Oscillations

Class 11 Physics · 24 NEET MCQs with answers & explanations

Oscillations covers simple harmonic motion (SHM), springs, pendulums, energy in SHM, damped and forced oscillations. NEET tests SHM equations (displacement, velocity, acceleration), time period of spring and pendulum systems, and energy at different positions. This is a high-weightage, formula-intensive chapter.

Key SHM Formulas

Concept	Key Formula
Displacement	$x = A \sin(\omega t + \varphi)$; A = amplitude, $\omega = 2\pi/T$
Velocity	$v = A\omega \cos(\omega t + \varphi) = \omega\sqrt{(A^2 - x^2)}$; max at mean, zero at extreme
Acceleration	$a = -\omega^2 x$; max at extreme, zero at mean; always towards mean
Spring time period	$T = 2\pi\sqrt{(m/k)}$; independent of amplitude and g
Pendulum time period	$T = 2\pi\sqrt{(L/g)}$; independent of mass and amplitude (small angle)
Energy in SHM	$KE = \frac{1}{2}m\omega^2(A^2 - x^2)$; $PE = \frac{1}{2}m\omega^2 x^2$; total $E = \frac{1}{2}m\omega^2 A^2$ = constant

Questions

Q1. A simple pendulum performs small oscillations. Its time period is given by:

(A) $T = 2\pi\sqrt{(L/g)}$
(B) $T = 2\pi\sqrt{(g/L)}$
(C) $T = 2\pi\sqrt{(Lg)}$
(D) $T = 2\pi \times Lg$

Q2. Which of the following conditions is necessary and sufficient for a particle to execute SHM?

(A) Restoring force is directly proportional to displacement and directed toward the mean position
(B) Velocity remains constant throughout the motion
(C) Acceleration is constant in magnitude and direction
(D) The particle moves with uniform speed between two fixed points

Q3. A particle executes SHM according to $x = A \sin(\omega t + \varphi)$. The quantity φ is called:

(A) Angular frequency
(B) Phase constant
(C) Amplitude
(D) Time period

Q4. A block attached to a horizontal spring executes SHM. The restoring force acting on the block is:

(A) Proportional to displacement and directed toward the mean position
(B) Constant throughout the motion
(C) Proportional to velocity
(D) Equal to the weight of the block

Q5. A body performing angular SHM has restoring torque proportional to which of the following?

(A) Negative angular displacement
(B) Angular velocity
(C) Angular acceleration
(D) Time

Q6. According to Hooke's law, the restoring force acting on a particle executing SHM is:

(A) $F = -kx$
(B) $F = kx^2$
(C) $F = ma$
(D) $F = -mv$

Q7. A body is said to execute forced oscillations when it oscillates under the action of:

(A) An external periodic force
(B) A restoring force only
(C) Gravity only
(D) Friction only

Q8. A damped oscillator is one in which:

(A) The amplitude decreases continuously with time
(B) The time period continuously decreases
(C) The restoring force becomes zero
(D) The frequency continuously increases

Q9. A particle in SHM has total energy E. At displacement x = A/2, what is the kinetic energy?

(A) E/4
(B) E/2
(C) 3E/4
(D) E

Q10. Which of the following best defines periodic motion?

(A) A motion that repeats with changing time interval
(B) A motion that repeats itself after equal intervals of time
(C) A motion with constant speed only
(D) A motion having constant acceleration

Q11. In an ideal simple harmonic motion, the total mechanical energy remains:

(A) Constant throughout the motion
(B) Maximum at the mean position
(C) Maximum at the extreme position
(D) Zero at the mean position

Q12. In SHM, the phase difference between displacement and acceleration is:

(A) π rad
(B) $\pi/2$ rad
(C) 0
(D) 2π rad

Q13. Which one of the following quantities always has its maximum value at the extreme position of SHM?

(A) Potential Energy
(B) Kinetic Energy
(C) Speed
(D) Momentum

Q14. Which one of the following is periodic but NOT oscillatory?

(A) To-and-fro motion of a simple pendulum
(B) Vertical oscillation of a spring-block system
(C) Uniform circular motion of a satellite
(D) Vibration of a tuning fork

Q15. The second hand of a clock completes one revolution in 60 s. Its frequency is:

(A) 60 Hz
(B) 1 Hz
(C) 0.5 Hz
(D) 1/60 Hz

Q16. A particle performs 150 oscillations in 5 minutes. Its time period is:

(A) 2 s
(B) 0.5 s
(C) 5 s
(D) 150 s

Q17. Which of the following correctly states the relationship between oscillatory and periodic motion?

(A) All periodic motions are oscillatory
(B) Oscillatory motion need not repeat after equal intervals of time
(C) All oscillatory motions are periodic, but not all periodic motions are oscillatory
(D) Periodic motion always occurs about an equilibrium position

Q18. Which of the following is a necessary and sufficient condition for a motion to be classified as oscillatory?

(A) Motion must have constant time period
(B) The body must move to and fro about a fixed equilibrium position under a restoring influence
(C) The body must have constant mechanical energy throughout motion
(D) The acceleration of the body must be constant in magnitude

Q19. If a particle completes one oscillation in time T, its angular frequency ω is given by:

(A) $2\pi/T$
(B) $T/2\pi$
(C) $1/T$
(D) πT

Q20. A body completes one oscillation in 0.4 s. Its angular frequency is:

(A) 2π rad s^{-1}
(B) π rad s^{-1}
(C) 10π rad s^{-1}
(D) 5π rad s^{-1}

Q21. All of the following are oscillatory motions EXCEPT:

(A) Vibration of a stretched string
(B) Rotation of Earth about its own axis
(C) Vertical motion of a mass on a spring
(D) Small oscillations of a simple pendulum

Q22. A student claims: "Every motion having a fixed time period is oscillatory." Which of the following correctly identifies the flaw in this statement?

(A) Oscillatory motion requires constant velocity
(B) Oscillatory motion requires the net force to always be zero
(C) A periodic motion is oscillatory only if it occurs to and fro about an equilibrium position under a restoring influence
(D) Oscillatory motions cannot have a fixed time period

Q23. A particle starts from maximum positive displacement (+A) at t = 0 and executes oscillatory motion with time period T. After what time does it first reach the mean position?

(A) T/8
(B) T/4
(C) T/2
(D) 3T/4

Q24. Consider the following statements about oscillatory motion: I. It must be periodic. II. Net displacement after one complete oscillation is always zero. III. The restoring force always acts away from the mean position. IV. It can occur without a mean equilibrium position. How many of the above statements are correct?

(A) Only I and II
(B) Only I, II and III
(C) Only II and IV
(D) All four

Answer key

1-A	**2-A**	**3-B**	**4-A**	**5-A**	**6-A**	**7-A**	**8-A**
9-C	**10-B**	**11-A**	**12-A**	**13-A**	**14-C**	**15-D**	**16-A**
17-C	**18-B**	**19-A**	**20-D**	**21-B**	**22-C**	**23-B**	**24-A**

Answers with explanations

Q1 — Answer: (A) $T = 2\pi\sqrt{(L/g)}$
For small oscillations, $T = 2\pi\sqrt{(L/g)}$. Option B inverts L and g inside the square root — the single most common formula error. T increases with L and decreases with g.

Q2 — Answer: (A) Restoring force is directly proportional to displacement and directed toward the mean position
SHM requires $F = -kx$: restoring force proportional to displacement and directed toward mean position. Constant acceleration (C) describes uniform force, not SHM. Uniform speed (D) means no restoring force acts.

Q3 — Answer: (B) Phase constant
In $x = A \sin(\omega t + \varphi)$, φ is the phase constant (initial phase). It determines the state of the particle at $t = 0$. Angular frequency is ω, amplitude is A, and time period is $T = 2\pi/\omega$.

Q4 — Answer: (A) Proportional to displacement and directed toward the mean position
By Hooke's law, F = −kx. Force is proportional to displacement and always directed toward equilibrium. Option C confuses restoring force with damping force, which is velocity-dependent.

Q5 — Answer: (A) Negative angular displacement
tau = -C x theta; torque is proportional to angular displacement with a negative sign, always directed toward equilibrium. Angular velocity and acceleration are not the cause. tau is not time-dependent.

Q6 — Answer: (A) F = −kx
F = −kx: the negative sign shows force is always directed opposite to displacement, towards mean position. F = kx² is non-linear so does not give SHM. F = −mv is a damping-type force, not restoring.

Q7 — Answer: (A) An external periodic force
Forced oscillations occur when an external periodic driving force continuously acts on the system, overriding its natural frequency tendency. Options B, C, D describe forces present in free oscillations, not the defining feature of forced oscillations.

Q8 — Answer: (A) The amplitude decreases continuously with time
Damping causes loss of mechanical energy via resistive forces, reducing amplitude gradually. Frequency changes only slightly for light damping; restoring force is never zero in oscillatory motion.

Q9 — Answer: (C) 3E/4
KE = E(1 - x²/A²). At x = A/2, KE = E(1 - 1/4) = 3E/4. PE = E/4 at this point; the particle retains three-quarters of total energy as kinetic energy at half-amplitude.

Q10 — Answer: (B) A motion that repeats itself after equal intervals of time
Periodic motion repeats after equal time intervals (T). Speed and acceleration need not be constant. Every oscillatory motion is periodic, but not vice versa.

Q11 — Answer: (A) Constant throughout the motion
Total energy E = KE + PE = ½kA² is constant because no non-conservative force acts in ideal SHM. Options B and C confuse total energy with individual KE and PE, which do vary with position.

Q12 — Answer: (A) π rad
a = −ω²x: acceleration is always opposite to displacement, so phase difference = π rad. Option B (π/2) is the phase difference between displacement and velocity — a closely related but distinct relationship.

Q13 — Answer: (A) Potential Energy
At the extreme position displacement is maximum, so potential energy (½kx²) is maximum. The particle momentarily stops there, so kinetic energy, speed and momentum are all zero.

Q14 — Answer: (C) Uniform circular motion of a satellite
Uniform circular motion repeats after equal intervals but lacks to-and-fro motion about a mean position, so it is not oscillatory. All other options involve restoring motion about equilibrium.

Q15 — Answer: (D) 1/60 Hz
Frequency f = 1/T = 1/60 Hz. A common error is writing f = T = 60, confusing period with frequency. The second hand completes one cycle per 60 seconds, not 60 cycles per second.

Q16 — Answer: (A) 2 s
Total time = 5 × 60 = 300 s. T = 300/150 = 2 s. Option D is the trap for students who forget to convert minutes to seconds.

Q17 — Answer: (C) All oscillatory motions are periodic, but not all periodic motions are oscillatory
Every oscillatory motion repeats after equal intervals, making it periodic. Uniform circular motion is periodic but not oscillatory — it has no equilibrium position about which it oscillates.

Q18 — Answer: (B) The body must move to and fro about a fixed equilibrium position under a restoring influence
Oscillatory motion requires to-and-fro motion about a mean position with a restoring tendency. Constant time period is a feature, not the defining condition. Constant acceleration violates the restoring force criterion.

Q19 — Answer: (A) 2π/T
Angular frequency ω = 2π/T, expressing how many radians of phase the oscillation completes per second. Option C gives ordinary frequency f, not angular frequency.

Q20 — Answer: (D) 5π rad s^{-1}
ω = 2π/T = 2π/0.4 = 5π rad s^{-1}. Option C (10π) is the trap for students who incorrectly use ω = 2πT instead of ω = 2π/T.

Q21 — Answer: (B) Rotation of Earth about its own axis
Earth's rotation is periodic (completes one rotation per day) but not oscillatory — it does not move to and fro about a mean position. All other options involve restoring motion about equilibrium.

Q22 — Answer: (C) A periodic motion is oscillatory only if it occurs to and fro about an equilibrium position under a restoring influence
Periodic motion requires only equal time intervals of repetition. Oscillatory motion additionally demands to-and-fro displacement about a mean position with a restoring force. Circular motion disproves the student's claim.

Q23 — Answer: (B) T/4
From maximum displacement, the particle reaches mean position after T/4 (one quarter of a full cycle: +A → 0). T/8 is a common trap — students incorrectly halve T/4, not recognising the quarter-cycle rule.

Q24 — Answer: (A) Only I and II
Statements I and II are correct: oscillatory motion is always periodic and net displacement per cycle is zero. Statement III is wrong — restoring force acts toward mean position. Statement IV is wrong — equilibrium position is essential.

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