

Oscillations — NEET Physics PYQ (2005-2021)

Class 11 Physics · 24 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. A spring is stretched by 5 cm by a force 10 N. The time period of the oscillations when a mass of 2 kg is suspended by it is :

- (A) 0.0628 s
- (B) 6.28 s
- (C) 3.14 s
- (D) 0.628 s

NEET 2020 · Q145

2. The phase difference between displacement and acceleration of a particle in a simple harmonic motion is :

- (A) π rad
- (B) $3\pi/2$ rad
- (C) $\pi/2$ rad
- (D) zero

NEET 2019 · Q10

3. The displacement of a particle executing simple harmonic motion is given by $y = A_0 + A \sin \omega t + B \cos \omega t$. Then the amplitude of its oscillation is given by:

- (A) $A_0 + \sqrt{A^2 + B^2}$
- (B) $\sqrt{A^2 + B^2}$
- (C) $\sqrt{A_0^2 + (A + B)^2}$
- (D) $A + B$

NEET 2019 · Q19

4. Average velocity of a particle executing SHM in one complete vibration is:

- (A) $A\omega/2$
- (B) $A\omega$
- (C) $A\omega^2/2$
- (D) zero

NEET 2018 · Q25

5. A pendulum is hung from the roof of a sufficiently high building and is moving freely to and fro like a simple harmonic oscillator. The acceleration of the bob of the pendulum is 20 m/s^2 at a distance of 5 m from the mean position. The time period of oscillation is

- (A) 2 s
- (B) π s
- (C) 2π s
- (D) 1 s

NEET 2017 · Q147

6. A particle executes linear simple harmonic motion with an amplitude of 3 cm. When the particle is at 2 cm from the mean position, the magnitude of its velocity is equal to that of its acceleration. Then its time period in seconds is:

- (A) $\sqrt{5}/\pi$
- (B) $\sqrt{5}/2\pi$
- (C) $4\pi/\sqrt{5}$
- (D) $2\pi/\sqrt{3}$

7. A spring of force constant k is cut into lengths of ratio 1 : 2 : 3. They are connected in series and the new force constant is k' . Then they are connected in parallel and force constant is k'' . Then $k' : k''$ is:

- (A) 1 : 6
- (B) 1 : 9
- (C) 1 : 11
- (D) 1 : 14

8. A body of mass m is attached to the lower end of a spring whose upper end is fixed. The spring has negligible mass. When the mass m is slightly pulled down and released, it oscillates with a time period of 3 s. When the mass m is increased by 1 kg, the time period of oscillations becomes 5 s. The value of m in kg is

- (A) $3/4$
- (B) $4/3$
- (C) $16/9$
- (D) $9/16$

9. A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position are V_1 and V_2 , respectively. Its time period is:

- (A) $2\pi\sqrt{((V_1^2 - V_2^2)/(x_1^2 - x_2^2))}$
- (B) $2\pi\sqrt{((x_1^2 + x_2^2)/(V_1^2 + V_2^2))}$
- (C) $2\pi\sqrt{((x_2^2 - x_1^2)/(V_1^2 - V_2^2))}$
- (D) $2\pi\sqrt{((V_1^2 + V_2^2)/(x_1^2 + x_2^2))}$

10. When two displacements represented by $y_1 = a \sin(\omega t)$ and $y_2 = b \cos(\omega t)$ are superimposed the motion is:

- (A) simple harmonic with amplitude $(a + b)/2$
- (B) not a simple harmonic
- (C) simple harmonic with amplitude a/b
- (D) simple harmonic with amplitude $\sqrt{a^2 + b^2}$

11. Two particles are oscillating along two close parallel straight lines side by side, with the same frequency and amplitudes. They pass each other, moving in opposite directions when their displacement is half of the amplitude. The mean positions of the two particles lie on a straight line perpendicular to the paths of the two particles. The phase difference is

- (A) π
- (B) $\pi/6$
- (C) 0
- (D) $2\pi/3$

12. Out of the following functions representing motion of a particle which represents SHM?

- (A) $y = \sin \omega t - \cos \omega t$
- (B) $y = \sin^3 \omega t$
- (C) $y = 5 \cos(3\pi/4 - 3\omega t)$
- (D) $y = 1 + \omega t + \omega^2 t^2$

- (A) Only $y = \sin \omega t - \cos \omega t$ and $y = \sin^3 \omega t$
- (B) Only $y = \sin \omega t - \cos \omega t$
- (C) Only $y = 1 + \omega t + \omega^2 t^2$ does not represent SHM
- (D) Only $y = \sin \omega t - \cos \omega t$ and $y = 5 \cos(3\pi/4 - 3\omega t)$

13. The displacement of a particle along the x-axis is given by $x = a \sin^2 \omega t$. The motion of the particle corresponds to

- (A) Simple harmonic motion of frequency $\omega/(2\pi)$
- (B) Simple harmonic motion of frequency ω/π
- (C) Simple harmonic motion of frequency $3\omega/(2\pi)$
- (D) Non simple harmonic motion

14. The period of oscillation of a mass M suspended from a spring of negligible mass is T . If along with it another mass M is also suspended, the period of oscillation will now be

- (A) $\sqrt{2} T$
- (B) T
- (C) $T/\sqrt{2}$
- (D) $2T$

15. A simple pendulum performs simple harmonic motion about $x = 0$ with an amplitude a and time period T . The speed of the pendulum at $x = a/2$ will be:

- (A) $\pi a/T$
- (B) $3\pi^2 a/T$
- (C) $\pi a\sqrt{3}/T$
- (D) $\pi a\sqrt{3}/(2T)$

16. Which one of the following equations of motion represents simple harmonic motion? Where k , k_0 , k_1 and a are all positive.

- (A) acceleration = $-k(x + a)$
- (B) acceleration = $k(x + a)$
- (C) acceleration = kx
- (D) acceleration = $-k_0x + k_1x^2$

17. Two simple harmonic motions of angular frequency 100 and 1000 rad s^{-1} have the same displacement amplitude. The ratio of their maximum accelerations is

- (A) 1 : 10^4
- (B) 1 : 10
- (C) 1 : 10^2
- (D) 1 : 10^3

18. A point performs simple harmonic oscillation of period T and the equation of motion is given by $x = a \sin(\omega t + \pi/6)$. After the elapse of what fraction of the time period the velocity of the point will be equal to half of its maximum velocity?

- (A) $T/12$
- (B) $T/8$
- (C) $T/6$
- (D) $T/3$

19. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is

- (A) π
- (B) 0.707π
- (C) zero
- (D) 0.5π

20. The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively

- (A) $K_0/2$ and K_0
- (B) K_0 and $2K_0$
- (C) K_0 and K_0
- (D) 0 and $2K_0$

21. A particle executes simple harmonic oscillation with an amplitude a . The period of oscillation is T . The minimum time taken by the particle to travel half of the amplitude from the equilibrium position is

- (A) $T/8$
- (B) $T/12$
- (C) $T/2$
- (D) $T/4$

22. A rectangular block of mass m and area of cross-section A floats in a liquid of density ρ . If it is given a small vertical displacement from equilibrium it undergoes oscillation with a time period T . Then :

- (A) $T \propto \sqrt{\rho}$
- (B) $T \propto 1/\sqrt{A}$
- (C) $T \propto 1/\rho$
- (D) $T \propto 1/\sqrt{m}$

23. The circular motion of a particle with constant speed is :

- (A) simple harmonic but not periodic
- (B) periodic and simple harmonic
- (C) neither periodic nor simple harmonic
- (D) periodic but not simple harmonic

24. A particle executing simple harmonic motion of amplitude 5 cm has maximum speed of 31.4 cm/s. The frequency of its oscillation is :

- (A) 2 Hz
- (B) 1.5 Hz
- (C) 0.5 Hz
- (D) 1 Hz

Answer key and explanations

1. Answer: (D) 0.628 s

$k = F/x = 10/0.05 = 200 \text{ N/m}$. $T = 2\pi\sqrt{m/k} = 2\pi\sqrt{2/200} = 2\pi \times 0.1 = 0.628 \text{ s}$. 6.28 s would result from forgetting to convert 5 cm into metres.

2. Answer: (A) π rad

In SHM $a = -\omega^2 x$, so acceleration is always opposite to displacement, a phase difference of π rad. The $\pi/2$ difference is between displacement and velocity.

3. Answer: (B) $\sqrt{A^2 + B^2}$

A_0 only shifts the mean position; $A \sin \omega t + B \cos \omega t$ combine into a single sinusoid of amplitude $\sqrt{A^2 + B^2}$. Adding A_0 to it gives the maximum displacement from the origin, not the amplitude about the mean position.

4. Answer: (D) zero

After one complete vibration the particle returns to its starting point, so displacement is zero and average velocity is zero. $A\omega$ is the maximum speed, not the average velocity.

5. Answer: (B) π s

In SHM $a = \omega^2 x$, so $\omega^2 = 20/5 = 4$ and $\omega = 2 \text{ rad/s}$. $T = 2\pi/\omega = \pi \text{ s}$; $2\pi \text{ s}$ would correspond to $\omega = 1 \text{ rad/s}$.

6. Answer: (C) $4\pi/\sqrt{5}$

Speed $v = \omega\sqrt{A^2 - x^2} = \omega\sqrt{9 - 4} = \sqrt{5} \omega$ and acceleration $a = \omega^2 x = 2\omega^2$ (in cm units). Setting them equal gives $\omega = \sqrt{5}/2$ rad/s, so $T = 2\pi/\omega = 4\pi/\sqrt{5}$ s. $\sqrt{5}/2\pi$ is the frequency, not the period.

7. Answer: (C) 1 : 11

Spring constant is inversely proportional to length, so the pieces ($l/6$, $2l/6$, $3l/6$) have constants $6k$, $3k$ and $2k$. In series they rebuild the original spring, $k' = k$; in parallel $k'' = 6k + 3k + 2k = 11k$. Hence $k' : k'' = 1 : 11$.

8. Answer: (D) 9/16

$T \propto \sqrt{m}$, so $3/5 = \sqrt{(m/(m+1))}$ and $9/25 = m/(m+1)$. Then $9m + 9 = 25m$, giving $m = 9/16$ kg. Inverting the ratio leads to $16/9$ kg.

9. Answer: (C) $2\pi\sqrt{(x_2^2 - x_1^2)/(V_1^2 - V_2^2)}$

$V_1^2 = \omega^2(a^2 - x_1^2)$ and $V_2^2 = \omega^2(a^2 - x_2^2)$. Subtracting, $V_1^2 - V_2^2 = \omega^2(x_2^2 - x_1^2)$, so $\omega = \sqrt{(V_1^2 - V_2^2)/(x_2^2 - x_1^2)}$ and $T = 2\pi\sqrt{(x_2^2 - x_1^2)/(V_1^2 - V_2^2)}$. The inverted ratio gives $1/T$, not T .

10. Answer: (D) simple harmonic with amplitude $\sqrt{a^2 + b^2}$

$a \sin \omega t + b \cos \omega t = \sqrt{a^2 + b^2} \sin(\omega t + \phi)$ with $\tan \phi = b/a$: a single SHM of the same ω . The two are 90° out of phase, so amplitudes add as $\sqrt{a^2 + b^2}$, not $(a + b)/2$.

11. Answer: (D) $2\pi/3$

$x = A \sin \phi = A/2$ gives $\phi = \pi/6$ for one particle and $5\pi/6$ for the other, since they move in opposite directions at that displacement. Phase difference $= 5\pi/6 - \pi/6 = 2\pi/3$. Zero would mean they move together, and π would mean they cross only at the mean position.

12. Answer: (D) Only $y = \sin \omega t - \cos \omega t$ and $y = 5 \cos(3\pi/4 - 3\omega t)$

$\sin \omega t - \cos \omega t = \sqrt{2} \sin(\omega t - \pi/4)$ and $5 \cos(3\pi/4 - 3\omega t)$ are single sinusoids, so both are SHM. $\sin^3 \omega t = (3 \sin \omega t - \sin 3\omega t)/4$ is periodic but a mix of two frequencies, so not SHM, and $1 + \omega t + \omega^2 t^2$ is not even periodic. So only the first and third functions are SHM; the claim that only the last function fails is wrong because $\sin^3 \omega t$ also fails.

13. Answer: (B) Simple harmonic motion of frequency ω/π

$x = a \sin^2 \omega t = (a/2)(1 - \cos 2\omega t)$. This is a cosine oscillation of amplitude $a/2$ about the shifted mean position $x = a/2$ with angular frequency 2ω , so $d^2(x - a/2)/dt^2 = -4\omega^2(x - a/2)$: it is SHM of frequency $2\omega/2\pi = \omega/\pi$. Calling it non-SHM ignores the shift of the mean position; $\omega/2\pi$ uses the wrong angular frequency.

14. Answer: (A) $\sqrt{2} T$

$T = 2\pi\sqrt{M/k}$, so $T \propto \sqrt{M}$. Doubling the mass gives $T' = \sqrt{2} T$. $2T$ would need four times the mass.

15. Answer: (C) $\pi a\sqrt{3}/T$

$v = \omega\sqrt{a^2 - x^2}$ with $\omega = 2\pi/T$. At $x = a/2$, $v = (2\pi/T)\sqrt{(3a^2/4)} = (2\pi/T)(\sqrt{3}a/2) = \pi a\sqrt{3}/T$. The value with $2T$ in the denominator forgets that ω already carries the factor 2π .

16. Answer: (A) acceleration $= -k(x + a)$

Put $X = x + a$; then acceleration $= -kX$, which is SHM about $x = -a$ with $\omega^2 = k$. Acceleration $= +kx$ or $k(x + a)$ points away from equilibrium, and the x^2 term makes the motion non-linear.

17. Answer: (C) 1 : 10^2

Maximum acceleration $= \omega^2 A$. For equal amplitudes the ratio is $(100/1000)^2 = 1 : 10^2$. $1 : 10$ is the ratio of maximum velocities (ωA), not accelerations.

18. Answer: (A) $T/12$

$v = a\omega \cos(\omega t + \pi/6)$. Setting $v = a\omega/2$ gives $\omega t + \pi/6 = \pi/3$, so $\omega t = \pi/6$ and $t = (\pi/6)/(T/2\pi) = T/12$. $T/6$ would be the answer if the initial phase $\pi/6$ were ignored.

19. Answer: (D) 0.5π

If $x = A \sin \omega t$, then $v = A\omega \cos \omega t$ and $a = -A\omega^2 \sin \omega t$, so acceleration leads velocity by $\pi/2 = 0.5\pi$. A phase difference of π exists between displacement and acceleration, not velocity and acceleration.

20. Answer: (C) K_0 and K_0

Kinetic energy is maximum (K_0) at the mean position, where all energy is kinetic, so total energy $= K_0$. Potential energy is maximum at the extremes and also equals K_0 . $2K_0$ wrongly adds the two maxima.

21. Answer: (B) $T/12$

$x = a \sin \omega t$; $x = a/2$ when $\omega t = \pi/6$, so $t = (\pi/6)/(2\pi/T) = T/12$. $T/4$ is the time to reach the full amplitude.

22. Answer: (B) $T \propto 1/\sqrt{A}$

When the block is pushed down by y , the extra buoyant force is $A\rho gy$, so it behaves like a spring of constant $k = A\rho g$. Hence $T = 2\pi\sqrt{m/(A\rho g)}$, which varies as $1/\sqrt{A}$ (and as $1/\sqrt{\rho}$, $\sqrt{m}$). T is not proportional to $\sqrt{\rho}$ or $1/\rho$, and it increases, not decreases, with m .

23. Answer: (D) periodic but not simple harmonic

Uniform circular motion repeats after every revolution, so it is periodic. It is not SHM, because SHM is motion along a line under a restoring force $\propto$ displacement; only the projection of circular motion is SHM.

24. Answer: (D) 1 Hz

$v_{\text{max}} = A\omega$, so $\omega = 31.4/5 = 6.28 \text{ rad/s}$ and $f = \omega/2\pi = 1 \text{ Hz}$. Taking 6.28 as the frequency or dividing wrongly gives 2 Hz or 0.5 Hz.

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