Mahavir Senior Model School
Class Assignment
Class : XI-C
Subject : Physics
Chapter : Oscillations

COMPTENCY BASED QUESTIONS
MUTIPLE CHOICE QUESTIONS

Q-1- The displacement of simple harmonic oscillator after 3 seconds starting from its mean position is equal to half of its amplitude. The time period of harmonic motion is

(a) 6 s (b) 8 s (c) 12 s (d) 36 s

Q-2- A particle has displacement y given by $y = 3 \sin(5\pi t + \pi)$, where y is in meter and t is in second. What are frequency and period of motion?

(a) 0.4 Hz, 2.5 s (b) 2.5 Hz, 0.4 s (c) 2.5 Hz, 2.5 s (d) 0.4 Hz, 0.4 s

Q-3- Two simple motions are represented by $y_1 = 5 \sin(2\pi t + \sqrt{3} \cos 2\pi t)$; $y_2 = 5 \sin(2\pi t + \pi/4)$. The ratio of the amplitude of two S.H.M.'s is

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) $1 : \sqrt{3}$

Q-4- Two pendulums have time periods T and 5T/4. They start SHM at the same time from the mean position. What will be the phase difference between them after the bigger pendulum completed one oscillation?

(a) 45^0 (b) 90^0 (c) 60^0 (d) 30^0

Q-5- A particle executes SHM. Its time period is 16 s. If it passes through the center of oscillation, then its velocity is 2 m/s at time 2 s. The amplitude will be

(a) 7.2 cm (b) 4 cm (c) 6 cm (d) 0.72 m

Q-6- A particle executing SHM has an amplitude of 6 cm. Its acceleration at a distance of 2 cm from the mean position is 8 cm/s^2. The maximum speed of the particle in cm/s is

(a) 24 (b) 16 (c) 12 (d) 4

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

(a) 0.01 s (b) 0.1 s (c) 10 s (d) 100 s

Q-8- In a simple harmonic oscillator, at the mean position

(a) Kinetic energy is minimum, potential energy is maximum.
(b) Both kinetic and potential energies are maximum.
(c) Kinetic energy is maximum, potential energy is minimum.
(d) Both kinetic and potential energies are minimum.

Q-9- The potential energy of a simple harmonic oscillator when the particle is half way to its end point is

(a) 2/3 E (b) 1/8 E (c) ¼ E (d) ½ E

Q-10- A particle is having potential energy 1/3 of the maximum value at a distance of 4 cm from mean position. Amplitude of motion is

(a) $4\sqrt{3}$ (b) $6/\sqrt{2}$ (c) $2/\sqrt{6}$ (d) $2\sqrt{6}$

Q-11- In a simple harmonic oscillator, at the mean position

(a) Kinetic energy is minimum, potential energy is maximum.
(b) Both kinetic and potential energies are maximum.
(c) Kinetic energy is maximum, potential energy is minimum.
(d) Both kinetic and potential energies are minimum.

Q-12- The potential energy of a simple harmonic oscillator when the particle is half way to its end point is

(a) 2/3 E (b) 1/8 E (c) ¼ E (d) ½ E

Q-13- The potential energy of a particle doing SHM is 2.5 J when displacement is half of amplitude. Then the total energy is

(a) 5 J (b) 10 J (c) 15 J (d) 20 J

Q-14- Time period of a simple pendulum will be doubled, if we

(a) Decrease the length 2 times (b) Decrease the length 4 times
(c) Increase the length 2 times (d) Increase the length 4 times

Q-15- If the time period of a two-meter-long simple pendulum is 2 s, the acceleration due to gravity at the place where pendulum is executing SHM is

(a) $9.8\ m/s^2$ (b) $16\ m/s^2$ (c) $\pi^2\ m/s^2$ (d) $2\ \pi^2\ m/s^2$

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COMPTENCY BASED QUESTIONS
ASSERTIONS AND REASONS

DIRECTIONS

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) If Assertion is true but Reason is false.
(d) If both Assertion and Reason are false.

Q-1- **Assertion**: In S.H.M., the motion is to and fro and periodic.
Reason: Velocity of the particle, $v = \omega\sqrt{(a^2 - x^2)}$ where x is displacement.

Q-2- **Assertion**: In simple harmonic motion, the velocity is maximum, when the acceleration is minimum.
Reason: Displacement and velocity in simple harmonic motion differ in phase by $\pi/2$.

Q-3- **Assertion**: The amplitude of an oscillating pendulum decreases gradually with time.
Reason: The frequency of the pendulum decreases with time.

Q-4- **Assertion**: The time period of a pendulum on a satellite orbiting the earth is infinity.
Reason: The time period of a pendulum is inversely proportional to $\sqrt{g}$.

Q-5- **Assertion**: Water in a U-tube executes S.H.M. The time period for mercury filled up to the same height in the U-tube will be greater than that in case of water.
Reason: The amplitude of an oscillating pendulum goes on increasing.

Q-6- **Assertion**: Resonance is a special case of forced vibration in which the nature and frequency of vibration of the body is the same as the impressed frequency and the amplitude of forced vibration, is maximum.
Reason: The amplitude of forced vibrations of a body increases with an increase in the frequency of the externally impressed periodic force.

Q-7- **Assertion**: The bob of a simple pendulum is a ball full of water, if a fine hole is made in the bottom of the ball, the time period first increases and then decreases.
Reason: As water flows out of the bob, the weight of the bob decreases.

Q-8- **Assertion**: The periodic time of a hard spring is less as compared to that of a soft spring.
Reason: The periodic time depends upon the spring constant, which is large for hard spring.

Q-9- **Assertion**: When a pendulum is made to oscillate to oscillate on the surface of the Moon, its time period increases.
Reason: Moon is much smaller as compared to earth.

Q-10- **Assertion**: If a pendulum is suspended in a lift and lift is falling freely, then its time period becomes infinite.
Reason: Free falling body has acceleration equal to acceleration due to gravity.

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COMPTENCY BASED QUESTIONS
CASE STUDY BASED QUESTIONS

PARAGRAPH : Simple Harmonic Motion

A particle is said to execute simple harmonic motion if it moves to and fro about a mean position under the action of a restoring force which is directly proportional to its displacement from the mean position and is always directed towards the mean position. For small displacement,

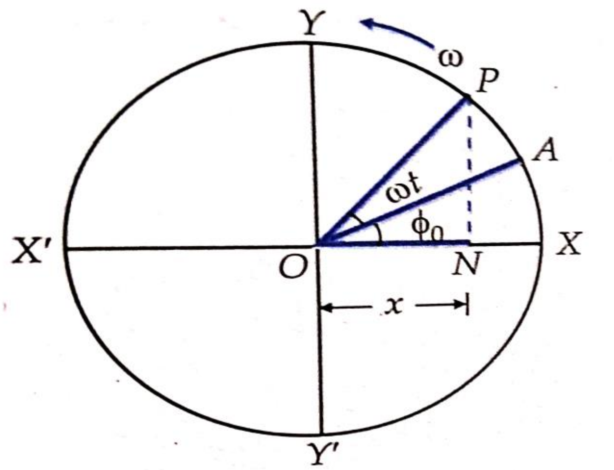
Restoring force α Displacement or $F \alpha x$ of $F = - kx$

This equation defines S.H.M. Here k is a positive constant called force constant or spring factor. As shown in the Figure, consider a particle P moving along a circle of radius A with uniform angular velocity ω. N is the projection of P on the diameter XX'. As the particle P revolves along the circle, the projection N moves to and fro about the point O along the diameter XX'. The motion of N about O is simple harmonic. Suppose the particle P starts from A and reaches point P at time t such that AQP = ωt. Displacement of projection B from center O is x = ON.

In right Δ ONP, $ON/OP = \cos(\omega t + \phi_0)$ => $x/A = \cos(\omega t + \phi_0)$

$$x = A \cos(\omega t + \phi_0)$$

This equation gives displacement of the particle in S.H.M. The quantity $(\omega t + \phi_0)$ is called phase and ϕ_0 is called initial phase while A is the amplitude of S.H.M.



QUESTIONS (Answer any four of the following questions)

Q-1- The motion of a particle executing S.H.M. in one dimension is described by $x = - 0.5 \sin(2t + \pi/4)$ where x is in meters and t in seconds. The frequency of oscillation in Hz is

(a) 2 (b) π (c) π/2 (d) 1/π

Q-2- A particle executing simple harmonic motion has a time period of 4 s. If the particle starts from the mean position at t = 0 then after how much interval of time from t = 0, will its displacement be half of its amplitude?

(a) 1/3 s (b) ½ s (c) 2/3 s (d) 1/6 s

Q-3- A particle is executing S.H.M. with amplitude A, along X-axis. Initially the particle is x = A/2, while moving along + X-direction. If the equation for the oscillation is given by $x = A \sin(\omega t + \delta)$, then δ is

(a) 5π/6 (b) 2π/3 (c) π/6 (d) 2π/5

Q-4- The displacement of a particle (in meter) is given by $Y = 0.2 \sin(10\pi t + 1.5\pi) \cos(10\pi t + 1.5\pi)$. The motion of the particle is

(a) Periodic but not S.H.M.

(b) Non-periodic.

(c) Simple harmonic motion with period 0.1 s.

(d) Simple harmonic motion with period 0.2 s.

Q-5- Which of the following functions represents a simple harmonic oscillation?

(a) $\sin \omega t - \cos \omega t$ (b) $\sin \omega t + \sin 2\omega t$ (c) $\sin \omega t - \sin 2\omega t$ (d) $\sin^2 \omega t$

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COMPTENCY BASED QUESTIONS
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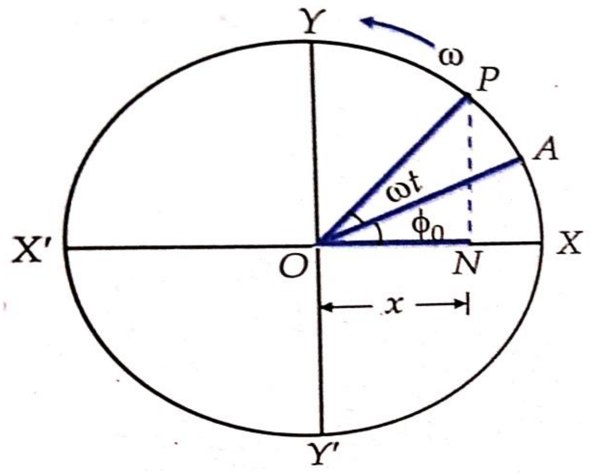
In right Δ ONP, $ON/OP = \cos(\omega t + \phi_0)$ => $x/A = \cos(\omega t + \phi_0)$

$$x = A\cos(\omega t + \phi_0)$$

This equation gives displacement of the particle in S.H.M. The quantity $(\omega t + \phi_0)$ is called phase and ϕ_0 is called initial phase while A is the amplitude of S.H.M.



QUESTIONS (Answer any four of the following questions)

Q-1- The motion of a particle executing S.H.M. in one dimension is described by $x = - 0.5 \sin (2t + \pi/4)$ where x is in meters and t in seconds. The frequency of oscillation in Hz is

(b) 2 (b) π (c) π/2 (d) 1/π

Q-2- A particle executing simple harmonic motion has a time period of 4 s. If the particle starts from the mean position at t = 0 then after how much interval of time from t = 0, will its displacement be half of its amplitude?

(b) 1/3 s (b) ½ s (c) 2/3 s (d) 1/6 s

Q-3- A particle is executing S.H.M. with amplitude A, along X-axis. Initially the particle is x = A/2, while moving along + X-direction. If the equation for the oscillation is given by $x = A \sin (\omega t + \delta)$, then δ is

(b) 5π/6 (b) 2π/3 (c) π/6 (d) 2π/5

Q-4- The displacement of a particle (in meter) is given by Y = 0.2 sin (10πt + 1.5π) cos (10πt + 1.5 π). The motion of the particle is

(b) Periodic but not S.H.M.
(b) Non-periodic.
(c) Simple harmonic motion with period 0.1 s.
(d) Simple harmonic motion with period 0.2 s.

Q-5- Which of the following functions represents a simple harmonic oscillation?

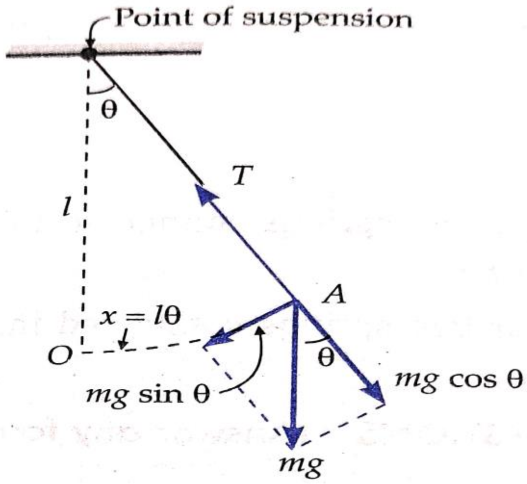
(b) sin ωt – cos ωt (b) sin ωt + sin 2ωt (c) sin ωt – sin 2ωt (d) $\sin^2\omega t$

PARAGRAPH : Oscillations of a Simple Pendulum

A simple pendulum is a heavy point mass suspended by a weightless inextensible and a perfectly flexible string from a rigid support about which it can vibrate freely. The distance of the point of suspension and the point of oscillation is called length of the pendulum. When the metallic bob is displaced slightly on either side and released, it begins to oscillate about the mean position. If the thread makes angle Θ with the vertical at any instant, then the forces acting on the bob are
(i) Weight mg of the bob acting vertically downwards.
(ii) The tension T is the string.
The weight mg has two rectangular components
(a) mg cos Θ acting along the thread which balances the tension T.
(b) tangential component mg sin Θ which provides the restoring force.

F = - mg sin Θ

For small Θ, sin Θ ≈≈ Θ = arc/radius = x/l
.˙. F = - mg x/l or ma = - mgx/l or a = - gx/l = $-\omega^2 x$

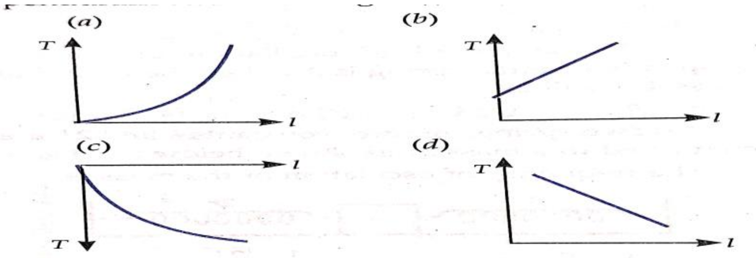


This implies that motion of the pendulum in simple harmonic with time period.

T = 2π/ω = 2π/√(g/l) = 2 π√(l/g).

QUESTIONS (Answer any four of the following questions)

Q-1- The graph of time period (T) of a simple pendulum versus its length (l) is



Q-2- To show that a simple pendulum executes simple harmonic motion, it is necessary to assure that
(a) Length of the pendulum is small (b) Amplitude of oscillation is small
(c) Mass of the pendulum is small (d) Acceleration due to gravity is small

Q-3- A simple pendulum is executing simple harmonic motion with a time period T. If the length of the pendulum is increased by 21%, the increase in the time period of the pendulum of increased length is
(a) 10% (b) 30% (c) 21% (d) 50%

Q-4- The mas and the radius of a planet are twice that of earth. Then, period of oscillation of a second pendulum on that planet will be
(a) $1/\sqrt{2}$ s (b) $2\sqrt{2}$ s (c) 2 s (d) ½ s

Q-5- The time period of a simple pendulum on a satellite, orbiting around the earth, is
(a) Infinite (b) Zero (c) 84.6 min (d) 24 hours

PARAGRAPH : Energy in Simple Harmonic Motion

When a simple harmonic oscillator is displaced from its equilibrium position by doing work on it against restoring forces, it acquires potential energy. When released, it begins to move back with a velocity, thus acquiring kinetic energy.
At instant t,

Displacement, $x = A\cos(\omega t + \phi_0)$

Velocity, $v = dx/dx = -\omega A \sin(\omega t + \phi_0)$

Kinetic energy, $K = \frac{1}{2} mv^2 = \frac{1}{2} mv^2 A^2 \sin^2(\omega t + \phi_0) = \frac{1}{2} kA^2 \sin^2(\omega t + \phi_0) = \frac{1}{2} k(A^2 - x^2)$

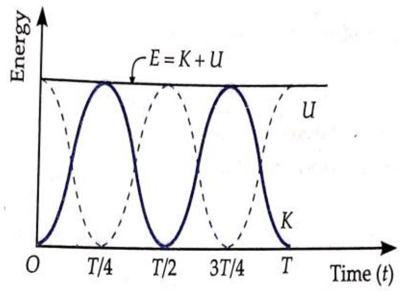
As the restoring force F = - kx is a conservative force, the oscillator is associated with potential energy,

$$U = \frac{1}{2} kx^2 = \frac{1}{2} kA^2 \cos^2(\omega t + \phi_0)$$

Total energy at any displacement x is

$$E = K + U = \frac{1}{2} kA^2[\sin^2(\omega t + \phi_0) + \cos^2(\omega t + \phi_0)]$$

or $$E = \frac{1}{2} kA^2 - \frac{1}{2} mv^2 A^2 = 2\pi^2 mv^2 A^2$$



Total energy is independent of time displacement. In the absence of any frictional force total energy is conserved in S.H.M. as shown graphically. Both kinetic and potential energies vary periodically with time period $\tau/2$.

QUESTIONS (Answer any four of the following questions)

Q-1- For a particle executing simple harmonic motion, which of the following statements is not correct?
(a) Total energy of the particle always remains the same.
(b) Restoring force is always directed towards a fixed point.
(c) Restoring force is maximum at the extreme positions.
(d) Acceleration of the particle is maximum at the equilibrium position.

Q-2- A particle is executing linear simple harmonic motion of amplitude A. At what fraction of the total energy is kinetic when the displacement is half the amplitude?
(a) ¾ (b) $1/2\sqrt{2}$ (c) ½ (d) ¾

Q-3- Average value of kinetic energy and potential energy over entire time period in a S.H.M. is
(a) 0, $\frac{1}{2}m\omega^2A^2$ (b) $\frac{1}{2}m\omega^2A^2$, 0 (c) $\frac{1}{2}m\omega^2A^2$, $\frac{1}{2}m\omega^2A^2$ (d) $1/4m\omega^2A^2$, $1/4m\omega^2A^2$

Q-4- For any S.H.M., amplitude is 6 cm. If instantaneous potential energy is half the total energy, then distance of particle from its mean position is
(a) 3 cm (b) 4.2 cm (c) 5.8 cm (d) 6 cm

Q-5- If the frequency of oscillations of a particle doing S.H.M. is n, the frequency of kinetic energy is
(a) 2 n (b) n (c) n/2 (d) None of these