$

$\frac{v}{2l} = 105$ Hz

S17. Ans.(a)

For S.H.M.

Maximum acceleration $= \omega^2 A = \alpha$

Maximum velocity $= \omega A = \beta$

$\frac{\alpha}{\beta} = \frac{A\omega^2}{\omega A} = \omega = \frac{2\pi}{T}$

$\Rightarrow T = \frac{2\pi\beta}{\alpha}$

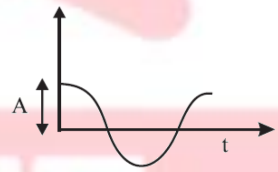
S18. Ans.(c)

Displacement, $x = A\cos(\omega t)$

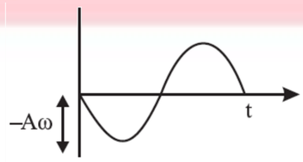
At t = 0

$x = A\cos(\omega \times 0)$

x = A



$V = \frac{dx}{dt} = -A\omega\sin\omega t$ on comparing this with $V = V_0\sin\omega t$ [$\because$ sin function starts from origin]



$a = \frac{dV}{dt} = -A\omega^2\cos\omega t$

[$\because$ cos function do not starts from origin]