DPP – 1 (SHM)

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/90

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Q 1. A particle moves such that its acceleration is given by:

$\alpha = -\beta(x - 2)$

Here : β is a positive constant and x the position from origin. Time period of oscillations is:

(a) $2\pi\sqrt{\beta}$ (b) $2\pi\sqrt{\frac{1}{\beta}}$

(c) $2\pi\sqrt{\beta + 2}$ (d) $2\pi\sqrt{\frac{1}{\beta+2}}$

Q 2. The maximum acceleration of a particle in SHM is made two times keeping the maximum speed to be constant. It is possible when:
(a) amplitude of oscillation is doubled while frequency remains constant
(b) amplitude is doubled while frequency is halved
(c) frequency is doubled while amplitude is halved
(d) frequency of oscillation is doubled while amplitude remains constant

Q 3. A particle moves according to the law $x = a \cos \frac{\pi t}{2}$. The distance covered by it in the time interval between t = 0 to t = 3 s is :
(a) 2a (b) 3a (c) 4a (d) a

Q 4. For a particle executing SHM, which of the following statements does not hold good?
(a) Frequency of speed is two times of that of displacement.
(b) the restoring force is always directed towards a fixed point
(c) the restoring force is maximum at the extreme positions
(d) the velocity of the particle is minimum at the centre of motion of the particle

Q 5. The acceleration of a particle moving along x-axis is a = – 100x + 50. It is released from x = 2. Here 'a' and 'x' are in S.I units. The motion of particle will be :
(a) periodic, oscillatory but not SHM. (b) periodic but not oscillatory.
(c) oscillatory but not periodic. (d) simple harmonic.

Q 6. For a particle in S.H.M., if the amplitude of displacement is 'a' and the amplitude of velocity is 'v' the amplitude of acceleration is
(a) va (b) $\frac{v^2}{a}$ (c) $\frac{v^2}{2a}$ (d) $\frac{v}{a}$

Q 7. A particle executes SHM along x-axis about the centre at x = - a with frequency f Hz. Initially the particle is at rest at the origin. Its equation of motion will be

(a) x = 2a(1 – cos2πft) (b) x = a cos 2 π ft

(c) x = a (cos 2 π ft – 1) (d) x = a (1 – cos 2 π ft)

Q 8. A particle moves according to the equation x = a $Sin^2\left(\omega t - \frac{\pi}{2}\right)$. Its amplitude and angular frequency are

(a) a,ω (b) $\frac{a}{2}$, ω (c) $\frac{a}{2}$, $\frac{\omega}{2}$ (d) $\frac{a}{2}$, 2ω

Q 9. A particle is executing SHM of amplitude A and angular frequency ω. The average acceleration of particle for half the time period is (sailing from mean position)

(a) $\frac{2A\omega^2}{\pi}$ (b) $\frac{A\omega^2}{\pi}$ (c) $\frac{3A\omega^2}{2\pi}$ (d) $\frac{A\omega^2}{2}$

Q 10. The velocities of a particle in SHM at positions x_1 and x_2 are v_1 and v_2 respectively, its time period will be -

(a) 2p $\sqrt{(v_1^2 - v_2^2)/(x_2^2 - x_1^2)}$

(b) 2p $\sqrt{(x_1^2 + x_2^2)/(v_2^2 - v_1^2)}$

(c) 2p $\sqrt{(x_1^2 - x_2^2)/(v_2^2 - v_1^2)}$

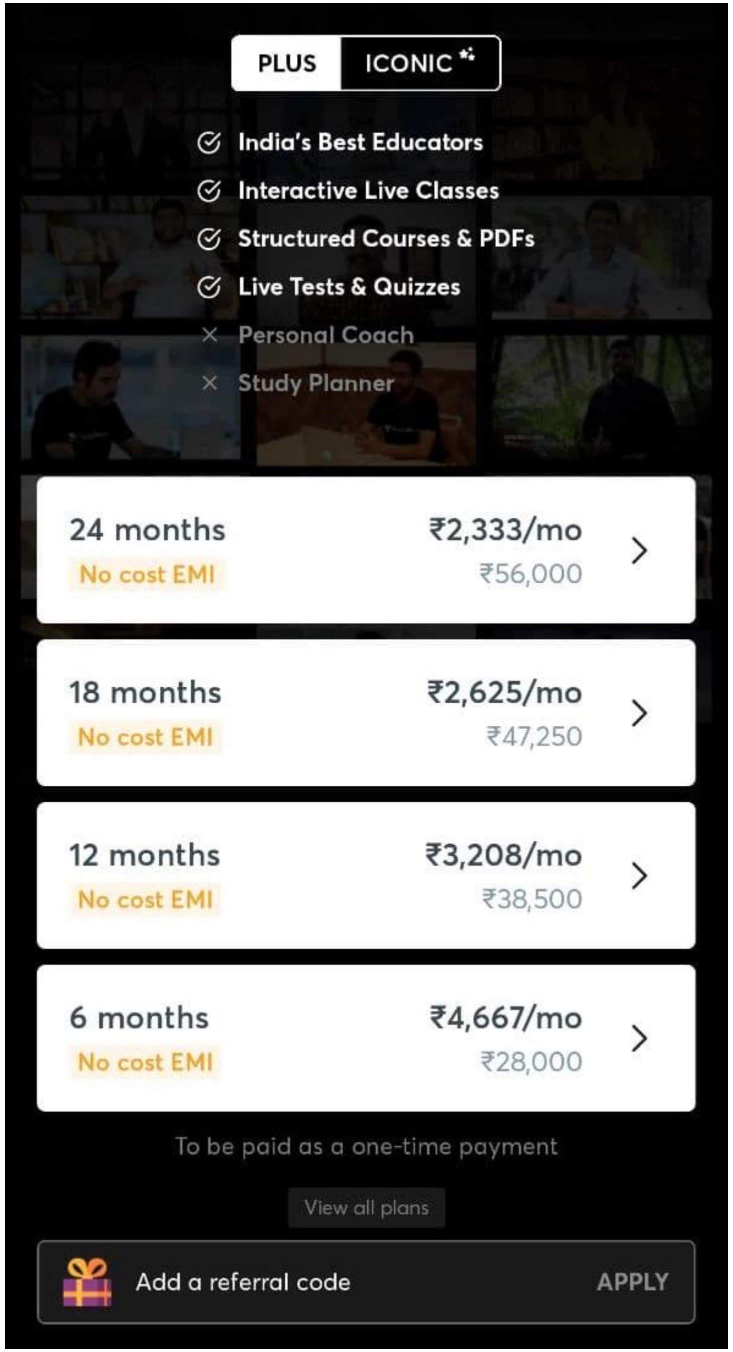
(d) 2p $\sqrt{(x_1^2 + x_2^2)/(v_2^2 + v_1^2)}$

Q 11. In SHM, the phase difference between the displacement and acceleration is:

(a) 0 (b) p/2 (c) p (d) 2 p

Answer Key

Q.1 b	**Q.2 c**	**Q.3 b**	**Q.4 d**	**Q.5 d**
Q.6 b	**Q.7 c**	**Q.8 d**	**Q.9 a**	**Q.10 c**
Q.11 c				



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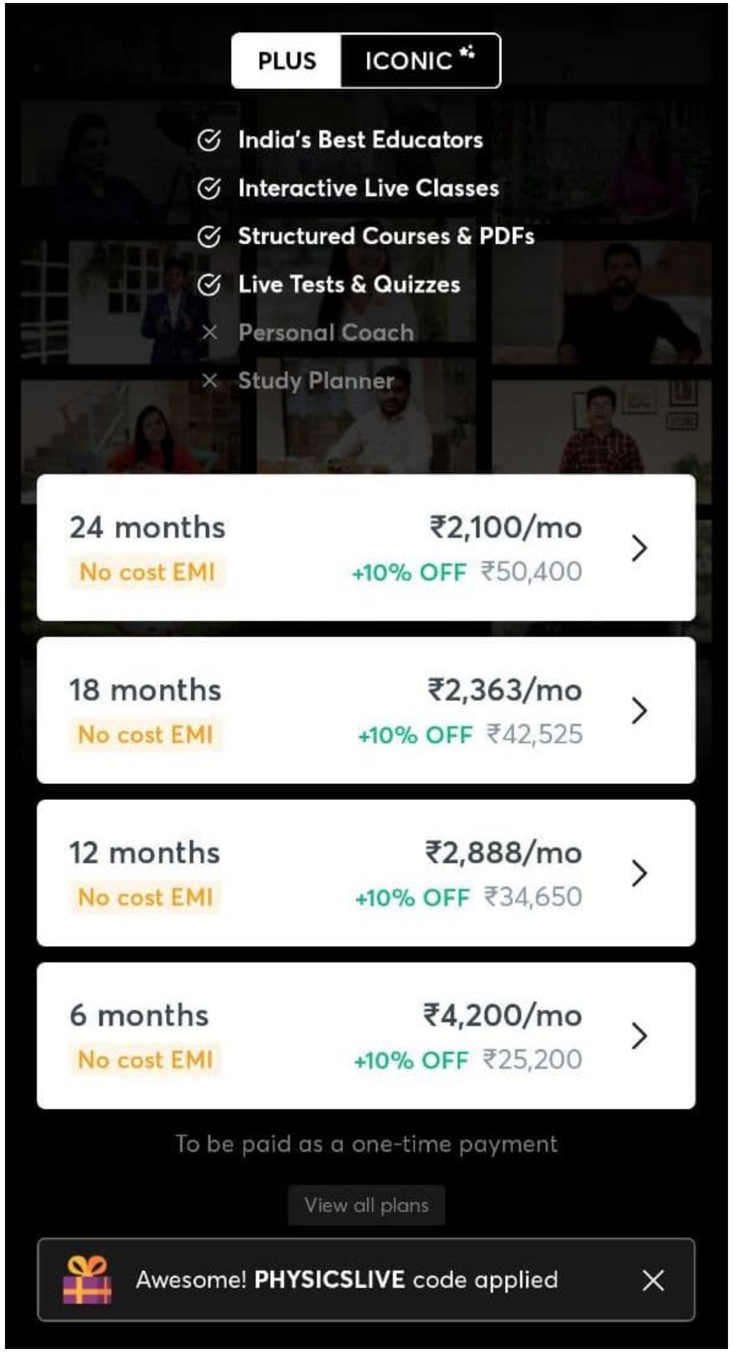

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Physics DPP - Solution

DPP- 1 S.H.M. : Displacement ,Velocity and Accaleration in S.H.M. , Graphs between v,x & a

By Physicsaholics Team

Q1) A particle moves such that its acceleration is given by:

$$\alpha = -\beta(x - 2)$$

Here : β is a positive constant and x the position from origin. Time period of oscillations is:

$\alpha = -\beta(x-2)$, $a = -\omega^2 x$

$(x-2)$ → displacement from mean position

$\alpha = -\beta X$, $X = x - 2$

$\omega^2 = \beta$

$\omega = \sqrt{\beta}$

$T = \frac{2\pi}{\sqrt{\beta}}$

(a) $2\pi\sqrt{\beta}$

(b) $2\pi\sqrt{\frac{1}{\beta}}$

(c) $2\pi\sqrt{\beta + 2}$

(d) $2\pi\sqrt{\frac{1}{\beta+2}}$

Q2) The maximum acceleration of a particle in SHM is made two times keeping the maximum speed to be constant. It is possible when:

$$a_{max} = \omega^2 A$$

$$V_{max} = \omega A$$

$$a_{max} = V_{max}\,\omega$$

(a_{max} → 2 times, V_{max} → constant, ω → 2 times)

but $\omega A = \text{Constant} \Rightarrow A \propto \frac{1}{\omega}$ (A → $\frac{1}{2}$ times, ω → 2 times)

(a) amplitude of oscillation is doubled while frequency remains constant

(b) amplitude is doubled while frequency is halved

(c) frequency is doubled while amplitude is halved ✓

(d) frequency of oscillation is doubled while amplitude remains constant

Q3) A particle moves according to the law x = a cos $\frac{\pi t}{2}$. The distance covered by it in the time interval between t = 0 to t = 3 s is :

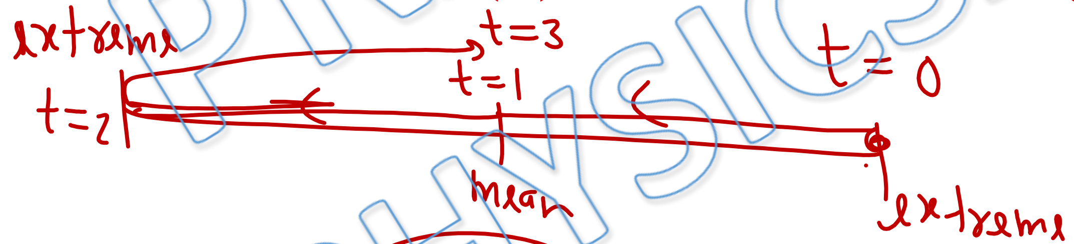
$x = a\cos\frac{\pi t}{2} = a\sin\left(\frac{\pi t}{2} + \frac{\pi}{2}\right)$

$\omega = \pi/2 \Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi/2} = 4\,\text{sec}$

$T/4 = 1\,\text{Sec}$

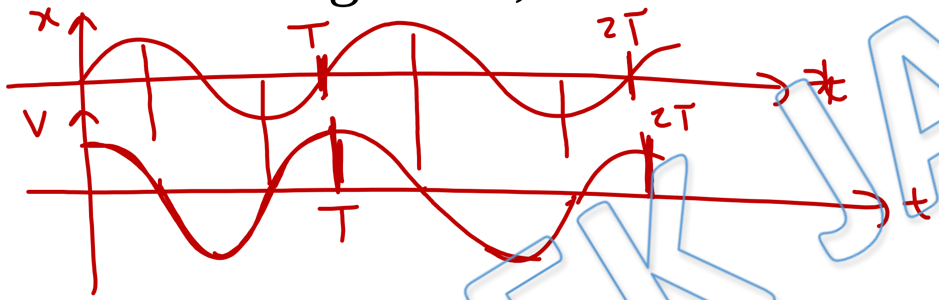
at $t = 0,\ x = a\cos 0 = a$

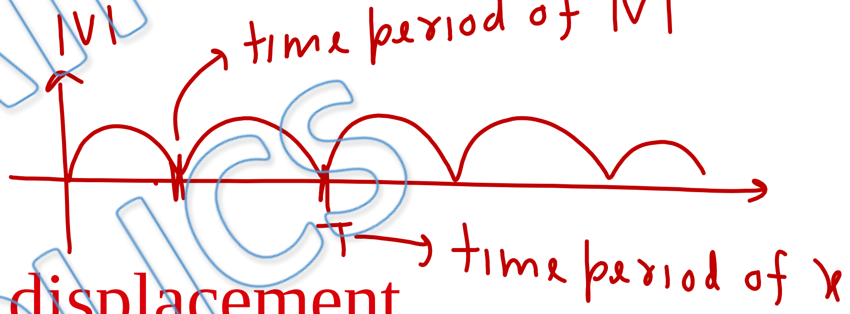
(a) 2a (b) 3a (c) 4a (d) a



$S = 3a$

Q4) For a particle executing SHM, which of the following statements does not hold good ?



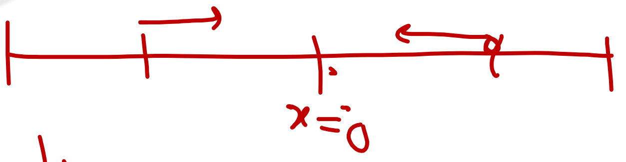


(a) Frequency of speed is two times of that of displacement.

(b) the restoring force is always directed towards a fixed point

(c) the restoring force is maximum at the extreme positions

(d) the velocity of the particle is minimum at the centre of motion of the particle



$F = -m\omega^2 x$

$V = V_{max} = A\omega$ at centre.

Q5) The acceleration of a particle moving along x-axis is a = – 100x + 50. It is released from x = 2. Here ‘a’ and ‘x’ are in S.I units. The motion of particle will be :

$a = -100x + 50$

$a = -100\left(x - \frac{1}{2}\right)$ → mean position $X = 0$

$a = -\omega^2 X$

X → Displacement from mean position

$x - \frac{1}{2} = 0$

$x = \frac{1}{2}$

(a) periodic, oscillatory but not SHM. (b) periodic but not oscillatory.

(c) oscillatory but not periodic. ✓ (d) simple harmonic.

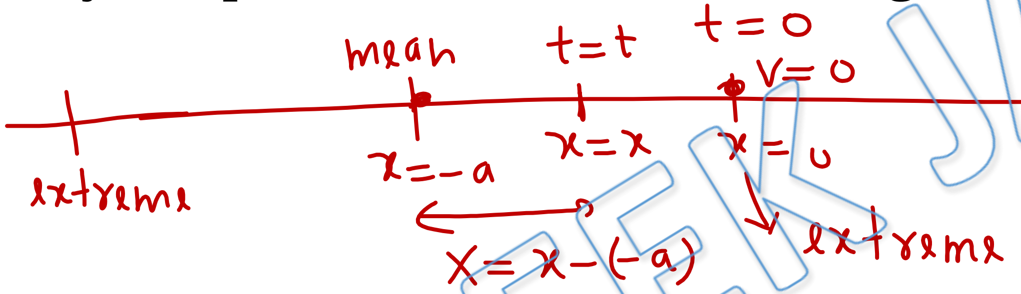
Q6) For a particle in S.H.M., if the amplitude of displacement is 'a' and the amplitude of velocity is 'v' the amplitude of acceleration is

$V_{max} = A\omega = V$

$a_{acc} = A\omega^2 = \frac{A^2\omega^2}{A} = \frac{V^2}{a}$

(a) va (b) $\frac{v^2}{a}$ (c) $\frac{v^2}{2a}$ (d) $\frac{v}{a}$

Q7) A particle executes SHM along x-axis about the centre at x = - a with frequency f Hz. Initially the particle is at rest at the origin. Its equation of motion will be



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

$x + a = a\sin(\omega t+\phi)$

$x = a\sin(\omega t+\pi/2) - a$

$= a(\cos\omega t - 1)$

$= a(\cos 2\pi f t - 1)$

(a) x = 2a(1 – cos2πft)

(b) x = a cos 2 π ft

(c) x = a (cos 2 π ft – 1) ✓

(d) x = a (1 – cos 2 π ft)

$x = a\sin(\omega t+\phi) - a$

at $t=0$, $x=0 \Rightarrow a\sin\phi - a = 0$

$\sin\phi = 1 \Rightarrow \phi = \pi/2$

$\sin(\omega t - \pi/2) = -\sin(\pi/2 - \omega t) = -\cos\omega t$

Q8) A particle moves according to the equation x = a $Sin^2\left(\omega t - \frac{\pi}{2}\right)$. Its amplitude and angular frequency are

$\cos 2\omega t = 2\cos^2\omega t - 1$

$x = \frac{a}{2} \times 2\cos^2\omega t$

$x = \frac{a}{2}\left[1 + \cos 2\omega t\right]$

$x = \frac{a}{2} + \frac{a}{2}\cos 2\omega t$

(a) a,ω (b) $\frac{a}{2}$, ω (c) $\frac{a}{2}$, $\frac{\omega}{2}$ (d) $\frac{a}{2}$, 2ω ✓

$\left(x - \frac{a}{2}\right) = \frac{a}{2}\sin(2\omega t + \pi/2)$

$X = \frac{a}{2}\sin(2\omega t + \pi/2)$

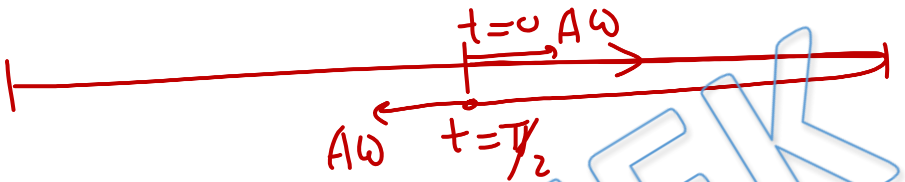
Mean position

$X = 0$, $x = a/2$

$A = a/2$

Angular freq = 2ω

Q9) A particle is executing SHM of amplitude A and angular frequency ω. The average acceleration of particle for half the time period is (sailing from mean position)



$$\Delta V = (-A\omega) - (A\omega) = -2A\omega$$

$$|a_{av}| = \frac{|\Delta v|}{\Delta t} = \frac{2A\omega}{T/2} = \frac{4A\omega}{2\pi/\omega} = \frac{2A\omega^2}{\pi}$$

(a) $\frac{2A\omega^2}{\pi}$ (b) $\frac{A\omega^2}{\pi}$ (c) $\frac{3A\omega^2}{2\pi}$ (d) $\frac{A\omega^2}{2}$

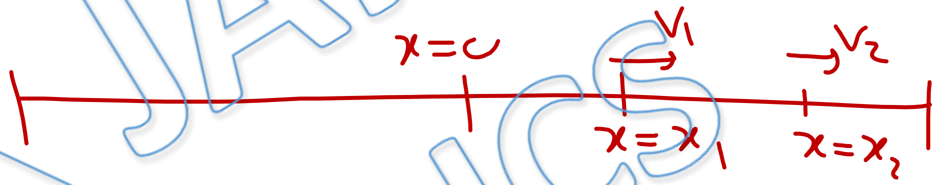
Q10) The velocities of a particle in SHM at positions x_1 and x_2 are v_1 and v_2 respectively, its time period will be -

(a) $2\pi\sqrt{(v_1^2 - v_2^2)/(x_2^2 - x_1^2)}$

(b) $2\pi\sqrt{(x_1^2 + x_2^2)/(v_2^2 - v_1^2)}$

(c) $2\pi\sqrt{(x_1^2 - x_2^2)/(v_2^2 - v_1^2)}$

(d) $2\pi\sqrt{(x_1^2 + x_2^2)/(v_2^2 + v_1^2)}$



$V^2 = \omega^2(A^2 - x^2)$

$V_1^2 = \omega^2(A^2 - x_1^2)$

$V_2^2 = \omega^2(A^2 - x_2^2)$

$V_1^2 - V_2^2 = \omega^2(x_2^2 - x_1^2)$

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

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

Q11) In SHM, the phase difference between the displacement and acceleration is:

$x = A \sin \omega t$

$v = A\omega \cos \omega t$

$a = -A\omega^2 \sin \omega t = A\omega^2 \sin(\omega t + \pi)$

phase difference $= \pi$

$a = -\omega^2 x$

(a) 0 (b) $\pi/2$ (c) π (d) 2π

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Chalo Niklo