DPP – 1 (SHM)

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Q 1. A particle executes simple harmonic motion with an amplitude of 5 cm. When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in second is

(a) $\frac{8\pi}{3}$ (b) $\frac{4\pi}{3}$

(c) $\frac{3\pi}{8}$ (d) $\frac{7\pi}{3}$

Q 2. In an engine, the piston undergoes vertical simple harmonic motion with amplitude 7 cm. A washer rests on top of the piston and moves with it. The motor speed is slowly increased. The frequency of the piston at which the washer no longer stays in contact with the piston is close to

(a) 0.7 Hz (b) 1.9 Hz

(c) 1.2 Hz (d) 0.1 Hz

Q 3. The maximum velocity a particle, executing simple harmonic motion with an amplitude 7 mm, 4.4 m/s. The period of oscillation is.

(a) 0.01 s (b) 10 s

(c) 0.1 s (d) 100 s

Q 4. A particle executes simple harmonic motion with an angular velocity and maximum acceleration of 3.5 rad/s and 7.5 m/s^2 respectively. The amplitude of oscillation

(a) 0.28 m (b) 0.36 m

(c) 0.53 m (d) 0.61 m

Q 5. While a particle executes simple harmonic motion, the rate of change of acceleration is maximum and minimum respectively at

(a) the mean position and extreme positions

(b) the extreme positions and mean position

(c) the mean position alternatively

(d) the extreme positions alternatively

Q 6. A particle executes simple harmonic motion and is located at x = a, b and c at times t_0, $2t_0$ and $3t_0$ respectively. The frequency of the oscillation is

(a) $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{2a+3c}{b}\right)$ (b) $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+c}{2b}\right)$

(c) $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+b}{2c}\right)$ (d) $\frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+2b}{3c}\right)$

Q 7. A particle executes simple harmonic motion according to equation $4\frac{d^2x}{dt^2} + 320x = 0$. Its time period of oscillation is :-

(a) $\frac{2\pi}{5\sqrt{3}}$ s (b) $\frac{\pi}{3\sqrt{2}}$ s

(c) $\frac{\pi}{2\sqrt{5}}$ s (d) $\frac{2\pi}{3}$ s

Q 8. A particle executes simple harmonic motion with a time period of 16s. At time t=2s, the particle crosses the mean position while at time t = 4s its velocity is 4m/s. Find its amplitude of motion.

(a) 13.2 m (b) 14.4 m

(c) 16.8 m (d) 19.3 m

Q 9. A particle executes a simple harmonic motion of time period T. Find the time taken by the particle to go directly from its mean position to half the amplitude.

(a) $\frac{T}{2}$ (b) $\frac{T}{4}$

(c) $\frac{T}{8}$ (d) $\frac{T}{12}$

Q 10. A particle is executing simple harmonic motion with an amplitude of 0.02 meter and frequency 50 Hz. The maximum acceleration of the particle is

(a) 100 m/s^2 (b) $100\pi^2$ m/s^2

(c) 100 m/s (d) $200\pi^2$ m/s^2

Q 11. Which of the following equation does not represent a simple harmonic motion:

(a) Y = a $\sin(\omega t)$ (b) Y = a $\cos(\omega t)$

(c) Y = a $\sin(\omega t)$ + b $\cos(\omega t)$ (d) Y = a $\tan(\omega t)$

Q 12. A particle executing SHM has amplitude 0.01 and frequency 60 Hz. The maximum acceleration of the particle is

(a) $60\pi^2\ m/s^2$ (b) $88\pi^2\ m/s^2$

(c) $104\pi^2\ m/s^2$ (d) $144\pi^2\ m/s^2$

Q 13. What is the phase difference between acceleration and velocity of a particle executing simple harmonic motion?

(a) zero (b) $\frac{\pi}{2}$

(c) π (d) 2π

Q 14. A particle moves such that its acceleration a is given by a = −bx, where x is the displacement from equilibrium position and b is a constant. The period of oscillation is

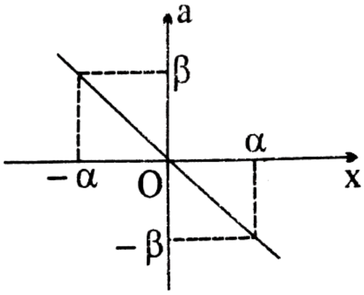
(a) $2\pi\sqrt{b}$ (b) $\frac{2\pi}{\sqrt{b}}$

(c) $\frac{2\pi}{b}$ (d) $2\sqrt{\frac{\pi}{b}}$

Q 15. A simple harmonic wave having an amplitude a and time period T is represented by the equation y = 5 sin π(t+4) m. Then the value of amplitude (a) in (m) and time period (T) in second are

(a) a = 10, T = 2 (b) a = 5, T = 1
(c) a = 10, T = 1 (d) a = 5, T = 2

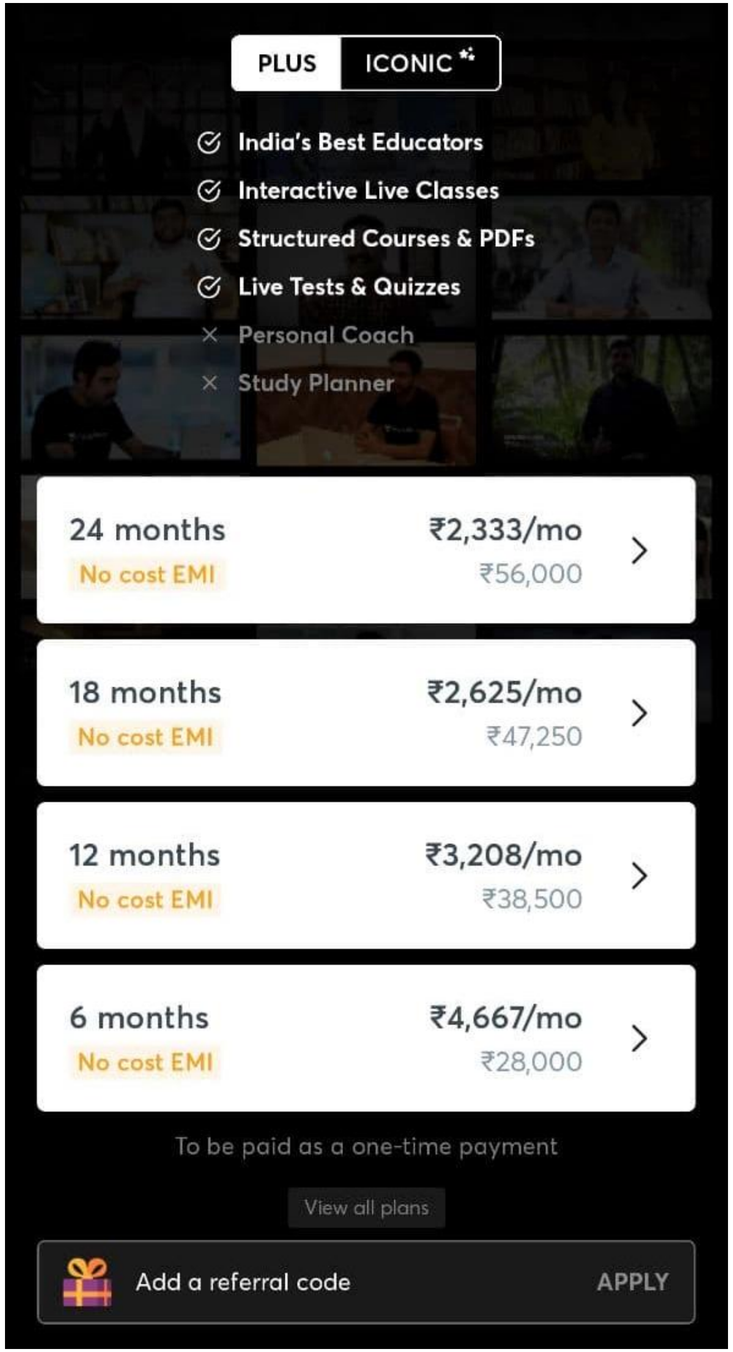
Q 16. The acceleration-displacement (a – x) graph of a particle executing simple harmonic motion is shown in the figure. Find the frequency of oscillation



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

Answer Key

Q.1 a	Q.2 b	Q.3 a	Q.4 d	Q.5 a
Q.6 b	Q.7 c	Q.8 b	Q.9 d	Q.10 d
Q.11 d	Q.12 d	Q.13 b	Q.14 b	Q.15 d
Q.16 a				



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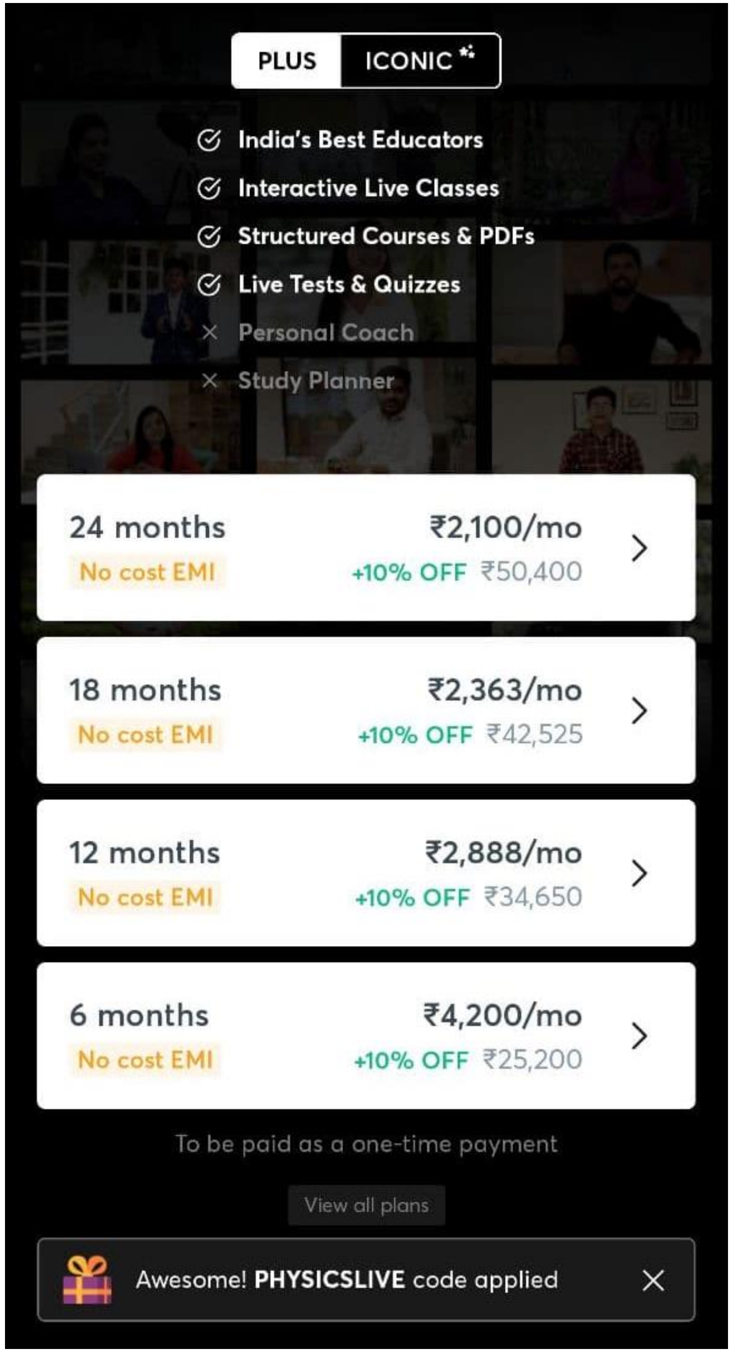

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NEET & JEE Main
Physics DPP - Solution

DPP-1 SHM: Velocity, displacement, acceleration time period & frequency of SHM etc. and graphs

By Physicsaholics Team

Solution: 1

$A = 5\ cm$

$x = 4\ cm$

$|v| = |a|$

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

$\sqrt{5^2 - 4^2} = \omega(4)$

$\boxed{\omega = \frac{3}{4}\ rad/s}$

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

$T = \frac{2\pi}{(3/4)}$

$\boxed{T = \frac{8\pi}{3}\ sec}$ Ans.

Ans. a

Solution: 2

$A = 7\ cm$

if $a_{max} \geq g$

then washer is loose contact. $\rightarrow$ $\boxed{f = 1.9\ Hz}$ Ans.

So, $\omega^2 A \geq g$

$\omega^2 \geq \frac{g}{A} \Rightarrow \omega_{min}^2 = \frac{g}{A}$

$(2\pi f_{min})^2 = \frac{g}{A}$

$f_{min}^2 = \frac{g}{4\pi^2 A}$

$f_{min}^2 = \frac{10}{(2 \times 3.14)^2 \times 7 \times 10^{-2}}$

$f^2 = 3.62$

Ans. b

Solution: 3

$$v_{max} = A\omega = 4.4\ m/s$$

$$(7\times10^{-3})\times\omega = 4.4$$

$$\omega = \frac{4.4}{7}\times10^{3}$$

$$\frac{2\pi}{T} = \frac{4.4}{7}\times10^{3}$$

$$T = 2\left(\frac{22}{7}\right)\times\frac{7}{4.4}\times10^{-3}$$

0.2 0.1

$$T = 10^{-2}\ sec$$

$$\boxed{T = 0.01\ sec}$$ Ans.

Ans. a

Solution: 4

$\omega = 3.5$ rad/s

$a_{max} = \omega^2 A = 7.5$ m/s^2

$(3.5)^2 A = 7.5$

$A = \frac{7.5}{(3.5)^2}$

$\boxed{A = 0.61 \text{ m}}$ Ans.

Ans. d

Solution: 5

$$a = -\omega^2 x$$

Rate of change of acceleration $= \frac{da}{dt} = -\omega^2 \frac{dx}{dt}$

$$\frac{da}{dt} = -\omega^2 v \Rightarrow \left|\frac{da}{dt}\right| = \omega^2 v$$

at mean position

$v = max \Rightarrow$ so; $\left(\frac{da}{dt}\right)_{max}$

at extreme position

$v = zero \Rightarrow$ so; $\left(\frac{da}{dt}\right)_{min}$ Ans.

Ans. a

Solution: 6

$x = A \sin\omega t$

so, $a = A\sin(\omega t_0)$

$b = A\sin(2\omega t_0)$

$c = A\sin(3\omega t_0)$

$a + c = A[\sin(\omega t_0) + \sin(3\omega t_0)]$

$= A\left[2\sin\left(\frac{\omega t_0 + 3\omega t_0}{2}\right)\cos\left(\frac{3\omega t_0 - \omega t_0}{2}\right)\right]$

$[\because \sin a + \sin b = 2\sin\left(\frac{a+b}{2}\right)\cos\left(\frac{a-b}{2}\right)]$

$= A[2\sin(2\omega t_0)\cos(\omega t_0)]$

$a + c = A\sin(2\omega t_0) \times [2\cos\omega t_0]$

$a + c = b(2\cos\omega t_0)$

$\frac{a+c}{2b} = \cos\omega t_0$

$\omega t_0 = \cos^{-1}\left(\frac{a+c}{2b}\right)$

$\omega = \frac{1}{t_0}\cos^{-1}\left(\frac{a+c}{2b}\right) = 2\pi f$

$\boxed{f = \frac{1}{2\pi t_0}\cos^{-1}\left(\frac{a+c}{2b}\right)}$ Ans.

Ans. b

Solution: 7

$$4\frac{d^2x}{dt^2} + 320x = 0$$

$$\frac{d^2x}{dt^2} = -\frac{320}{4}x = -80x$$

$$\therefore \frac{d^2x}{dt^2} = -\omega^2 x$$

$$\text{So: } \omega^2 = 80 \Rightarrow \omega = \sqrt{16\times5} = 4\sqrt{5}$$

$$\frac{2\pi}{T} = 4\sqrt{5} \Rightarrow T = \frac{2\pi}{4\sqrt{5}}$$

$$\boxed{T = \frac{\pi}{2\sqrt{5}}\ \text{sec}}\ \text{Ans.}$$

Ans. c

Solution: 8

$T = 16\ sec \Rightarrow \frac{2\pi}{\omega} = 16$

at $t = 4\ sec$

$\boxed{\omega = \frac{\pi}{8}\ rad/s}$

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

at, $t = 2\ sec \Rightarrow x = 0$

so; $0 = A\sin\left(\frac{\pi}{8} \times 2 + \phi\right)$

$\sin\left(\frac{\pi}{4} + \phi\right) = 0$

$\frac{\pi}{4} + \phi = 0, \pi, 2\pi$

$\phi = -\frac{\pi}{4}$

$x = A\sin\left(\omega t - \frac{\pi}{4}\right)$

so; $v = A\omega \cos\left(\omega t - \frac{\pi}{4}\right)$

at $t = 4\ sec$, $v = 4\ m/s$

$4 = A\left(\frac{\pi}{8}\right)\cos\left(\frac{\pi}{8} \times 4 - \frac{\pi}{4}\right)$

$4 = \frac{\pi}{8} A \cos\left(\frac{\pi}{2} - \frac{\pi}{4}\right)$

$\frac{32}{\pi} = A\cos\left(\frac{\pi}{4}\right) = \frac{A}{\sqrt{2}}$

$\boxed{A = \frac{32\sqrt{2}}{\pi}\ m}$

or

$\boxed{A = 14.4\ m}$ Ans.

Ans. b

Solution: 9

$$x = A\sin\omega t$$

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

$$x = A\sin\left(\frac{2\pi}{T}t\right)$$

$$\frac{A}{2} = A\sin\left(\frac{2\pi}{T}t\right)$$

$$\frac{1}{2} = \sin\left(\frac{2\pi}{T}t\right)$$

$$\frac{2\pi}{T}t = \frac{\pi}{6}$$

$$\boxed{t = \frac{T}{12}\text{ sec}}$$ Ans

Ans. d

Solution: 10

$A = 0.02\ m$

$f = 50\ Hz$

$\omega = 2\pi f$

$\omega = 100\pi\ rad/s$

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

$a_{max} = (100\pi)^2 \times 0.02$

$= 10^4 \times \pi^2 \times 0.02$

$= 10^4 \times \pi^2 \times 0.02$

$a_{max} = 200\pi^2\ m/s^2$ Ans

Ans. d

Solution: 11

(a) $y = a\sin\omega t$

shows SHM

(b) $y = a\cos\omega t$

shows SHM

(c) $y = a\sin\omega t + b\cos\omega t$

$$\frac{dy}{dt} = a\omega\cos\omega t - b\omega\sin\omega t$$

$$\frac{d^2y}{dt^2} = -a\omega^2\sin\omega t - b\omega^2\cos\omega t$$

$$\frac{d^2y}{dt^2} = -\omega^2(a\sin\omega t + b\cos\omega t)$$

$$\boxed{\frac{d^2y}{dt^2} = -\omega^2 y}$$

so; it shows SHM

(d) $y = a\tan\omega t$

$$\frac{dy}{dt} = a\omega\sec^2\omega t$$

$$\frac{d^2y}{dt^2} = a\omega^2(2\sec\omega t)(\sec\omega t\tan\omega t)$$

so; $\frac{d^2y}{dt^2} \neq -\omega^2 y$

so; $y = a\tan\omega t$

do not represent equation of SHM

Ans.

Ans. d

Solution: 12

$A = 0.01$

$f = 60\ Hz$

$\omega = 2\pi f$

$\omega = 120\pi\ rad/s$

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

$a_{max} = (120\pi)^2 \times 0.01$

$= 14400 \times \pi^2 \times 0.01$

$a_{max} = 144\pi^2\ m/s^2$ Ans

Ans. d

Solution: 13

$x = A\sin\omega t$

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

$a = -A\omega^2\sin\omega t = A\omega^2\cos\left(\frac{\pi}{2}+\omega t\right)$

So; phase difference btwn v & a is '$\frac{\pi}{2}$' Ans.

Ans. b

Solution: 14

$a = -bx$

$a = -\omega^2 x$

$\Rightarrow \omega^2 = b \Rightarrow \omega = \sqrt{b}$

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

$T = \frac{2\pi}{\sqrt{b}}$ Ans.

Ans. b

Solution: 15

$y = 5 \sin \pi(t+4)$

$y = 5 \sin(\pi t + 4\pi) = 5 \sin(4\pi + \pi t)$

$y = 5 \sin \pi t$

$\omega = \pi$

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

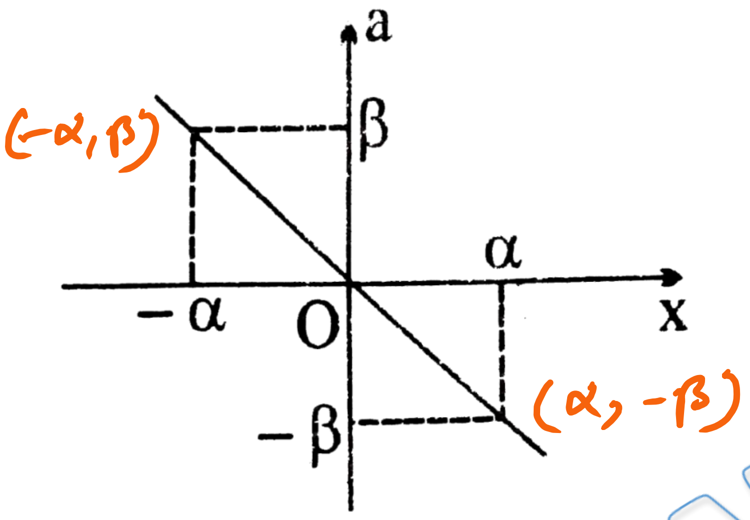
$T = \frac{2\pi}{\pi}$

$\boxed{T = 2 \text{ sec}}$ Ans.

& Amplitude; $\boxed{A = 5 \text{ m}}$ Ans.

Ans. d

Solution: 16



$$a = -\frac{\beta}{\alpha} x$$

$$a = -\omega^2 x$$

So; $\omega^2 = \beta/\alpha$

$$\omega = \sqrt{\frac{\beta}{\alpha}}$$

$$2\pi f = \sqrt{\frac{\beta}{\alpha}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{\beta}{\alpha}}$$ Ans.

Ans. a

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