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CLASS 11 PHYSICS · NCERT CHAPTER 13 · IMU CET PRACTICE

Oscillations

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Questions: 45 MCQs

Each question has exactly one correct option. Attempt all questions first, then check the Answer Key and Solutions at the end.

- 1 In simple harmonic motion, the restoring force is proportional to
 - (A) displacement and directed towards the mean position
 - (B) square of displacement
 - (C) displacement and directed away from the mean position
 - (D) velocity
- 2 The displacement of a particle in SHM is $x = 5 \sin(4\pi t + \pi/3)$ cm. Its amplitude is
 - (A) 5 cm
 - (B) 4π cm
 - (C) 10 cm
 - (D) $\pi/3$ cm
- 3 For $x = 5 \sin(4\pi t + \pi/3)$, the time period is
 - (A) 0.25 s
 - (B) 4 s
 - (C) 2 s
 - (D) 0.5 s
- 4 The maximum velocity of a particle in SHM with amplitude A and angular frequency ω is
 - (A) $A\omega$
 - (B) ω/A
 - (C) A/ω
 - (D) $A\omega^2$
- 5 The maximum acceleration of a particle in SHM is
 - (A) $A\omega$
 - (B) $A\omega^2$
 - (C) zero
 - (D) $A^2\omega$
- 6 In SHM, at the mean position,
 - (A) both are maximum
 - (B) velocity is maximum and acceleration is zero
 - (C) both are zero
 - (D) velocity is zero and acceleration is maximum
- 7 The phase difference between displacement and velocity in SHM is
 - (A) $\pi/2$
 - (B) 2π
 - (C) π
 - (D) 0
- 8 The phase difference between displacement and acceleration in SHM is
 - (A) 0
 - (B) $\pi/2$
 - (C) π
 - (D) $\pi/4$



- 9 The time period of a spring-mass system is
(A) $2\pi\sqrt{(k/m)}$ (B) $2\pi mk$
(C) $2\pi\sqrt{(m/k)}$ (D) $(1/2\pi)\sqrt{(m/k)}$
- 10 A mass of 1 kg attached to a spring of $k = 100 \text{ N/m}$ oscillates. Its time period is
(A) 0.628 s (B) 1 s
(C) 0.1 s (D) 6.28 s
- 11 If the mass attached to a spring is made four times, the period becomes
(A) unchanged (B) four times
(C) half (D) twice
- 12 A spring of constant k is cut into two equal halves. The spring constant of each half is
(A) k (B) $k/2$
(C) $4k$ (D) $2k$
- 13 Two springs of constants k_1 and k_2 connected in series have an effective spring constant
(A) $k_1k_2/(k_1 + k_2)$ (B) $k_1 + k_2$
(C) $(k_1 + k_2)/2$ (D) $\sqrt{(k_1k_2)}$
- 14 Two springs of constants k_1 and k_2 connected in parallel have an effective spring constant
(A) $k_1k_2/(k_1 + k_2)$ (B) $k_1 + k_2$
(C) $(k_1 + k_2)/2$ (D) $k_1 - k_2$
- 15 The time period of a simple pendulum of length l is
(A) $2\pi\sqrt{(l/g)}$ (B) $2\pi lg$
(C) $\sqrt{(l/g)}$ (D) $2\pi\sqrt{(g/l)}$
- 16 The length of a seconds pendulum ($T = 2 \text{ s}$) on Earth is about ($g = 9.8 \text{ m/s}^2$)
(A) 0.25 m (B) 2 m
(C) 0.5 m (D) 1 m
- 17 If the length of a simple pendulum is increased by 44%, its time period increases by
(A) 22% (B) 20%
(C) 44% (D) 12%
- 18 A pendulum clock is taken to the Moon ($g_{\text{moon}} = g/6$). Its time period becomes
(A) $T/\sqrt{6}$ (B) $6T$
(C) $T/6$ (D) $\sqrt{6} T$
- 19 A simple pendulum is in a lift accelerating upward with acceleration a . Its time period is
(A) $2\pi\sqrt{(l/g)}$ (B) infinite
(C) $2\pi\sqrt{(l/(g - a))}$ (D) $2\pi\sqrt{(l/(g + a))}$
- 20 The time period of a simple pendulum in a freely falling lift is
(A) zero (B) $2\pi\sqrt{(l/g)}$
(C) infinite (D) $2\pi\sqrt{(2l/g)}$



- 21 The total energy of a particle in SHM is
(A) $\frac{1}{2}m\omega A$ (B) $m\omega^2 A^2$
(C) $\frac{1}{2}m\omega^2 x^2$ (D) $\frac{1}{2}m\omega^2 A^2$
- 22 In SHM, kinetic energy equals potential energy at a displacement of
(A) $A/\sqrt{2}$ (B) $A/2$
(C) A (D) $A/4$
- 23 When the displacement is half the amplitude in SHM, the fraction of total energy that is kinetic is
(A) $1/2$ (B) $3/4$
(C) $1/8$ (D) $1/4$
- 24 The frequency of oscillation of kinetic energy of a particle in SHM of frequency f is
(A) $4f$ (B) f
(C) $f/2$ (D) $2f$
- 25 The equation $a = -16x$ (SI) describes SHM. The angular frequency is
(A) 8 rad/s (B) 16 rad/s
(C) 4 rad/s (D) 2 rad/s
- 26 Which of the following represents SHM?
(A) $x = A t \sin \omega t$ (B) $x = A \sin \omega t + B \sin 2\omega t$
(C) $x = A \sin \omega t + B \cos \omega t$ (D) $x = A e^{(-\omega t)}$
- 27 The function $\sin^2 \omega t$ represents
(A) a periodic motion with period π/ω , which is SHM about a shifted mean
(B) non-periodic motion
(C) SHM with period $4\pi/\omega$
(D) SHM with period $2\pi/\omega$
- 28 A particle in SHM has amplitude 4 cm and period 2 s. Its maximum speed is
(A) $2\pi \text{ cm/s}$ (B) $4\pi \text{ cm/s}$
(C) $8\pi \text{ cm/s}$ (D) $16\pi \text{ cm/s}$
- 29 A particle executes SHM with amplitude 10 cm and $\omega = 2 \text{ rad/s}$. Its speed at $x = 6 \text{ cm}$ is
(A) 12 cm/s (B) 16 cm/s
(C) 20 cm/s (D) 8 cm/s
- 30 The time taken by a particle in SHM to go from the mean position to half the amplitude is
(A) $T/4$ (B) $T/8$
(C) $T/12$ (D) $T/6$
- 31 The time taken from the extreme position to half the amplitude is
(A) $T/12$ (B) $T/4$
(C) $T/6$ (D) $T/3$
- 32 Damped oscillations have
(A) increasing amplitude (B) amplitude decreasing with time
(C) increasing frequency (D) constant amplitude



- 33** Resonance occurs when
(A) amplitude is minimum
(B) the driving frequency equals the natural frequency
(C) damping is maximum
(D) the driving frequency is zero
- 34** Soldiers are asked to break step while crossing a bridge to avoid
(A) interference (B) damping
(C) resonance (D) beats
- 35** The motion of a simple pendulum is approximately simple harmonic for
(A) only when the bob is heavy (B) any amplitude
(C) small angular displacement (D) large angular displacement
- 36** The time period of a simple pendulum does NOT depend on
(A) mass of the bob (B) acceleration due to gravity
(C) location on Earth (D) length
- 37** A spring-mass system has period T on the Earth. On the Moon, its period will be
(A) T (B) $6T$
(C) $T/\sqrt{6}$ (D) $\sqrt{6} T$
- 38** A particle performs SHM with period 12 s. The minimum time for its displacement to change from $+A$ to $+A/2$ is
(A) 3 s (B) 4 s
(C) 2 s (D) 1 s
- 39** The potential energy of a particle in SHM at displacement x is
(A) $\frac{1}{2}k(A^2 - x^2)$ (B) $\frac{1}{2}kA^2$
(C) kx (D) $\frac{1}{2}kx^2$
- 40** The displacement-time graph of SHM is
(A) a parabola (B) sinusoidal
(C) a straight line (D) an exponential curve
- 41** The velocity-displacement graph of a particle in SHM is
(A) a straight line (B) a parabola
(C) a hyperbola (D) an ellipse
- 42** The acceleration-displacement graph of a particle in SHM is
(A) an ellipse
(B) a straight line with negative slope through origin
(C) a parabola
(D) a circle
- 43** A mass m on a spring has period 2 s. When an extra mass of 2 kg is added, the period becomes 3 s. The value of m is
(A) 1.6 kg (B) 3.2 kg
(C) 0.8 kg (D) 2 kg



- 44** The motion of the Earth around the Sun is
- (A) SHM
 - (B) oscillatory and SHM
 - (C) periodic but not SHM
 - (D) non-periodic
-
- 45** In SHM, the speed is maximum when the displacement is
- (A) $A/\sqrt{2}$
 - (B) half the amplitude
 - (C) maximum
 - (D) zero
-

Answer Key

1	2	3	4	5	6	7	8	9	10
A	A	D	A	B	B	A	C	C	A
11	12	13	14	15	16	17	18	19	20
D	D	A	B	A	D	B	D	D	C
21	22	23	24	25	26	27	28	29	30
D	A	B	D	C	C	A	B	B	C
31	32	33	34	35	36	37	38	39	40
C	B	B	C	C	A	A	C	D	B
41	42	43	44	45					
D	B	A	C	D					

Hints & Solutions

- (A) $F = -kx$.
- (A) Comparing with $x = A \sin(\omega t + \phi)$, $A = 5 \text{ cm}$.
- (D) $\omega = 4\pi \rightarrow T = 2\pi/\omega = 0.5 \text{ s}$.
- (A) $v = \omega\sqrt{A^2 - x^2}$, maximum at $x = 0$: $v_{\max} = A\omega$.
- (B) $a = -\omega^2 x \rightarrow |a|_{\max} = \omega^2 A$ at the extreme position.
- (B) At $x = 0$, $v = A\omega$ (max) and $a = -\omega^2 x = 0$.
- (A) $x = A \sin \omega t$, $v = A\omega \cos \omega t = A\omega \sin(\omega t + \pi/2)$.
- (C) $a = -\omega^2 x$, so acceleration is opposite to displacement.
- (C) $\omega = \sqrt{k/m} \rightarrow T = 2\pi\sqrt{m/k}$.
- (A) $T = 2\pi\sqrt{1/100} = 2\pi/10 = 0.628 \text{ s}$.
- (D) $T \propto \sqrt{m} \rightarrow 2T$.
- (D) $k \propto 1/\text{length} \rightarrow$ each half has $2k$.
- (A) $1/k = 1/k_1 + 1/k_2$.
- (B) Both stretch equally; forces add $\rightarrow k = k_1 + k_2$.
- (A) For small oscillations, $T = 2\pi\sqrt{l/g}$.
- (D) $I = gT^2/4\pi^2 = 9.8 \times 4/39.5 \approx 0.99 \text{ m}$.
- (B) $T \propto \sqrt{l} \rightarrow \sqrt{1.44} = 1.2 \rightarrow 20\% \text{ increase}$.
- (D) $T \propto 1/\sqrt{g} \rightarrow \sqrt{6} T$.
- (D) Effective $g = g + a$.
- (C) $g_{\text{eff}} = 0 \rightarrow T = \infty$ (the pendulum does not oscillate).
- (D) $E = \frac{1}{2}kA^2 = \frac{1}{2}m\omega^2 A^2$, constant.
- (A) $\frac{1}{2}k(A^2 - x^2) = \frac{1}{2}kx^2 \rightarrow x = A/\sqrt{2}$.
- (B) $PE = \frac{1}{2}k(A/2)^2 = E/4 \rightarrow KE = 3E/4$.



24. (D) $KE \propto \cos^2 \omega t$, which oscillates at twice the frequency.
25. (C) $a = -\omega^2 x \rightarrow \omega^2 = 16 \rightarrow \omega = 4 \text{ rad/s}$.
26. (C) $A \sin \omega t + B \cos \omega t = R \sin(\omega t + \phi)$, a single-frequency sinusoid — SHM.
27. (A) $\sin^2 \omega t = \frac{1}{2} - \frac{1}{2} \cos 2\omega t \rightarrow$ SHM about $\frac{1}{2}$ with angular frequency 2ω , period π/ω .
28. (B) $\omega = \pi \text{ rad/s} \rightarrow v_{\max} = A\omega = 4\pi \text{ cm/s}$.
29. (B) $v = \omega\sqrt{A^2 - x^2} = 2\sqrt{100 - 36} = 16 \text{ cm/s}$.
30. (C) $A/2 = A \sin(2\pi t/T) \rightarrow 2\pi t/T = \pi/6 \rightarrow t = T/12$.
31. (C) $x = A \cos \omega t = A/2 \rightarrow \omega t = \pi/3 \rightarrow t = T/6$.
32. (B) Damping forces dissipate energy, so the amplitude decays (exponentially).
33. (B) At resonance the amplitude of forced oscillation becomes maximum.
34. (C) Marching frequency might match the bridge's natural frequency, causing large-amplitude resonance.
35. (C) $\sin \theta \approx \theta$ only for small θ , giving $F \propto -\theta$.
36. (A) $T = 2\pi\sqrt{l/g}$ is independent of the bob's mass.
37. (A) $T = 2\pi\sqrt{m/k}$ does not depend on g .
38. (C) From extreme to $A/2$ takes $T/6 = 2 \text{ s}$.
39. (D) $U = \frac{1}{2}kx^2$ for a restoring force $F = -kx$.
40. (B) $x = A \sin(\omega t + \phi)$ is a sine curve.
41. (D) $v^2/(\omega A)^2 + x^2/A^2 = 1$ is the equation of an ellipse.
42. (B) $a = -\omega^2 x$ is linear with slope $-\omega^2$.
43. (A) $T^2 \propto m \rightarrow 4/9 = m/(m + 2) \rightarrow 9m = 4m + 8 \rightarrow m = 1.6 \text{ kg}$.
44. (C) It repeats every year (periodic) but there is no to-and-fro motion about a mean position.
45. (D) $v = \omega\sqrt{A^2 - x^2}$ is maximum at $x = 0$.

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