SIMPLE HARMONIC MOTION

- **Periodic Motion:** If the motion of a body is re peated in regular intervals of time, then the motion is called periodic Motion.
- **Harmonic Motion:** If the displacement of a particle either in periodic motion or in vibratory motion is expressed in harmonic functions like "sine" or "cosine", such a motion often is called Harmonic Motion.

All vibratory motions are periodic. But all periodic motions need not be vibratory

Ex: Motion of earth around the sun is periodic but not vibratory

- **CONDITIONS FOR S.H.M.:** The body is said to be in SHM if :
  (i) it moves to and fro about a fixed point
  (ii) its acceleration is always directed towards the fixed point and
  (iii) the acceleration is directly proportional to the displacement and opposite to its direction $a \propto -y$; $a = -\omega^2 y$.
- **EXAMPLES FOR SIMPLE HARMONIC MOTION:**
  1. Simple Pendulum
  2. Motion of needle of a sewing machine
  3. Motion of the prongs of a vibrating tuning fork.
  4. Vertical oscillatory motion of a loaded spring.
- **AMPLITUDE(A):**
  i) The maximum displacement of the particle executing S.H.M is known as amplitude.
  ii) If s is the span of S.H.M, amplitude A will be s/2.
- **PHASE (ϕ):**
  Phase represents the state of vibration of the particle at an instant of time. It gives the position, velocity, direction of motion, acceleration of the particle at that instant.
  Phase is a linear function of time. A graph drawn between time on X-axis and phase ϕ on Y-axis is a straight line not passing through the origin.

NOTE:

In SHM equal changes of phase occur in equal intervals of time.

EQUATIONS OF S.H.M.:

- If x is displacement of a body executing simple harmonic oscillatation (S.H.O.) from its mean position, then

$$x = ASin(\omega t + \phi)$$

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

Where

Phase = $(\omega t + \phi)$

ϕ = initial phase angle from mean position (epoch)

A = Amplitude; T = time period of oscillation; n = frequency;

- If the particle is initially at the mean position. Then $\phi = 0$, $x = ASin\omega t$
- In a time interval $t = \frac{T}{12}$ from mean position, $x = \frac{A}{2}$ from mean position.

In a time interval $t = \frac{T}{6}$ from extreme position. $x = \frac{A}{2}$ from mean position.

In a time interval $t = \frac{T}{8}$ from mean position, $x = \frac{A}{\sqrt{2}}$ from mean position

(Where T is time period of oscillation; A = amplitude)

If the particle is initially in the extreme position. Then $\phi = 90°$

Substituting in $x = ASin(\omega t + \phi)$

We get $x = ACos\omega t$

- If V is velocity of S.H.O. at a phase angle θ or at a displacement x from mean position, then

$$V = \omega ACos(\omega t + \phi) = V_{max}Cos(\omega t + \phi)$$
$$= \omega\sqrt{A^2 - x^2}$$

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

- **Average speed in SHM:**
  The average speed during one complete oscillation is given by $V_{Avg} = \frac{4A}{T}$, where T is time period of oscillation.
  Note: Average velocity during one complete oscillation is zero.
- If a is acceleration of S.H.O. at a displacement x from mean position, then
  $a = -\omega^2 ASin(\omega t + \phi) = -\omega^2 x$
- **TIME PERIOD:**
  i) The time taken by the particle to complete one oscillation (i.e., one complete to and fro motion) is known as time period.

ii) The smallest time interval after which the oscillation repeats itself is called the time period of oscillation.
iii) If 'x' is the displacement of the particle executing S.H.M. at any time 't', it will achieve the same position again for the first time if time is advanced by $\left(\frac{2\pi}{\omega}\right)$.

i.e., $t' = t + \left(\frac{2\pi}{\omega}\right)$ so that

$$x' = A\sin(\omega t' + \phi) = A\sin\left[\omega\left(t + \frac{2\pi}{\omega}\right) + \phi\right]$$

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

iv) In other words, the displacement repeats after a time interval of $\frac{2\pi}{\omega}$ so that $T = \frac{2\pi}{\omega}$

(v) When a hole is drilled along the diameter of the earth and if a body is dropped in it, it moves to and fro about the centre of the earth and is in S.H.M. with a time period of

$$T = 2\pi\sqrt{\frac{R}{g}} = 84.6 \text{ minutes } or\, T = \sqrt{\frac{3\pi}{GD}}$$

D = *Mean density of the earth.*

G = Gravitational constant.

- **FREQUENCY (n):**
i) The number of oscillations made by the vibrating body in one second is known as frequency.
ii) The reciprocal of time period is known as frequency. n = 1/T
iii) The S.I. unit of frequency is hertz. (cycle / sec)

- Phase difference between displacement and velocity of S.H.O. = $\frac{\pi}{2}$ radian $= 90^o$
- Phase difference between displacement and acceleration of S.H.O. = π radian = 180^o
- Phase difference between velocity and acceleration of S.H.O. = $\frac{3\pi}{2}$ *or* $\frac{\pi}{2}$ radian
- If F is force acting on S.H.O. at a displacement x from mean position, then

$F = -m\omega^2 x$

i) When x = 0, F = 0 (min)
ii) When x = $\pm$ A then F = $\mu m\omega^2 x$ (max.)

- If T is time period of oscillation, n is frequency of S.H.O. then

$$T = 2\pi\sqrt{\frac{x}{a}} \implies n = \frac{1}{2\pi}\sqrt{\frac{a}{x}}$$

where a is acceleration of S.H.O. at a displacement x from its mean position.

- A particle is vibrating in SHM. If its velocities are V_1 and V_2 when the displacements from the mean position are y_1 and y_2 respectively. then its time period is $2\pi\sqrt{\frac{y_2^2 - y_1^2}{V_1^2 - V_2^2}}$

- **ENERGY OF S.H.O.:**
Kinetic Energy

$$K.E. = \frac{1}{2}m\omega^2(A^2 - x^2) = \frac{1}{2}m\omega^2 A^2 Cos^2\theta$$

$$K.E. = K.E_{max}\left(1 - \frac{x^2}{A^2}\right) = K.E_{max} Cos^2\theta$$

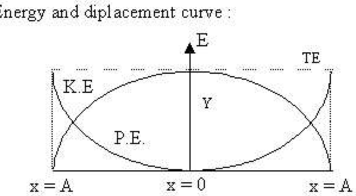
Potential Energy

$$P.E. = \frac{1}{2}m\omega^2 x^2 + U_O = \frac{1}{2}m\omega^2 A^2 Sin^2\theta + U_O$$

where m = mass of S.H.O.
x = displacement of S.H.O. from its mean position
A = amplitude of oscillation ; θ = phase angle from its mean position
U_O = P.E. of S.H.O. at its mean position; Total energy $\Rightarrow T.E. = \frac{1}{2}m\omega^2 A^2 + U_O$

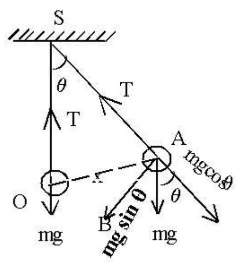
- K.E. of S.H.O. is maximum at its mean position and zero at extreme position
- P.E. of S.H.O. is minimum at its mean position and maximum at its extreme position
- T.E. is constant at all positions of S.H.O.,

Energy and diplacement curve :



- If P.E. = 0 at mean position of S.H.O., then
- K.E. = P.E. at a displacement $x = \frac{A}{\sqrt{2}}$ from mean position
- K.E. = 3 x P.E. at a displacement $x = \frac{A}{2}$ from mean position
- Displacement and acceleration graph of a S.H.O. is a straight line passing through origin

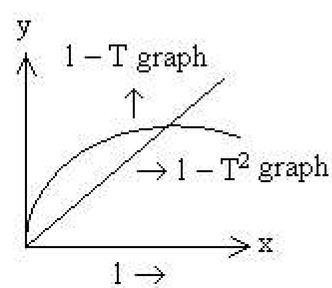
- Displacement and velocity graph of a S.H.O. is an ellipse
- Velocity and acceleration graph of a S.H.O. is an ellipse.
- If 'n' is the frequency of oscillation of a S.H.M , then its P.E and K.E veries with a frequency of 2n.
- **Simple Pendulum :** • The arrangement, in which a point mass is suspended from a massless flexible and inextensible thread clamped to a rigid support, is defined as simple pendulum.



- An ideal simple pendulum is not possible hence a heavy bob suspended from a light inextensible string acts as a simple pendulum.
- The tension in the string at any position is equal to

$$= mg\cos\theta + \frac{mv^2}{l}$$

- Equation of motion of a simple pendulum in differential form is $\frac{d^2y}{dt^2} + \omega^2 y = 0$, $\omega^2 = g/l$
- Time period of a simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$ for smaller amplitudes.
- The period of oscillation of a simple pendulum of constant length is independent of the size, shape, mass and material of the bob provided it is not made of a very light substance like cork.
- The period of oscillation of a simple pendulum of constant length is independent of the amplitude, provided the amplitude is small.
- $T \alpha \sqrt{l}$ or $\frac{l}{T^2} =$ constant (at a place)
- $\frac{l_1}{l_2} = \frac{T_1^2}{T_2^2}$
- for smaller percentages, $\frac{\Delta T}{T}\% = \frac{1}{2}\frac{\Delta l}{l}\%$
- $T \alpha \frac{1}{\sqrt{g}}$ or $gT^2 =$ constant (if length of the pendulum is constant)
- $\frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}}$
- $l \alpha g$ or $\frac{g}{l} =$ constant (when T is constant)
- When a pendulum clock is taken from the equator to the poles the time period decreases. Hence it makes more oscillations and gains time and moves fast.
- When a pendulum is taken from the earth to moon, the time period increases (as g is less on moon). Hence it makes less number of oscillations and looses time or moves slow.
- When a pendulum clock is taken from the earth to the moon, to keep the time correct its length must be decreased.
- If the pendulum of a clock is made of metal, it runs slow during summer and fast during winter due to thermal expansion or contraction.
- If a boy sitting in a swing stands up, as centre of mass raises up, distance to the centre of mass decreases and hence the period of the swing decreases.
- If the bob of a pendulum is made hollow and filled with water, and the water is drained out as the water goes down, centre of mass shifts down, and then rises to its original position. Hence time period first increases and then decreases and reaches its original value.
- l - T^2 graph of a simple pendulum is **straight line** passing through origin.
- l -T graph of a simple pendulum is **parabola.**



- At the point of intersection of l - T graph and l - T^2 graph of a simple pendulum
  - T = 1 second
  - n = 1 Hz.
  - $l = \frac{g}{4\pi^2} \cong$ 25 cm on the surface of the earth.

29. **APPLICATIONS:**

- For percentage $\geq 5\%$, if the percentage change is "n" then $\frac{\Delta T}{T}\times 100=\left(2n+\frac{n^2}{100}\right)$
- When the elevator is going up with an acceleration a, then its time period is given by $T=2\pi\sqrt{\frac{L}{g+a}}$ and frequency n is given by $n=\frac{1}{2\pi}\sqrt{\frac{g+a}{L}}$
- When the elevator is moving down with an acceleration a, then its time period is given by $T=2\pi\sqrt{\frac{L}{g-a}}$ and frequency n is given by $n=\frac{1}{2\pi}\sqrt{\frac{g-a}{L}}$
- When the elevator is at rest or moving up or down with constant velocity then the time period is given by $T=2\pi\sqrt{\frac{L}{g}}$; $n=\frac{1}{2\pi}\sqrt{\frac{g}{L}}$
- When the elevator is moving down with an retardation (+a) then its time period is given by $T=2\pi\sqrt{\frac{L}{g+a}}$; $n=\frac{1}{2\pi}\sqrt{\frac{g+a}{L}}$.
- In case of downward accelerated motion if a > g the pendulum turns upside and oscillates about the highest point with $T=2\pi\sqrt{\frac{L}{a-g}}$.
- If a simple pendulum of length 'L' suspended in a car travelling with a constant speed around a circle of radius 'r', Then its time period of oscillation is given by $T=2\pi\sqrt{\frac{L}{\sqrt{g^2+\left(\frac{v^2}{r}\right)^2}}}$
- If a simple pendulum of length 'L' suspended in car moving horizontally with an acceleration 'a' then its time period is given by $T=2\pi\sqrt{\frac{L}{\sqrt{g^2+(a)^2}}}$. The equilibrium position is inclined to the vertical by an angle $'\theta'$. where $\theta=tan^{-1}\left(\frac{a}{g}\right)$ opposite to the acceleration.
- If a simple pendulum of length L is suspended from the ceiling of a cart which is sliding without friction on an inclined plane of inclination $'\theta'$. Then the time period of oscillation is given by $T=2\pi\sqrt{\frac{L}{g\,cos\theta}}$ Since the effective acceleration changes from g to $g\,cos\theta$.
- If the length of the pendulum is infinite i.e., $l=\alpha$ $T=84.6$ minutes.
- If the length of the pendulum is equal to radius of the earth, then its time period is

$$T=2\pi\sqrt{\frac{R}{2g}}=59\ \min\ \&\ 5\sec.$$

- If the length of the pendulum considerably large.

$$T=2\pi\sqrt{\frac{l.R}{g(l+R)}}$$ where R= radius of earth. l= length of the pendulum

- Work done by tension in the string of the simple pendulum during one complete vibration equal to zero.
- A simple pendulum fitted with a metallic bob of density d has a time period T. When it is made to oscillate in a liquid of density d_L, then its time period increases.

$$T=2\pi\sqrt{\frac{l}{g\left(1-\frac{d_l}{d_s}\right)}}=2\pi\sqrt{\frac{l}{g\left[1-\frac{1}{d_{rel}}\right]}}$$

- When two simple pendula of lengths l_1 and l_2 are set into vibration in the same direction at the same instant with same phase, again they will be in same phase after the shorter pendulum has completed n oscillations. To find the value of n.

$$n\ T_s=(n-1)T_L\ and\ T\ \alpha\sqrt{l}$$

$$\therefore\frac{n}{n-1}=\frac{T_L}{T_s}\ or\ \frac{n}{n-1}=\sqrt{\frac{l_L}{l_S}},$$ L= longer S=shorter

- **Seconds pendulum:**
  - The simple pendulum whose time period is equal to 2 seconds is called seconds pendulum.
  - Its length at a place where $g=9.8\,m/s^2$ is 100 cm
  - Since $T=2\sec$

$$L=\frac{g.T^2}{4\pi^2};\ L=\frac{g}{4\pi^2}.4\ \ \therefore L=\frac{g}{\pi^2}$$

  - The length of a pendulum at a place where $g=g_1$ is l_1 and its length at a place where $g=g_2\ is\ l_2$. To keep the time period constant at $T=2\sec$, its length has to be decreased or increased corresponding to the value of 'g' at that place.

Decrease in length $= \frac{g_1 - g_2}{\pi^2} \left(if\ g_1 > g_2 \right)$

Increase in length $= \frac{g_2 - g_1}{\pi^2} \left(if\ g_2 > g_1 \right)$

- Due to small change in the value of g, the error in the time shown by a pendulum clock during t seconds $= -\frac{1}{2} \frac{\Delta g}{g} \times t$
- Due to small change in the length of pendulum of pendulum clock, error in the time shown by it during t seconds $= \frac{1}{2} \frac{\Delta l}{l} \times t$

- **SPRING – MASS SYSTEM :**
  - Resorting force $F = -kx$
  - When the load is pulled down and released, it makes vertical oscillations $T = 2\pi \sqrt{\frac{M}{K}}$
  - Time period of spring mass system is independent of acceleration due to gravity.
  - When a clock fitted with spring mass system is taken to the surface of the moon, it's time period will remain constant.
  - If the spring mass is considered .

$$T = 2\pi \sqrt{\frac{M + \frac{m}{3}}{K}} \quad (m = \text{mass of the spring})$$

- Spring constant 'K' is inversely proportional to its length.
- When a spring of force constant K and length l is cut into two parts of lengths l_1 and l_2 having force constants K_1 and K_2

$$K \alpha \frac{1}{l} \text{ or } Kl = K_1 l_1 = k l_2$$

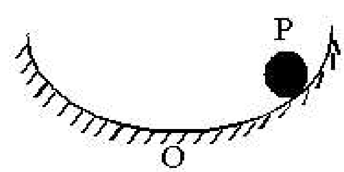
- If a spring of spring constant 'K' is divided into 'n' equal parts, then spring constant of each part is 'nK'.
- If a spring of spring constant 'K' and length 'l' is cut into two springs of lengths 'l_1' and 'l_2' then the spring constants of the two parts are

$$K_1 = \frac{K\left(l_1 + l_2\right)}{l_1} \text{ and } K_2 = \frac{K\left(l_1 + l_2\right)}{l_2}$$

- When two springs of force constants K_1 and K_2 are connected in series, then the effective force constant is $K = \frac{K_1 K_2}{K_1 + K_2}$
- When two springs of force constants k_1 and k_2 connected in parallel, the effective spring constant is $k = k_1 + k_2$
- A spring of force constant K_1 attached to a mass 'm' oscillates with a time period of T_1 and another spring of force constant K_2 attached to the same mass 'm' oscillates with a time period of T_2.
- When the springs are joined in series to the same mass 'm' the time period of oscillation is given by $T = \sqrt{T_1^2 + T_2^2}$
- When the springs are joined in parallel to the same mass 'm' the time period of oscillation is given by $T = \frac{T_1 T_2}{\sqrt{T_1^2 + T_2^2}}$.

- **MOTION OF A BALL IN A BOWL** :
If a small ball of mass m is placed at a small distance from O on a smooth concave surface of radius R and released, it will execute SHM about O.
The time period of its SHM is

$$\boxed{T = 2\pi \sqrt{\frac{R}{g}}}$$



CONCEPTUAL QUESTIONS

DISPLACEMENT, VELOCITY & ACCELERATION

1. If a particle is executing SHM, with an amplitude A, the distance moved and the displacement of the body in a time equal to its period are
1) 2A, A 2) 4A, 0 3) A,A 4) 0, 2A
2. The equation of motion of particle is given by $dp/dt + m\omega^2 y = 0$ where p is momentum and y is its position. Then the particle
1) moves along a straight line
2) moves along a parabola
3) executes simple harmonic motion
4) falls freely under gravity

3. A particle is in SHM. Then the graph of its acceleration as a function of displacement is
1) circle 2) hyperbola
3) straight line with negative slope
4) straight line with positive slope

4. A hole is bored along the diameter of the earth and a stone is dropped into it. If the radius of the earth is R then the speed of the stone, when it is at the centre of the earth, is

1) $\sqrt{\frac{gR}{2}}$ 2) $\sqrt{gR}$ 3) $\sqrt{2gR}$ 4) zero

5. For a particle in S.H.M. the amplitude and maximum velocity are A and V respectively. Then its maximum acceleration is
1) $V^2/2A$ 2) V^2A 3) V^2/A 4) V/A.

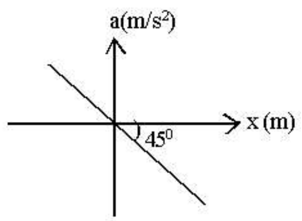
6. The equation of motion of a particle in S.H.M. is given by a= B x where a is the acceleration, B is a constant and x is displacement. Period of oscillation of the particle is

1) $2\pi\sqrt{B}$ 2) $2\pi/B$ 3) $2\pi/\sqrt{B}$ 4) $2\pi\ B$

7. The amplitude of a particle performing S.H.M. is 'a' . The displacement at which its velocity will be half the maximum velocity is

1) a/2 2) a/3 3) $\sqrt{3}\,a/2$ 4) $2a/\sqrt{3}$

8. Acceleration-displacement graph of a particle executing SHM is as shown in fig. The time period of oscillation is (sec)



1) $\frac{\pi}{2}$ 2) 2π 3) π 4) $\pi/4$

9. A particle moves along Y-axis according to equation $y = 3 + 4\cos\omega t$. The motion of particle is
1) not SHM 2) oscillating but not SHM
3) SHM 4) translatory

10. The motion of a particle varies with time according to the relation $y = a\sin\omega t + a\cos\omega t$. Then
1) the motion is oscillatory but not SHM
2) the motion is SHM with amplitude a
3) The motion is SHM with amplitude a$\sqrt{2}$
4) the motion is SHM with amplitude a

11. A ‘U’ tube held vertically contains liquid column of height L. If the liquid in one of the limbs is depressed and released, it oscillates with a period of

1) $2\pi\sqrt{\frac{L}{g}}$ **2)** $2\pi\sqrt{\frac{3L}{g}}$ **3)** $2\pi\sqrt{\frac{2L}{g}}$ **4)** $2\pi\sqrt{\frac{g}{2L}}$

APPARENT WEIGHT

12. A person stands on a platform which oscillates up and down simple harmonically. If he stands on the weighing machine, the reading of the machine will be minimum.
1) at the highest point 2) at the lowest point
3) at the equilibrium position
4) Reading is same at all positions

PHASE

13. The equation of the displacement of two particles making SHM are represented by $y_1 = a\sin(\omega t+\phi)$ & $Y_2 = a\ \cos(\omega t)$ The phase difference of the velocities of the two particles is

1) $\frac{\pi}{2}+\phi$ 2) $-\phi$ 3) ϕ 4) $\phi-\frac{\pi}{2}$

14. The phase difference between displacement and acceleration of a particle executing simple harmonic motion is
1) $\frac{\pi}{2}$ rad 2) π rad 3) $\frac{3\pi}{2}$ rad 4) 2π rad

15. The displacement equations of two simple harmonic oscillators are given by
$x_1 = A_1\ \cos\ \omega t;\ x_2 = A_2\ Sin\left(\omega t+\frac{\pi}{6}\right)$ the phase difference between them is
1) 30° 2) 60° 3) 90° 4) 120°

16. At t = 0, the displacement of a particle in S.H.M. is half its amplitude. Its initial phase is

1) $\frac{\pi}{6}rad$ 2) $\frac{\pi}{3}rad$ 3) $\frac{2\pi}{3}rad$ 4) $\frac{\pi}{2}rad$

SIMPLE PENDULUM

17. In a simple pendulum if iron sphere is replaced by a wooden sphere of same mass time period.
1) increases 2) decreases
3) remains same
4) The pendulum does not oscillate

18. A simple pendulum has a hollow sphere containing mercury suspended by means of a wire. If a little mercury is drained off, the period of the pendulum will
1) increase 2) decrease
3) remains unchanged 4) become erratic

19. If a pendulum clock is shifted from earth to the surface of moon. Then it
1) Loses time 2) Gains time
3) Keeps correct time 4) does not function

20. A girl is in standing position in an oscillating swing. If the girl sits in the swing, the frequency of oscillation
1) Increases 2) Decreases
3) Does not change 4) Becomes zero

21. The frequency of oscillation of a simple pendulum suspended in a satellite that revolve around earth is
1) 1 Hertz 2) 2 Hertz 3) Zero 4) Infinity

22. A hollow sphere of simple pendulum is first filled with mercury and then with water. The time periods are in the ratio if their densities are in the ratio 13.6 : 1.
1) 1 : 1 2) 1 : 2 3) 1 : 13.6 4) 13.6 : 1
23. The work done by the tension in the string of a simple pendulum in one complete oscillation is equal to
1) Zero 2) total energy of the pendulum
3) P.E. of the pendulum 4) K.E. of the pendulum
24. The period of a simple pendulum suspended from the ceiling of a car is T when the car is at rest. If the car moves with a constant acceleration the period of the pendulum
1) Remains same 2) decreases
3) increases 4) first increases then decreases
25. A pendulum clock is taken to the bottom of a deep mine. Will it gain or lose time ? How should its length be altered to correct the time?
1) looses time, length to be increased
2) looses time, length to be decreased
3) gains time, length to be increased
4) gains time, length to be decreased
26. A pendulum bob is in SHM. The velocity of the bob in the mean position is V. If now the amplitude of oscillation is doubled and the length of the pendulum is also doubled, the speed of the bob in the mean position would be
1) V 2) $\sqrt{2}$ V 3) V/2 4) 4V
27. If T_1, T_2 and T_3 are the time periods of a given simple pendulum on the surface of the earth, at a depth 'h' in a mine and at an altitude 'h' above the earth's surface respectively, then
1) $T_1 = T_2 = T_3$ 2) $T_2 < T_1 > T_3$
3) $T_2 > T_1 < T_3$ 4) $T_1 > T_2 > T_3$
28. A pendulum of length L swings from rest to rest n times in one second. The value of acceleration due to gravity is
1) $4\pi^2n^2L$ **2)** $2\pi^2n^2L$ **3)** π^2n^2L **4)** $\frac{\pi^2n^2L}{2}$
29. The percentage change in the time period of a seconds pendulum when its amplitude is reduced by 30% is
1) 45% 2) 0% 3) 27% 4) 70%
30. The frequency of a pendulum whose normal period 2 sec, when it is in an elevator in free fall, then the frequency will be
1) zero 2) Infinity
3) 2sec 4) cannot be determined
31. A simple pendulum of length 'l' is performing S.H.M. with maximum angular displacement θ. If the mass of the bob is 'm' then the maximum KE at its mean position is
1) $\frac{1}{2}m\left(\frac{l}{g}\right)$ 2) $\frac{mgl\sin\theta}{2}$
3) $mgl/2$ 4) $mgl\left[1-\cos\theta\right]$
32. A simple pendulum of length L has been set up inside a railway wagon sliding down a frictionless inclined plane of inclination θ with the horizontal. What will be its period of oscillation as recorded by an observer inside the wagon
1) $2\pi\sqrt{\frac{L}{g\cos\theta}}$ 2) $2\pi\sqrt{\frac{L}{g}}$
3) $2\pi\sqrt{\frac{L}{g\,Sin\theta}}$ 4) $2\pi\sqrt{\frac{LCos\theta}{g}}$
33. A seconds pendulum is suspended from the roof of a bus. The time period of oscillation when the bus is moving along a straight horizontal road with uniform acceleration is
1) 2 sec 2) < 2 sec 3) > 2 sec 4) 0
34. The frequency of a particle executing simple harmonic motion is 10 hertz. The frequency of variation of its kinetic energy is
1) 20 Hz 2) 10 Hz 3) 5 Hz 4) Zero

SPRINGS

35. The time period of a loaded spring on earth is 6s. On the surface of moon, the time period of the same loaded spring will be
1) $\sqrt{6}s$ 2) $6\sqrt{6}s$ 3) 1s 4) 6s
36. T_1 is time period of oscillation of a body suspended to a spring and T_2 is time period of oscillation of same body suspended to another spring. If same body suspended to series combination of same two springs, what is its time period of oscillation.
1) $T_1 + T_2$ 2) $\frac{T_1\,T_2}{T_1+T_2}$ 3) $\frac{T_1\,T_2}{\sqrt{T_1^2+T_2^2}}$ 4) $\sqrt{T_1^2+T_2^2}$
37. T_1, T_2 are time periods of oscillation of a block individually suspended to spring of force constants K_1, K_2 respectively. If same block is suspended to parallel combination of same two springs, its time period is
1) $T_1 + T_2$ 2) $\frac{T_1+T_2}{2}$ 3) $\frac{T_1\,T_2}{T_1+T_2}$ 4) $\frac{T_1\,T_2}{\sqrt{T_1^2+T_2^2}}$
38. A wrist watch keeps correct time on earth. If it is shifted to the surface of moon then it
1) Loses time 2) Gains time
3) Keeps correct time 4) does not function
39. A spring when loaded has a potential energy 'E'. Then 'm' turns out of 'n' turns are removed from the Spring. If the same load is suspended, then the energy stored in the spring is :
1) $\frac{n}{(n-m)}E$ 2) $\frac{mE}{n}$ 3) $\frac{(n-m)}{m}E$ 4) $\frac{(n-m)}{n}E$

40. A mass M is suspended from a light spring. An additional mass m added to it displaces the spring further by a distance x then its time period is

1) $T = 2\pi\sqrt{\frac{mg}{x(M+m)}}$ 2) $T = 2\pi\sqrt{\frac{(M+m)x}{mg}}$

3) $T = 2\pi\sqrt{\frac{(M+m)x}{Mg}}$ 4) $T = 2\pi\sqrt{\frac{Mx}{mg}}$

41. A clock S is based on oscillations of a spring and clock P is based on pendulum motion both clocks run at the same rate on Earth. On a planet having the same mas,. but twice the radius that of the earth
1) S will run faster than P 2) P will run faster than S
3) They will both run at the same rate as on Earth
4) Both do not function.

42. A hollow metal sphere is filled with water and it is hung by a long thread.It is made to oscillate. If there be a small hole in the bottom through which water slowly flows out, then its period of oscillation is
1) goes on increasing until the sphere is empty
2) goes on decreasing till the sphere is empty
3) remains unchanged throughout
4) first increases and later decreases until the sphere is empty

ENERGY

43. A body executing SHM has a total energy E. When its kinetic energy is $\frac{3E}{4}$, the displacement of the particle is (a is amplitude)

1) a 2) a/2 3) $\frac{\sqrt{3}a}{2}$ 4) $\frac{3a}{4}$

44. For a particle in SHM the K.E. at any instant is given by $K=K_o \cos^2 \omega t$. The total energy of SHM is
1) K_o 2) $2K_o$ 3) $K_o/2$ 4) $4K_o$

45. A particle executes SHM with a time period T. The time period with which its potential energy changes is
1) 2T 2) T 3) T/2 4) 3T/2

KEY

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

NEW PATTERN QUESTIONS

1. In SHM match the following

Column – I	*Column – II*
a) Maximum velocity	e) $\frac{1}{2}M\omega^2A^2$
b) Maximum acceleration	f) $\frac{1}{4}M\omega^2A^2$
c) Maximum Force	g) $A\omega$
d) Maximum total energy	h) $\omega^2 A$
	i) $m\omega^2 A$

1) a – g, b – h, c – i, d – e
2) a – h, b – g, c –i, d – e
3) a –g , b –h, c – f, d – e
4) a – g, b –i, c – h, d – f

2. When a body is in SHM, match the statements in Column A with that in Column B

Column A	*Column B*
a) Velocity is maximum	e) At half of the amplitude
b) Kinetic energy is 3/4th of total energy	f) At the mean position
c) Potential energy is 3/4th of total energy	g) At extreme position
d) Acceleration is maximum	h) At $\frac{\sqrt{3}}{2}$ times amplitude

1) a – f, b – e, c – h, d – g
2) a – e, b – f, c – g, d – h
3) a –g, b – h, c – e, d – f
4) a – h, b – e, c – f, d – e

3. Arrange the following simple pendula in ascending order of their periods of oscillation
a) length 1 m at a place of $g = 8\ m/s^2$
b) of length 2 m at a place of $g = 10\ m/s^2$
c) of length 4m at a place of $g= 4m/s^2$
1) a, b, c 2) b, a, c 3) b, c, a 4) c, b, a

4. In SHM at the equilibrium position
a) amplitude is minimum b) acceleration is zero
c) velocity is maximum
d) potential energy is maximum
1) all are true 2) b, c, d are true
3) b, c true 4) a, b, d true

5. If amplitude of particle executing SHM is doubled, which of the following quantities are doubled
a) Time period b) Maximum velocity
c) Maximum acceleration d) Total energy
1) b and c 2) a, b and c
3) a and c 4) a, b, c and d

6. If the length of the simple pendulum is equal to the radius of the earth, and it oscillates just above the surface of the earth then its time period is

a) $2\pi\sqrt{\frac{R}{2g}}$ b) $2\pi\sqrt{\frac{R}{g}}$

c) nearly 59.5 minutes d) 84.6 minutes

1) a is only correct 2) b is only correct
3) a and c are correct 4) a and d are correct

7. When a hole is drilled along the diameter of the earth and if a body is dropped into it, it executes SHM with a period T equal to (R & D are radius and density of the earth)

a) $2\pi\sqrt{\frac{R}{g}}$ b) $\sqrt{\frac{3\pi}{GD}}$ c) $2\pi\sqrt{\frac{\pi}{GD}}$ d) $2\pi\sqrt{\frac{R}{2g}}$

1) a and b are true 2) a and c are true
3) b and c are true 4) c and d are true

8. If a simple pendulum is arranged in an artificial satellite its
a) time period becomes infinity
b) frequency becomes infinity
c) both time period and frequency become infinity
d) it does not oscillate
1) a and d are correct 2) a and b are correct
3) b, c are correct 4) c, d are correct

9. ***Statement A :*** The average value of displacement, velocity and acceleration for one time period in SHM is zero.
Statement B : The acceleration of particle is maximum at extreme position.
1) A is true and B is false 2) A is false and B is true
3) Both A and B are true 4) Both A and B are false

KEY

1) 1 2) 1 3) 1 4) 3 5) 1
6) 3 7) 1 8) 1 9) 3

INSTRUCTION FOR QUESTIONS:

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements marks the correct answer

1) Both A and R are true and R is the correct explanation of A
2) Both A and R are true and R is not the correct explanation of A
3) A is true and R is false 4) A is false and R is true

1. ***Assertion (A):*** The bob of pendulum is immersed in a non viscous liquid (denser than water) completely. Time period of pendulum increases
Reason (R): Effective acceleration due to gravity increases

2. ***Assertion (A):*** When a spring is cut into two equal parts, spring constant of each piece is doubled.
Reason (R): Spring constant is inversely proportional to length of spring

3. ***Assertion (A):*** A loaded spring oscillating with frequency f continues to maintain the same frequency in an earth's satellite
Reason (R): Frequency of loaded spring is independent of acceleration due to gravity

4. ***Assertion (A):*** The pendulum clock made up of a metal losses time at high temperature
Reason (R): When a metal rod is heated, then it contracts

5. ***Assertion (A):*** The length-time period graph for simple pendulum is a parabola.
Reason (R): The length and time period at a given place are connected by the relation $l = KT^2$ (Where K is constant)

6. ***Assertion (A):*** The displacement time graph for a particle in SHM is sine curve, when the motion begins from mean position.
Reason (R): The displacement of a particle in SHM is given by $y = A \sin \omega t$

7. ***Assertion (A):*** A wooden cube of side 'a' floats in a non viscous liquid of density ρ. When it is slightly pressed and released, then it executes SHM
Reason (R): The net force responsible for SHM is the resultant of buoyancy force and true weight of the body.

8. ***Assertion (A):*** The phase difference between displacement and velocity in SHM is 90^o
Reason (R): The displacement is represented by $y=A \sin \omega t$ and $V=a\omega\cos\omega t$.

9. ***Assertion (A):*** The work done by the tension in the string of a simple pendulum in one complete oscillation is zero
Reason (R): No work is done by the tension in the string since tension is always at right angles to the motion of bob.

10. ***Assertion (A):*** In simple harmonic motion, the motion is to and fro and periodic
Reason (R): Velocity of the particle $V = \omega\sqrt{A^2 - x^2}$ where x is displacement as measured from extreme position

11. ***Assertion (A):*** A pendulum clock shows correct time at 0^oC, at a higher temperature the clock loses time
Reason (R): The period of oscillation increases due to increase in length so the clock loses time since it makes less number of oscillation in a day.

12. ***Assertion (A):*** When a clock fitted with a spring mass system is taken to the surface of the moon. Its time period is same as that on the earth.
Reason (R): The time period of a spring mass system is not affected by the variations of g.

13. ***Assertion (A):*** SHM is an example of varying velocity and varying acceleration
Reason (R): For a particle performing SHM in nonviscous medium its total energy is constant

14. ***Assertion (A):*** In damped vibrations, amplitude of oscillation decreases
Reason (R): Damped vibrations indicate loss of energy due to air resistance

KEY

01) 3	02) 1	03) 1	04) 3
05) 1	06) 1	07) 1	08) 1
09) 1	10) 3	11) 1	12) 1
13) 2	14) 1		

LEVEL-1

PERIODIC MOTION

1. A body is dropped from a height h on to the floor makes elastic collision with the floor. The frequency of oscillation of its periodic motion is

1) $\frac{1}{2}\sqrt{\frac{g}{2h}}$ 2) $\frac{1}{2}\sqrt{\frac{2h}{g}}$ 3) $\frac{1}{2\pi}\sqrt{\frac{g}{2h}}$ 4) $2\pi\sqrt{\frac{g}{2h}}$

DISPLACEMENT, VELOCITY AND ACCELERATION

2. A particle moves according to the equation x = $a\cos\left(\frac{\pi t}{2}\right)$. The distance covered by it in the time interval between t = 0 to t = 3 sec is
1) 2a 2) 3a 4) 4a 4) a

3. The resultant amplitude due to super position of two SHMs is
$x_1 = 10\sin(\omega t + 30^0)$ cm; $x_2 = -10\cos(\omega t - 60^0)$ cm
1) 5 cm 2) 10 cm 3) 20 cm 4) zero

4. A particle oscillates as per the equation x = 7 cos $(0.5\pi t)$ m, the time taken by the particle to move from the mean position to a point 3.5 m away is
1) 1/3 sec 2) 1/2 sec 3) 1 sec 4) 2/3 sec

5. Amplitude of oscillation of a particle that executes S.H.M. is 2 cm. Its displacement from its mean position in a time equal to 1/6th of its time period is

1) $\sqrt{2}cm$ 2) $\sqrt{3}cm$ 3) $\frac{1}{\sqrt{2}}$ cm 4) $\frac{1}{\sqrt{3}}$cm

6. A particle starts its SHM from mean position at t = 0. If its time period is T and amplitude A. The distance travelled by the particle in the time from t = 0 to $t = \frac{5T}{4}$ is
1) A 2) 2A 3) 4 A 4) 5A

7. A simple harmonic oscillator starts from extreme position and covers a displacement half of its amplitude in a time 't', the further time taken by it to reach mean position is

1) 2t 2) t 3) $\frac{t}{\sqrt{2}}$ 4) $\frac{t}{2}$

8. The velocity of a particle that executes S.H.M. at is 0.866 m/s. at its mean position velocity at a displacement half of its amplitude from mean positionis
1) 1 ms^{-1} 2) 1.414ms^{-1} 3) 0.5ms^{-1} 4) 0.75ms^{-1}

9. The time period of oscillation of a particle that executes S.H.M. is 1.2 sec. The time starting from extreme position, its velocity will be half of its velocity at mean position is
1) 0.1 sec 2) 0.2 sec 3) 0.4 sec 4) 0.6 sec

10. The time period of oscillation of a particle in S.H.M. is π sec. If its acceleration at extreme position 1 ms^{-2}, its velocity at mean position is

1) 0.5 ms^{-1} 2) 2ms^{-1} 3) $\frac{\pi}{2}ms^{-1}$ 4) $\pi\, ms^{-1}$

11. The period of oscillation of a particle in SHM is 4 sec and its amplitude of vibration is 4cm. The distance of the particle 1/3sec after passing the mean position is
1) 1.33 cm 2) 1.66 cm 3) 2cm 4) 2.33 cm

12. The period of oscillation of a particle in SHM is π sec and its amplitude of vibration is 10 cm. The acceleration of the particle π/12 sec after passing the mean position is
1) $20\sqrt{3}$ cm/s^2 2) 20cm/s^2
3) $20/\sqrt{3}$ cm/s^2 4) $2\sqrt{3}cm/s^2$

TIME PERIOD & FREQUENCY

13. A particle moves such that its acceleration is given by a = $-\beta(x-2)$.Here β is a positive constant and x is position from origin.The time period of oscillation is

1) $2\pi\sqrt{\beta}$ 2) $2\pi\sqrt{\frac{1}{\beta}}$ 3) $2\pi\sqrt{\beta+2}$ 4) $2\pi\sqrt{\frac{1}{\beta+2}}$

14. A particle executing S.H.M. has velocities 20cm/s, 16 cm/s at displacements 4 cm. 5cm from its mean position respectively. Its time period is

1) $\frac{\pi}{2}$ 2) π sec 3) 2π sec 4) $\frac{\pi}{4}$sec

15. If the displacement x and velocity v of a particle executing S.H.M. are related through the expression $4v^2 = 25 - x^2$. Then its time period is
1) π 2) 2π 3) 4π 4) 6π

16. The max. speed of a particle in S.H.M. is found to be 62.8 cm/s . If the amplitude is 20cm its period of oscillation is
1) 1 sec 2) 2 sec 3) 3 sec 4) 4 sec

17. For a body in S.H.M. the velocity is given by the relation $V=\sqrt{144-16x^2}$ ms^{-1}. The maximum acceleration is
1) 12 m/s^2 2) 16m/s^2 3) 36m/s^2 4) 48m/s^2

18. Two S.H.M.'s are represented by the relations
$x = 4\sin\left(80t+\frac{\pi}{2}\right)$ and $y = 2\cos\left(60t+\frac{\pi}{3}\right)$.
The ratio of their time periods is
1) 2: 1 2) 1: 2 3) 4 : 3 4) 3 : 4

19. The ratio between the acceleration to the displacement of a particle in S.H.M. is $4\pi^2$. The time period of S.H.M. is
1) 1sec 2) 2 sec 3) 2π sec 4) $\pi/2$ sec

20. A particle executes SHM along a straight line 4cm long. When the displacement is 1 cm its velocity and acceleration are numerically equal. The time period of SHM is
1) $2\pi\,s$ 2) $\frac{2\pi}{\sqrt{3}}s$ 3) $\frac{2\pi}{\sqrt{5}}s$ 4) $\frac{2\pi}{\sqrt{7}}s$

APPARENT WEIGHT

21. A man of mass 60kg standing on a platform executing SHM in a vertical plane. The displacement from mean position is $y = 0.5\sin(2\pi ft)$. The minimum value of f for which the man will feel weightlessness at the highest point is
1) $\frac{\sqrt{g}}{2\pi}$ 2) $\frac{\sqrt{2g}}{2\pi}$ 3) $\sqrt{\frac{g}{2\pi}}$ 4) $\frac{1}{2\pi}\sqrt{3g}$

22. A horizontal platform is executing SHM, up and down with period of 1 second. The maximum amplitude with which it can vibrate so that a small object placed on the platform does not leave it (Assume $\pi^2 = g$) is
1) 0.25 m 2) 0.5 m 3) 1m 4) 1.25 m

SIMPLE PENDULUM

23. The length of a pendulum changes from 1 m to 1.21m. The percentage change in its period is
1) 20% 2) 21% 3) 10% 4) 11%

24. If the radius of earth shrinks by 0.2% without change in its mass. The time period of oscillation of a simple pendulum
1) Increases by 0.2% 2) Decreases by 0.2%
3) Increases b y 0.1% 4) Decreases by 0.1%

25. The time period of oscillation of a simple pendulum is $\sqrt{2}$ sec, If its length is decreased to half of initial length, then its new period is
1) 1 sec 2) 0.707 sec 3) 0.414 sec 4) 0.5 sec

26 The length of seconds pendulum is 1m. The length of simple pendulum at the point of intersection of l-T graph and l - T^2 graph is
1) 25 cm 2) 50cm 3) $25\sqrt{2}$ cm 4) $50\sqrt{2}$

27. A seconds pendulum is suspended from the roof of a lift. If the lift is moving up with an acceleration 9.8 m/s^2, its time period is
1) 1 sec 2) $\sqrt{2}$ sec 3) $\frac{1}{\sqrt{2}}$ sec 4) $2\sqrt{2}$ sec

28. Two simple pendulum of lengths 1m and 2m have identical bobs and oscillating with same amplitudes. Their energies are in the ratio
1) 1: 2 2) 2 : 1 3) 4 : 1 4) 1 : 4

29. If the length of a simple pendulum is decreased by 75% then its time period
1) Decreases by 25% 2) Increases by 25%
3) Increases by 50% 4) Decreases by 50%

30. A seconds pendulum is shifted from a place where $g = 9.8\ m/s^2$ to another place where $g = 9.78\ m/s^2$. The change in its length so that its time period of oscillation does not change is
1) Should be decreased by $\frac{2}{\pi^2}cm$
2) Should be increased by $\frac{2}{\pi^2}cm$
3) Should be increased by $\frac{2}{\pi}cm$
4) Should be decreased by $\frac{2}{\pi}cm$

31. Two simple harmonic oscillators with amplitudes in the ratio 1:2 are having the same total energy. The ratio of their frequencies is
1) 1 : 4 2) 1:2 3) 2:1 4) 4 : 1

32. The acceleration due to gravity on a planet is 3/2 times that on the earth. If length of a seconds pendulum on earth is 1m, length of seconds pendulum on the planet is
1) 0.7m 2) 1m 3) 1.7m 4) 1.5 m

PHASE

33. The minimum phase difference between two SHM's
$y_1 = \sin\frac{\pi}{6}\sin\omega t + \sin\frac{\pi}{3}\cos\omega t$;
$y_2 = \cos\frac{\pi}{6}\sin\omega t + \cos\frac{\pi}{3}\cos\omega t$ is
1) $\frac{\pi}{3}$ 2) $\frac{\pi}{6}$ 3) $\frac{\pi}{12}$ 4) 0

34. E is kinetic energy of a simple harmonic oscillator at its mean position. The phase angle from mean position at which its kinetic energy is $\frac{E}{2}$ is

1) $\frac{\pi}{5}$ rad 2) $\frac{\pi}{4}$ rad 3) $\frac{\pi}{3}$ rad 4) None

RESTORING FORCE

35. A body of mass 1/4 kg is in S.H.M. and its displacement is given by the relation y = 0.05 Sin $\left(20t+\frac{\pi}{2}\right)$ m. If t is in seconds, the maximum force acting on the particle is

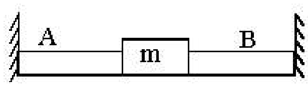
1) 5N 2) 2.5N 3) 10N 4) 0.25N

36. A body is executing SHM. If the force acting on the body is 6N when the displacement is 2 cm, then the force acting on the body when the displacement is 3 cm in newton is

1) 6N 2) 9N 3) 4N 4) $\sqrt{6}N$

LOADED SPRING

37. A and B are two thin rubber bands, each of force constant k. Assuming that they obey Hooke's law, the time period of horizontal SHM of the mass m is given by



1) $2\pi\sqrt{\frac{2m}{k}}$ 2) $\pi\sqrt{\frac{m}{k}}$ 3) $2\pi\sqrt{\frac{m}{2k}}$ 4) $2\pi\sqrt{\frac{m}{k}}$

38. A spring of natural length 80cm with a load has a length of 100cm. If it is slightly pulled down and released its period will be

1) 3s 2) 0.9 s 3) 0.81 s 4) 2s

39. A simple spring has length l and force constant K it is cut into two springs of length l_1 and l_2 such that $l_1 = nl_2$ (n = an integer). The force constant of spring of length l_1 is

1) K (1+n) 2) $\frac{K}{n}(1+n)$ 3) K 4) $\frac{K}{n+1}$

40. A 1kg weight is suspended to a massless spring and it has a period T. If now a 4kg is suspended from the same spring the new period will be

1) 4T 2) 2T 3) T 4) T/2

41. When a body is suspended to a spring its length is increased by 0.2 m, then the same body is further pull down by 5cm and released. Its time period of oscillation is

1) $\frac{\pi}{7}$ sec 2) $\frac{2\pi}{7}$ sec 3) $\frac{7}{\pi}$ sec 4) $\frac{7}{2\pi}$ sec

42. Two masses M and m are suspended together by a massless spring of force constant k. When the masses are in equilibrium, M is removed without disturbing the system. Then the amplitude of oscillation is

1) Mg/k 2) mg/k 3) (M+m)g/k 4) (M–m)g/k

43. In a spring block system length of the spring is reduced by 1%, the time period will

1) increase by 2% 2) increase by 0.5 %
3) decrease by 2% 4) decrease by 0.5%

44. A ball of mass 2 kg from a spring oscillates with a time period 2π sec. Ball is removed when it is in equilibrium position, then spring shortens by

1) g meters 2) g /2 meters
3) 2g meters 4) 2p meters

SIMPLE HARMONIC OSCILLATOR

45. The average kinetic energy of a simple harmonic oscillator is 2 joule and its total energy is 5 joule. its minimum potential energy is

1) 1J 2) 1.5 J 3) 2J 4) 3J

46. Potential energy of a simple harmonic oscillator at its mean position is 0.4 J. If its kinetic energy at a displacement half of its amplitude from mean position is 0.6 Joule, its total energy is

1) 1J 2) 1.2J 3) 1.4J 4) 1.6J

KINETIC AND POTENTIAL ENERGY

47. The displacement of a simple pendulum whose amplitude is A and the potential energy is 1/4th of total energy is

1) A/ $\sqrt{2}$ 2) A/2 3) A/4 4) A/5

48. The amplitude of a particle in SHM is 0.2m. The P.E. and K.E. of this particle 0.1 sec after passing the mean position are equal. The period of oscillation is

1) 1 sec 2) 0.8 sec 3) 0.6 sec 4) 0.4 sec

49. The amplitude of oscillation of particle in S.H.M. is $\sqrt{3}cm$. The displacement from mean position at which its potential and kinetic energies are in the ratio 1 : 2 is

1) 1cm 2) 0.866 c.m 3) $\frac{1}{\sqrt{3}}cm$ 4) $\sqrt{2}\ cm$

50. A particle is oscillating simple harmonically from its equilibrium position. Then the ratio of kinetic and potential energy of the particle at time T/12 is (T - time period)

1) 2 : 1 2) 3 : 1 3) 4 : 1 4) 1 : 4

51. The K.E. of a particle in S.H.M. is 8J at its mean position. If its mass is 4kg and amplitude is 1m, then its time period is

1) π second 2) 2 π second
3) π /2second 4) 4 π second

52. A long spring when stretched by x cm has a potential energy v on increasing the stretching to nx cm, the potential energy stored in the spring will be
1) $n^2/2v$ 2) n^2v 3) v/n^2 4) nv^2

KEY

01) 1	02) 2	03) 3	04) 4
05) 2	06) 4	07) 4	08) 4
09) 1	10) 1	11) 3	12) 2
13) 2	14) 1	15) 3	16) 2
17) 4	18) 4	19) 1	20) 2
21) 2	22) 1	23) 2	24) 2
25) 1	26) 1	27) 2	28) 2
29) 4	30) 1	31) 3	32) 4
33) 2	34) 2	35) 1	36) 2
37) 4	38) 2	39) 2	40) 2
41) 2	42) 1	43) 4	44) 1
45) 2	46) 2	47) 2	48) 2
49) 1	50) 2	51) 1	52) 2

LEVEL 2

DISPLACEMENT, VELOCITY AND ACCELERATION

1. A particle executes SHM along a straight line with mean position at x=0 and with a period of 20 sec and amplitude of 5cm. The shortest time taken by it to go from x= 4cm to x= –3cm is
1) 4sec 2) 5 sec 3) 7 sec 4) 10 sec
2. A body performs SHM along the straight line ABCDE with C is midpoint of AE. Its kinetic energies at B and D are each one fourth of its maximum value. If AE = 2A, then the distance between B and D is
1) A 2) $A\sqrt{2}$ 3) $A\sqrt{3}$ 4) $A\sqrt{5}$
3. The time taken by a particle performing SHM to pass from point A to B where its velocities are same is 2sec. After another 2sec, it returns to B. The time period of oscillation is
1) 4 sec 2) 6 sec 3) 8 sec 4) 10 sec
4. A particle executes SHM in a straight line. The maximum speed of the particle during its motion is V_m. Then the average speed of the particle during its SHM is
1) $\frac{V_m}{\pi}$ 2) $\frac{V_m}{2\pi}$ 3) $\frac{2V_m}{\pi}$ 4) $\frac{3V_m}{\pi}$
5. A body executing SHM has its velocity 10 cm/s and 7 cm/s when its displacements from mean position are 3 cm and 4 cm respectively. The length of path is
1) 10 cm 2) 9.5 cm 3) 4 cm 4) 11.36 cm
6. A particle in SHM has a period of 4 sec. It takes time t_1 to start from mean position and reach half the amplitude in another case it takes a time t_2 to start from extreme position and reach half the amplitude, then
1) $\frac{t_1}{t_2}=1$ 2) $\frac{t_1}{t_2}=1/2$ 3) $\frac{t_1}{t_2}=2$ 4) $\frac{t_1}{t_2}=3$
7. A particle performs SHM with a frequency of 2Hz. If the time is measured from its instantaneous rest position, then the time taken by it when its displacement becomes equal to half of its amplitude is
1) 1/12 sec 2) 1/6 sec 3) 1/2 sec 4) 1/24 sec
8. The velocity of a particle executing SHM is 50% of its maximum value at an instant of time. At that moment, acceleration is ....% of its maximum value
1) 50 2) 86.6 3) 75 4) 64.6
9. A sewing machine needle is oscillating vertically in a line of length 6cm with a frequency 30 per minute. The displacement of the needle 1/6 s after crossing the mean position is
1) $3\sqrt{3}$ cm 2) $\sqrt{3}$ cm 3) 3cm 4) 1.5 cm
10. The time period of oscillation of a S.H.O. is $\frac{\pi}{2}$ sec. Its acceleration at a phase angle $\frac{\pi}{3}$ rad from extreme position is $2ms^{-2}$, what is its velocity at a displacement equals to half of its amplitude from mean position ?
1) 0.707 ms^{-1} 2) 0.866 ms^{-1}
3) $\sqrt{2}$ ms^{-1} 4) $\sqrt{3}$ ms^{-1}
11. The period of a particle in SHM is 8 seconds. At t = 0 it is at the mean position. The ratio of the distance traveled by it in the first and the 2nd second is
1) 1/2 2) $\frac{1}{\sqrt{2}}$ 3) $\sqrt{2}$ 4) $\sqrt{2}+1$
12. The velocity of a particle in SHM at the instant when it is 0.6 cm away from the mean position is 4cm / sec. If the amplitude of vibration is 1cm then its velocity at the instant when it is 0.8 cm away from the mean position is
1) 2.25 cm/s 2) 2.5 cm/s 3) 3.0 cm/s 4) 3.5 cm/s

APPARENT WEIGHT

13. A person weighing 60kg stands on a platform which oscillates up and down at a frequency of 2Hz and amplitude 5cm. The maximum and minimum apparent weights are nearly ($g=10\ m/s^2$)
1) 108 kg-wt, 12kg-wt 2) 108kg-wt, 24kg-wt
3) 54 kg-wt, 12kg-wt 4) 54 kg-wt, 24kg-wt

TIME PERIOD AND FREQUENCY

14. The length of a seconds pendulum is 1m. The decrease in its length to decrease its time period of oscillation by 1 second is
1) 0.75 m 2) 0.5 m 3) 0.414 m 4) 0.25m
15. Three simple pendulums have lengths of strings 49 cms, 48 cms and 47 cms with diameters of the bobs 2 cms, 4 cm and 6 cm respectively. Then their periods are in the ratio:
1) 1 : 1 : 1 2) 1 : 2 : 3 3) 3 : 2 : 1 4) 51 : 52 : 53

16. The mass and diameter of a planet are twice those of earth. The period of oscillation of a pendulum on this planet if it is a seconds pendulum on earth is

1) $2\sqrt{3}$ sec 2) $2\sqrt{2}$ sec 3) 2 sec 4) 4 sec

17. On a planet, a body dropped from a height of 8m reaches the ground in 2 seconds. If the length of a simple pendulum on that planet is 1m, the period of oscillation is

1) $\frac{1}{3}$ S 2) $\frac{\pi}{2}$ S 3) π S 4) $\frac{1}{2}$ S

18. A simple pendulum with a brass bob has a period T. The bob is now immersed in a nonviscous liquid and oscillated. If the density of the liquid is 1/8th of brass, the time period of the same pendulum will be

1) $\sqrt{\frac{8}{7}}T$ 2) $\frac{8}{7}T$ 3) $\frac{64}{49}T$ 4) T

19. A seconds pendulum has time period 2 sec. The spherical bob which is empty has mass of 50 gm. This is replaced by another solid bob of same radius but having the mass of 100 gm. The new time period will be

1) 4 sec 2) 1 sec 3) 2 sec 4) 8 sec

20. A simple pendulum of length l is connected to the ceiling of a vehicle that is moving down along a smooth inclined plane 4 in 5. Then its period of oscillation is

1) $2\pi\sqrt{\frac{5l}{4g}}$ 2) $2\pi\sqrt{\frac{4l}{5g}}$ 3) $2\pi\sqrt{\frac{5l}{3g}}$ 4) $2\pi\sqrt{\frac{3l}{5g}}$

SIMPLE PENDULUM

21. A pendulum is taken 1 km inside the earth from mean sea level. Then the pendulum

1) loses 13.5 s per day 2) gains 13.5 s per day
3) looses 7s per day 4) gains 7s per day

22. The length of a seconds pendulum is 1m. The length of a seconds pendulum at a depth equal to one fourth of the radius of the earth is

1) 0.5 m 2) 0.75m 3) 0.25m 4) 1m

23. A simple pendulum is oscillating with an angular amplitude 30^o. If mass of its bob is 50g. The is tension in the string at its mean position ($g = 10 m/s^2$)

1) 0.634 N 2) 0.317 N 3) 1.268 N 4) 0.433 N

24. A simple pendulum of length 81 cm takes 3 minutes to execute 100 oscillations. The time that a simple pendulum of length 121 cm takes to make the same number of oscillations is

1) 2 minute 2) 3.66 minute
3) 4.2 minute 4) 4.67 minute

25. If pendulum which gives correct time beats seconds on ground at a place is moved to the top of a tower 320m high; The loss of time period in one day is

1) 2.16 sec 2) 1.08 sec 3) 0.54 sec 4) 4.32 sec

26. A simple pendulum consisting of a ball of mass m tied to a string of length l is made to swing on a circular arc of angle θ in a vertical plane. At the end of this arc, another ball of mass m is placed at rest. The momentum transferred to the ball at rest by the swinging ball is

1) $m\theta/\sqrt{l/g}$ 2) $m\theta/\sqrt{gl}$
3) $2\pi m/\sqrt{l/g}$ 4) zero

PHASE

27. Two particles are in S.H.M. along parallel straight lines with same amplitude and time period. If they cross each other in opposite directions at the mid point of mean and extreme positions. Phase difference between them is

1) 30^o 2) 120^o 3) 150^o 4) 180^o

28. A point mass 0.1 kg in SHM of amplitude 0.1 m. When the particle passes through the mean position, its kinetic energy is 8×10^{-3} J. The equation of motion of this particle if the initial phase of oscillation is 45^0 is

1) $y=0.1 \sin(4t + \pi/4)$ 2) $y=0.1 \cos(4t + \pi/4)$
3) $y=0.1 \sin(2t + \pi/4)$ 4) $y=0.1 \cos(2t + \pi/4)$

29. Two simple pendulums have time periods T and 5T/4. They start vibrating at the same instant from the mean position in the same phase. The phase difference between them when the pendulum with higher time period completes one oscillation is

1) 30^o 2) 45^o 3) 60^o 4) 90^o

30. Two simple pendulums of lengths 100 cm and 196 cm are in phase at the mean position at a certain time. If T is the time period of shorter pendulum, the minimum time offer which they will be again in phase

1) 2.5 T 2) 3.5 T 3) 5T 4) 7T

31. Two simple pendulums of length 100m and 121m start swinging together. They will swing together again after

1) the longer pendulum makes 10 oscillations
2) the shorter pendulum makes 10 oscillations
3) the longer pendulum makes 11 oscillations
4) the shorter pendulum makes 20 oscillations

32. The time periods of oscillation of two simple pendulums are 1 sec, 1.2 sec. Initially both are in same phase of oscillation. The minimum number of oscillations made by longer pendulum when they are again in same phase is

1) 5 2) 6 3) 10 4) 12

RESTORING FORCE

33. A body of mass 0.5 kg is performing S.H.M. with a time period $\pi/2$ seconds. If its velocity at mean position is 1 ms^{-1}, the restoring force acts on the body at a phase angle 60^o from extreme position is

1) 0.5 N 2) 1N 3) 2N 4) 4 N

34. Due to some force F_1 a body oscillates with period (4/5) s and the due to other force F_2 it oscillates with period 3/5 s. if both the forces acts simultaneously new period will be

1) 0.72 s 2) 0.64 s 3) 0.48 s 4) 0.36 s

LOADED SPRING

35. A particle hanging from spring stretches by 1 cm at earth's surface. At a point 800 km above earth's surface, the same spring stretches by the same partical (Radius of earth R = 6400 km)
1) 1 cm 2) 0.79 cm 3) 1.2 cm 4) 1.4 cm

36. The period of the vertical oscillation of a load of mass 4kg suspended form a spring is 0.4 sec. When an additional load of mass 5kg is applied the period of oscillation is
1) 0.9 sec 2) 0.8 sec 3) 0.7 sec 4) 0.6 sec

37. A block of mass M attached to an ideal spring oscillates with a time period of 2 seconds. If an additional mass 2 kg is attached to this block then time period of oscillation increases by 1 sec. The value of M is
1) 1.2 kg 2) 1.6 k.g 3) 2 kg 4) 2.4 kg

38. An oscillating mass spring system has a mechanical energy 1 Joule, when it has an amplitude 0.1m and maximum speed of 1 ms^{-1}. Then the force constant of the spring is
1) 100 $N.m^{-1}$ 2) 200 $N.m^{-1}$
3) 300 $N.m^{-1}$ 4) 50 $N.m^{-1}$

39. A force of 6.4N stretches a vertical spring by 0.1m. The mass that must be suspended from the spring so that it oscillates with a period of $\left(\pi/4\right)$ seconds.
1) $\left(\pi/4\right)$ kg 2) 1 kg 3) $\left(1/\pi\right)$ kg 4) 10 kg

KINETIC AND POTENTIAL ENERGY

40. The potential energy of particle in SHM 0.2 sec after passing the mean position is 1/4 of its total energy. The period of oscillation is
1) 3sec 2) 2.4 sec 3) 1.8 sec 4)1.2 sec

41. An object of mass 0.2 kg is in SHM along x-axis with a frequency of $\frac{25}{\pi}$ hertz. At the position x = 0.04m, it has KE of 0.5J and PE of 0.4J, its amplitude is
1) 0.06m 2) 0.05 m 3) 0.08 m 4) 0.09 m

42. The potential energy of a simple harmonic oscillator of mass 2 kg at its mean position is 5 J. If its total energy is 9 J and its amplitude is 0.01m, then its time period will be
1) $\frac{\pi}{100}$ sec 2) $\frac{\pi}{50}$ sec 3) $\frac{\pi}{20}$ sec 4) $\frac{\pi}{10}$ sec

LEVEL - 2 KEY

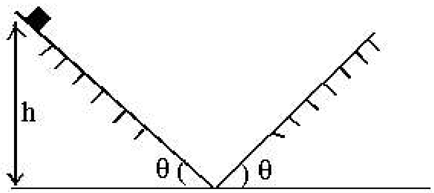
01) 2	02) 3	03) 3	04) 3
05) 2	06) 2	07) 1	08) 2
09) 4	10) 2	11) 4	12) 3
13) 1	14) 1	15) 1	16) 2
17) 3	18) 1	19) 3	20) 3
21) 3	22) 2	23) 1	24) 2
25) 4	26) 4	27) 2	28) 1
29) 2	30) 2	31) 1	32) 1
33) 2	34) 3	35) 2	36) 4
37) 2	38) 2	39) 2	40) 2
41) 1	42) 1		

HINTS

1. $y_1 = a\sin\omega t_1$ and $y_2 = a\sin\omega t_2$
4. $V_m = a\omega$ and $V_{avg} = \frac{4a}{T}$
7. $y = a\cos\omega t$
8. $V = \frac{v_m}{2}$, a = x% of a maximum
12. $V = \omega\sqrt{A^2 - Y^2}$
13. $W_{max} = Mg + ma\omega^2$ and $W_{min} = Mg - ma\omega^2$
16. $T = 2\pi\sqrt{\frac{l}{g}}$ where $g = \frac{GM}{R^2}$
18. $T' = \frac{T}{\sqrt{1 - d_l/d_s}}$
21. $\Delta T = \frac{ht}{2R}$
23. $T = mg\cos\theta + \frac{mv^2}{l}$
25. $\Delta T = \frac{ht}{R}$
31. $\frac{n}{n-1} = \sqrt{\frac{l_2}{l_1}}$
33. $A\omega = 1$ and $F = mA\omega^2\cos\theta$
34. $F\alpha\frac{1}{T^2}$
35. $x = \frac{mg}{k}$
36. $\frac{T_1}{T_2} = \sqrt{\frac{m}{M+m}}$
38. $K.E_{max} = \frac{1}{2}KA^2$
40. $P.E. = \frac{1}{2}m\omega^2 y^2$ where $y = A\sin\omega t$
41. $T.E. = \frac{1}{2}m\omega^2 a^2$

LEVEL 3
PERIODIC MOTION

1. If a particle slides back and forth between two smooth planes as shown in figure the correct statement is



a) The motion is oscillatory
b) the motion is SHM
c) If h is the initial height, then its period

$$T = \frac{4}{\sin\theta}\sqrt{\frac{2h}{g}}$$

d) If h is the initial height, then its period

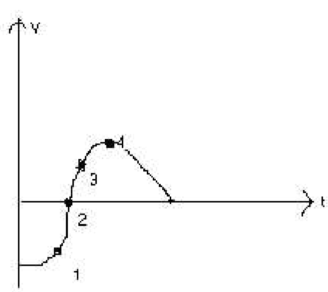
$$T = \frac{2}{\sin\theta}\sqrt{\frac{2h}{g}}$$

1) a, b 2) b, c 3) c, d 4) a, c

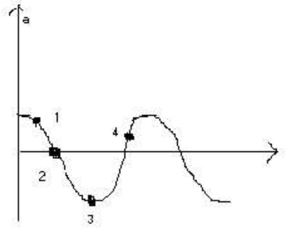
DISPLACEMENT, VELOCITY & ACCELERATION

2. If a particle is executing SHM on a straight line. A and B are two points at which its velocity is zero. It passes through a certain point P (AP < PB) at successive intervals of 0.5 sec and 1.5 sec with a speed of 3 m/s. The maximum speed of the particle is
1) 3 m/s 2) $3\sqrt{2}$ m/s3) $3\sqrt{3}$ m,/s 4) 6 m/s

3. Velocity - time graph of a particle executing SHM is as shown in fig. Select the correct alternatives.
a) at position 1, displacement of particle may be + ve or – ve
b) at position 2, displacement of particle is – ve
c) at position 3, acceleration of particle is + ve
d) at position 4, acceleration of particle is + ve
1) a, b 2) b, c 3) a, d 4) c, d



4. Acceleration - time graph of a particle executing SHM is as shown in fig. Then
a) displacement of particle at 1 is –ve
b) velocity of particle at 2 is + ve
c) potential energy of particle at 3 is maximum
d) speed of particle at 4 is decreasing.



1) only a, b are correct 2) only a,c,d are correct
3) only b,c,d are correct 4) all are correct

5. A particle moves with SHM in a straight line. In the first second after starting from rest, it travels a distance x_1 and in the second it travels a distance x_2 in the same direction. The amplitude of motion is
1) $\frac{x_1^2}{2x_1 - x_2}$ 2) $\frac{2x_1^2}{3x_1 - x_2}$ 3) $\frac{2x_2^2}{3x_2 - x_1}$ 4) $\frac{x_2^2}{2x_2 - x_1}$

6. A particle executes SHM with amplitudes 25 cm and period 3 seconds. The minimum time required for it to move between two points 12.5 cm on either side of the mean position is
1) 0.25 sec 2) 0.5 sec 3) 0.75 sec 4) 1 sec

TIME PERIOD AND FREQUENCY

7. A horizontal board is made to perform SHM oscillations horizontally moving to and fro through a distance 32 cm. If a heavy body placed on the table ($\mu = 0.2$) the maximum number of oscillation per second possible without moving the body is
1) $7/2\pi$ 2) $7/4\pi$ 3) $7/8\pi$ 4) $7/16\pi$

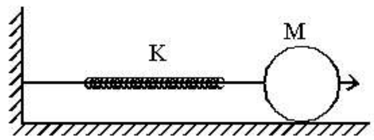
8. A spherical ball of mass m and radius r rolls without slipping on a concave surface of radius R. It makes small oscillations about the lowest point. Its time period is
1) $2\pi\sqrt{\frac{R}{g}}$ 2) $2\pi\sqrt{\frac{7(R-r)}{5g}}$
3) $2\pi\sqrt{\frac{R-r}{g}}$ 4) $\frac{1}{2\pi}\sqrt{\frac{7(R-r)}{g}}$

9. A cylindrical block of wood of radius r and mass M is floating in water of density ρ with its axis vertical. It is depressed a little and then released. Its frequency of oscillation is
1) $\frac{1}{2\pi}\sqrt{\frac{M}{g}}$ 2) $\frac{1}{2\pi}\sqrt{\frac{\pi r^2 \rho g}{M}}$
3) $2\pi\sqrt{\frac{\pi r^2 \rho g}{M}}$ 4) $\frac{1}{2\pi}\sqrt{\frac{\pi r^2 g}{M}}$

10. A particle executes SHM with a period of 'T' seconds. 't' seconds after it has crossed the equilibrium position it is at a point P. After how much time it will be again at P?
1) (T/2) – t 2) (T/4) – t
3) (T/2) – 2t 4) (T/4) – 25

11. A liquid of mass m filled into a U-tube of cross sectional area A is oscillated and the time period obtained is T. If the same liquid is filled into another U-tube of cross sectional area A/4 and oscillated, then its time period will be
1) T 2) T/2 3) 2T 4) 4T

12. A disc of mass M is attached to a horizontal massless spring of force constat K so that it can roll without slipping along a horizontal surface. If the disc is pushed a little towards right and then released, its centre of mass executes SHM with a period of

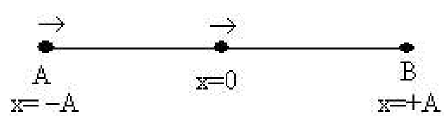


1) $2\pi\sqrt{\frac{M}{K}}$ 2) $2\pi\sqrt{\frac{3M}{K}}$ 3) $2\pi\sqrt{\frac{M}{2K}}$ 4) $2\pi\sqrt{\frac{3M}{2K}}$

PHASE

13. Two particles are executing SHM in a straight line with same amplitude A and time period T. At time t=0, one particle is at displacement $x_1=+A$ and the other at $x_2=-A/2$ and they are approaching towards each other. After what time they cross each other
1) T/3 2) T/4 3) 5T/6 4) T/6

14. Two particles undergo SHM along the same line with the same time period (T) and equal amplitude (A). At a particular instant one is at x = –A and the other is at x = 0. They move in the same direction they will cross each other at



a) $t=\frac{4T}{3}$ b) $t=\frac{3T}{8}$ c) $x=\frac{A}{2}$ d) $x=\frac{A}{\sqrt{2}}$
1) only a, c are correct 2) only a, d are correct
3) only b, c are correct 4) only b, d are correct

15. Two particles are in SHM with the same amplitude and frequency along the same line and about the same point. If the maximum separation between them is $\sqrt{3}$ times their amplitude, then the phase difference between them is
1) $\frac{\pi}{6}$ 2) $\frac{\pi}{3}$ 3) $\frac{2\pi}{3}$ 4) $\frac{\pi}{2}$

SPRINGS

16. Frequency of a particle executing SHM is 10Hz. The particle is suspended from a vertical spring. At the highest point of its oscillation the spring is unstretched, the maximum speed of the particle is (g=10 m/s^2)
1) 2π m/s 2) π m/s 3) $1/\pi$ m/s 4) $1/2\pi$ m/s

17. A mass M is suspended from a spring of negligible mass. The spring is pulled a little and then released so that the mass executes simple harmonic motion with time period T. If the mass is increased to 'm' then the time period becomes $\left(\frac{5T}{4}\right)$ the ratio $\left(\frac{m}{M}\right)$ is
1) $\frac{9}{16}$ 2) $\frac{25}{16}$ 3) $\frac{4}{5}$ 4) $\frac{5}{4}$

18. A light spiral spring supports 200gm weight at its lower end, it oscillates with a period of 1 sec. The weight in (gm) that must be removed from the lower end to reduce the period to 0.5 sec
1) 100 gm 2) 50gm 3) 150gm 4) 200gm

19. A spring of force constant K is cut in to two parts whose lengths are in the ratio 1 : 2. The two parts are now connected in parallel and a block of mass m is suspended at the end of the combined spring. The period of oscillation of block is
1) $2\pi\sqrt{\frac{2m}{9k}}$ **2)** $2\pi\sqrt{\frac{m}{9k}}$ **3)** $2\pi\sqrt{\frac{2m}{5k}}$ **4)** $2\pi\sqrt{\frac{m}{5k}}$

RESTORING FORCE

20. A 1 kg mass executes SHM with an amplitude 10cm, it takes π seconds to go from one end to the other end. The magnitude of the force acting on it at any end is ....
1) 0.1 N 2) 0.2 N 3) 0.5 N 4) 0.05 N

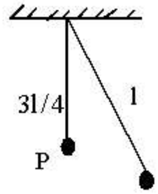
HARMONIC OSCILLATOR

21. A linear harmonic oscillator of force constant 2×10^6 N/m and amplitude 0.01 m has a total mechanical energy of 160J its
1) maximum potential energy is 100J
2) maximum kinetic energy is 100J
3) minimum potential energy is zero
4) maximum kinetic energy is 160 J

SIMPLE PENDULUM

22. For a simple pendulum, length expressed in meters is taken on X-axis and both T expressed in seconds and T^2 expressed in second^2 are plotted on the Y-axis. The L-T graph, which is like a parabola and the L–T^2 graph, which is a straight line, both pass through the origin and intersect at a point whose coordinates are (Take g = 10 m/s^2).
1) (1/4 m, 2 s) 2) (1/4 m, 1 s)
3) (1/2 m, 1 s) 4) (1 m, 4 s)

23. A pendulum has a period T for small oscillations. An obstacle P is fixed directly beneath the point of suspension so that only the lower one quarter of the string can follow the pendulum bob when it swings to the left of the equilibrium position. When the pendulum is released from rest as shown, the time it takes to come back to its initial position is



1) T/2 2) 3T/4 3) T/4 4) T

24. A block of mass M executes SHM with amplitude A and time period T. When it passes through the mean position, a lump of putty of mass m is dropped on it. The new amplitude of oscillation is

1) $A\sqrt{\frac{M+m}{m}}$ 2) $A\sqrt{\frac{M+m}{M}}$ 3) $A\sqrt{\frac{M}{M+m}}$ 4) $A\sqrt{\frac{m}{M+m}}$

25. In the above problem, new time period is

1) $T\sqrt{\frac{M+m}{m}}$ 2) $T\sqrt{\frac{M+m}{M}}$

3) $T\sqrt{\frac{m}{M+m}}$ 4) $T\sqrt{\frac{M}{M+m}}$

26. A particle executes SHM with amplitude A and angular frequency ω. At an instant the particle is at a distance A/5 from mean position and moving away from it. The time after which it will come back again to this position is

1) $\frac{2\sin^{-1}(1/5)}{\omega}$ 2) $\frac{2\cos^{-1}(1/5)}{\omega}$

3) $\frac{\sin^{-1}(1/5)}{\omega}$ 4) $\frac{\cos^{-1}(1/5)}{\omega}$

27. A simple pendulum of length l_1 has time period 4 sec and another simple pendulum of length l_2 has time period 3 sec, the time period of a simple pendulum of length $(l_1 - l_2)$ is

1) $7\sqrt{7}$ sec 2) $\sqrt{7}$ sec 3) $\sqrt{5}$ sec 4) $\sqrt{10}$ sec

ENERGY

28. A body is executing SHM under the action of a force whose maximum magnitude is 50 N. The magnitude of force acting on the particle at the time when its energy is half kinetic and half potential is

1) 25 N 2) $25\sqrt{2}$ N 3) $\frac{25}{\sqrt{2}}$ N 4) 12.5 N

KEY

01) 4	02) 2	03) 2	04) 4
05) 2	06) 2	07) 2	08) 2
09) 2	10) 3	11) 3	12) 4
13) 4	14) 4	15) 3	16) 4
17) 2	18) 3	19) 1	20) 1
21) 2	22) 2	23) 2	24) 3
25) 2	26) 2	27) 2	28) 2

HINTS

1. Time period $T = 4t \quad = 4\sqrt{\frac{2l}{g\sin\theta}}$

But $l = \frac{h}{\sin\theta}$

2. $V_{max} = a\omega$

6. $t = \frac{T}{12} + \frac{T}{12} = \frac{T}{6}$

7. $\mu mg = ma\omega^2$

8. $a = \frac{g\sin\theta}{1+\frac{k^2}{r^2}}$

9. Restoring force = $\pi r^2 \rho g$

11. $T = 2\pi\sqrt{\frac{h}{g}}$

13. $x_1 = A\cos\omega t$, $x_2 = A\sin\left(\omega t - \frac{\pi}{6}\right)$

equating $x_1 = x_2$ t=T/6

14. $x_1 = -a\cos\omega t$, $x_2 = a\sin\omega t$

But $x_1 = x_2$

16. Amplitude $A = \frac{mg}{k}$ $V_{max} = a\omega$

19. $T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$

22. $F = ma\omega^2$

23. After p the length of the pendulum becomes $\frac{1}{4}$

$\therefore$ Time period will become $T' = \frac{T}{2}$

$\therefore t = \frac{T}{2} + \frac{T'}{2} = \frac{3T}{4}$

28. K.E = P.E when $y = \frac{A}{\sqrt{2}}$

But $F = m\omega^2 y$

QUESTIONS FROM PREVIOUS EAMCET EXAMINATIONS

1. A pendulum beating seconds at the equator (g = 978 cm/sec^2) is taken to Antartica (g = 983 cm/s^{-2}), If it is to beat seconds at Antartica, its length to be increased by ....cm (1983E)
1) 0.5 cm 2) 1 cm 3) 1.5 cm 4) 2 cm

2. A seconds pendulum is taken from earth to moon. It is to act as a seconds pendulum there also, the length of the pendulum (1989E)
1) should be increased 2) should be decreased
3) need not be changed 4) difficult to imagine

3. A mass of 1kg stretches a spring by 0.8 m. If the mass is pulled down by another 0.05m and released then the period of oscillation is (1988E)
1) $\frac{2\pi}{7}$ 2) $2\pi\sqrt{\frac{0.85}{9.8}}$ 3) $\frac{4\pi}{7}$ 4) π sec

4. The mass and diameter of a planet are 2 times that of the earth. If a seconds pendulum is taken to that planet, the time period of oscillation of the pendulum will be (1986 & 87E&M)
1) $\sqrt{2}$ sec 2) 2 sec 3) $2\sqrt{2}$ sec 4) $1/\sqrt{2}$ sec

5. A girl is swinging in a sitting position. When the same girl stands up, the period of the swing is (1987E)
1) will be shorter 2) will be longer
3) will depend on height of girl 4) will not change

6. A body of mass 'M' when hung on a spiral spring, the spring stretches by 20 cm, when it is pulled down and released its period of oscillation is (1988 M)
1) $\frac{2\pi}{5}$sec 2) $\frac{2\pi}{7}$sec 3) $\frac{2\pi}{3}$sec 4) 2πsec

7. A person measures the time period of a simple pendulum inside a stationary lift and finds it to be T. If the lift starts accelerating upwards with an acceleration g/3, the time period of the pendulum will be (1992 E)
1) T 2) $\frac{\sqrt{3}}{2}T$ 3) $\frac{T}{\sqrt{3}}$ 4) $\frac{T}{3}$

8. A body executes S.H.M with a period of 11/7 sec and an amplitude of 0.025m. The maximum value of the acceleration is ______m/sec^2 (1986 E)
1) 0.1 2) 0.2 3) 0.3 4) 0.4

9. The maximum speed of a body vibrating under S.H.M. with time period of $\pi/4$ sec amplitude 7 cm is
1) 488 cm/sec 2) 56 cm/sec
3) 38.5 cm/sec 4) 5.5 cm/sec

10. A particle is in S.H.M. of amplitude 2cm. At extreme position the force is 4N. At the point midway between mean and extreme position, the force is (1990 E)
1) 1 N 2) 2N 3) 3N 4) 4N

11. A particle of mass 1kg is moving in a S.H.M. with an amplitude of 0.02m and a frequency of 60 Hz. The maximum force acting on the particle is _____ (1992 E)
1) 2.88×10^3 N 2) 1.44×10^3 N
3) 5.67×10^3 N 4) 0.75×10^3 N

12. $y = 0.05 \sin 2\pi(0.1x + 2t)$ represents a wave equation in which the distances are measured in metre and time in seconds. then wave velocity is (1992 E)
1) 10 m/s 2) 20 m/s 3) 30 m/s 4) 40 m/s

13. A simple harmonic oscillation is represented by the equation $y = 0.4 \sin\left(\frac{440t}{7} + 0.61\right)$ where y and t are in meters and seconds respectively the value of time period is (1991 E)
1) 0.1 sec 2) 0.2 sec 3) 0.3 sec 4) 0.4sec

14. The displacement of a particle executing S.H.M. is given by $Y = 10 \sin\left(6t + \frac{\pi}{3}\right)$ in metre and time in seconds. The initial displacement and velocity of the particle are respectively (1992E)
1) 25m and $5\sqrt{3}\ m/\text{sec}$ 2) 15m and $5\sqrt{3}\ m/\text{sec}$
3) $15\sqrt{3}m$ and $30\,m/\text{sec}$
4) $10\,\sqrt{3}/2$ m and $30m/\text{sec}$

15. A spring of force constant K is cut into two equal parts, then the force constant of each piece is (1994 E)
1) K 2) K/2 3) 4K 4) 2K

16. What should be the displacement of a simple pendulum whose amplitude is A at which potential energy is 1/4th of the total energy (1995E)
1) $A/\sqrt{2}$ 2) A/2 3) A/4 4) $A/2\sqrt{2}$

17. Average kinetic energy in one time period of a simple harmonic oscillator whose amplitude is A angular velocity w and mass M is (1996 E)
1) $\frac{1}{4}M\omega^2A^2$ 2) $\frac{1}{2}M\omega^2A^2$ 3) $M\omega^2A^2$ 4) 0

18. A body of mass 1kg executing S.H.M., its displacement y cm at t seconds is given by $y = 6\sin(100t + \pi/4)$. Its maximum kinetic energy is (2000 E)

1) 6J 2) 18J 3) 24J 4) 36J

19. A particle executing S.H.M. has an amplitude of 6 cm. Its acceleration at a distance of 2cm from the mean position is $8 cm/s^2$. The maximum speed of particle is (2001 E)

1) 8cm/s 2) 12 cm/s 3) 16 cm/s 4) 24cm/s

20. Two particles P and Q start from origin and execute S.H.M. along x-axis with same amplitude but with periods 3 seconds and 6 seconds respectively. The ratio of the velocities of P and Q when they are at mean position is (2001 E)

1) 1 : 2 2) 2 : 1 3) 2 : 3 4) 3 : 2

21. A body is executing S.H.M. at a displacement x its P.E. is E_1 and at a displacement y its P.E is E_2. The P.E at displacement (x+y) is (2001 E)

1) $\sqrt{E} = \sqrt{E_1} - \sqrt{E_2}$ 2) $\sqrt{E} = \sqrt{E_1} + \sqrt{E_2}$

3) $E = E_1 + E_2$ 4) $E = E_1 - E_2$

22. A body executes S.H.M. under the action of a force F_1 with a time period 4/5 seconds. If the force is changed to F_2 it executes S.H.M. with time period 3/5 seconds . If both the forces F_1 and F_2 act simultaneous in the same direction on the body. Its time period in seconds is (2002 E)

1) 12/25 2) 24/25 3) 25/24 4) 25/12

23. If the displacement (x) and velocity (v) of a particle executing S.H.M. are related through the expression $4v^2 = 25 - x^2$ then its time period is (2002 E)

1) π 2) 2π 3) 4π 4) 6π

24. The time period of a simple pendulum is T. When the length is increased by 10cm, the period is T_1. When the length is decreased by 10cm, its period is T_2. Then relation between T, T_1, T_2 is (2004 E)

1) $\frac{2}{T_2} = \frac{1}{T_1^2} + \frac{1}{T_2^2}$ 2) $\frac{2}{T_2} = \frac{1}{T_1^2} - \frac{1}{T_2^2}$

3) $2T^2 = T_1^2 + T_2^2$ 4) $2T^2 = T_1^2 - T_2^2$

25. When a body of mass 1.0 kg is suspended from a certain light spring hanging vertically, its length increases by 5cm. By suspending 2.0 kg block to the spring and if the block is pulled through 10cm and released, the maximum velocity of it in m/s is (Acceleration due to gravity = $10 m/s^2$) (2003, E)

1) 0.5 2) 1 3) 2 4) 4

26. An object is attached to the bottom of a light vertical spring and set vibrating. The maximum speed of the object is 15 cm/sec and the period is 628 milli seconds. The amplitude of the motion in centimeters is (2003, E)

1) 3.0 2) 2.0 3) 1.5 4) 1.0

27. A body of mass 'm' is suspended to an ideal spring of force constant 'k'. The expected change in the position of the body due to an additional force 'F' acting vertically downwards is : (2005 E)

1) $\frac{3F}{2k}$ 2) $\frac{2F}{k}$ 3) $\frac{5F}{2k}$ 4) $\frac{4F}{k}$

KEY

1) 1	2) 2	3) 3	4) 3
5) 1	6) 2	7) 2	8) 4
9) 2	10) 2	11) 1	12) 2
13) 1	14) 4	15)4	16) 2
17) 1	18) 2	19) 2	20) 2
21)2	22) 1	23) 3	24) 3
25) 2	26) 3	27) 2	

QUESTIONS FROM PREVIOUS EAMCET (MEDICAL)

1. In S.H.M. the velocity of particle at the mean position is 1m/sec and acceleration at the extreme position is $2m/sec^2$. Then the angular velocity of the motion is (1994)

1) 2 sec^{-1} 2) 1 sec^{-1} 3) 0.5 sec^{-1} 4) 3 sec^{-1}

2. A particle is executing S.H.M. with an amplitude of 4cm. At what position from equilibrium position, the kinetic energy is equal to potential energy(1993)

1) 1cm 2) $\sqrt{2}cm$ 3) 2cm 4) $2\sqrt{2}cm$

3. In a simple pendulum the period of oscillation (T) is related to the length of the pendulum (L) is

1) L/T = Constant 2) I^2/T^2 = Constant

3) L/T^2 = Constant 4) LT = Constant

4. The time period of a pendulum is 2 sec. If its length is increased by 4 times, the period becomes (1996)

1) 4 sec 2) 6 sec 3) 8 sec 4) 2 sec

5. If two bodies of same mass are executing S.H.M. with frequencies in the ratio 1 : 2 and amplitudes in the ratio 2:3 then the ratio of their total energies is (2001)

1) 1: 3 2) 1: 9 3) 1 : 4 4) 1: 6

6. The time period of a light loaded spring is 3.5 seconds. On changing the load by 1kg, the period decreases by 0.5 seconds. The initial load on the spring is (2001)

1) 3 (10/13) kg 2) 4 (10/13) kg

3) 5 (10/13) kg 4) 6 (10/13) kg

7. The mass and diameter of a planet are two times those of earth. If a seconds pendulum is taken to it, the time period of the pendulum in seconds is (2002)

1) $\frac{1}{\sqrt{2}}$ 2) 1/2 3) 2 4) $2\sqrt{2}$

8. The elongation of a spring of length L and of negligible mass due to a force is x. The spring is cut into two pieces of lengths in ratio 1: n. The ratio of the respective spring constants is (2002)

1) n : 1 2) 1 : n 3) $n^2 : 1$ 4) $1 : n^2$

9. Two springs of force constants 1000 N/m and 2000 N/m are stretched by same force. The ratio of their respective potential energies is (2002)

1) 2 : 1 2) 1 : 2 3) 4 : 1 4) 1 : 4

10. The equation of motion of particle executing SHM is $a + 16\pi^2 x = 0$. In this equation a is the linear acceleration in m/s^2, of the particle at a displacement x in meters. The time period of SHM, in seconds is (2004)

1) 1/4 2) 1/2 3) 1 4) 2

11. The time period of a particle in simple harmonic motion is 8 seconds. At t = 0 it is at the mean position. The ratio of the distances travelled by it is the first and second seconds is: (2003)

1) $\frac{1}{2}$ 2) $\frac{1}{\sqrt{2}}$ 3) $\frac{1}{\sqrt{2}-1}$ 4) $\frac{1}{\sqrt{3}}$

12. A body executing S.H.M. has a maximum velocity of 1 ms^{-1} and a maximum acceleration of 4 ms^{-2}. Its amplitude in metres is (2005)

1) 1 2) 0.75 3) 0.5 J 4) 0.25

KEY

1) 1 2) 4 3) 3 4) 1 5) 2 6) 1

7) 4 8) 2 9) 1 10) 2 11) 3 12) 4