DDS ACADEMY

DPP-2 SHM **JEE**

ADVANCE LEVEL - I

1. The displacement x (in cm) of an oscillating particle varies with time t (in seconds) according to the equation

$$x = 2\cos(0.5\,\pi t + \frac{\pi}{3})$$

Find :
(a) Amplitude of oscillation
(b) The time period of oscillation
(c) The maximum velocity of the particle
(d) The maximum acceleration of the particle.

2. A particle moving with simple harmonic motion has speeds 3 cm/s and 4 cm/s at distance is 8cm and 6 cm respectively from the equilibrium position. Find (a) period of oscillation (b) amplitude of oscillation.

3. The displacement of a particle executing periodic motion is given by $y = 4\cos^2\frac{1}{2}t\ \sin1000t$.
Find independent constituent harmonic motion.

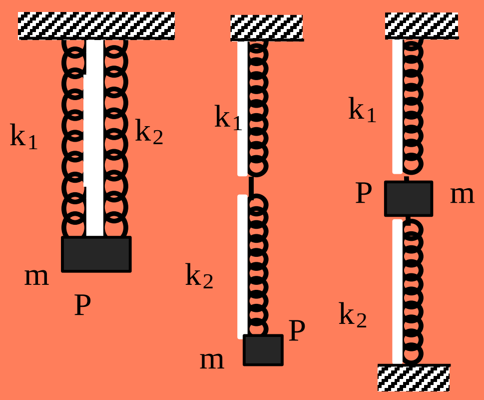
4. A particle moves with simple harmonic motion along x-axis. At time t and 2t its position given by x = a and x = b respectively. Find the time period of oscillation.

5. A block is resting on a piston which is moving with an S.H.M. of period 1.0 sec. At what amplitude of motion will the block and piston separate? What is the maximum velocity of the piston at this amplitude?

6. A 5.22kg object is attached to the bottom of a vertical spring and set vibrating. The maximum speed of the object is 15.3 cm/s and the period is 645 ms. Find
(a) The force constant of the spring
(b) Amplitude of the motion
(c) The frequency of oscillation

7. A uniform rod of mass m and length *l* is free to rotate about a fixed horizontal axis through its end and perpendicular to its length. Find the period of small oscillations of the rod.

8. Two springs, having spring constant as k_1 & k_2 have been connected in following three ways. Find the time period all three cases for the mass m.



9. A particle oscillating harmonically with an amplitude of 1.5 cm has maximum energy of 0.25 μJ. At what displacement from the equilibrium position will the particle be acted up by on a force of 2.5×10^{-5} N?

10. A block is executing simple harmonic motion on a frictionless horizontal surface with an amplitude 0.100 m. At a point 0.060 m away from equilibrium the speed of block is 0.360m/s.
(a) What is the period?
(b) What is the displacement when the speed is 0.120 m/s?
(c) A small object whose mass is much less than the mass of the block is placed on the oscillating block. If the small object is just on the verge of slipping at the end point of the path, what is the co-efficient of static friction between the small object and the block?

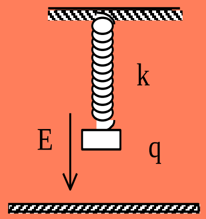
11. A bullet of mass 0.01 kg fired horizontally got struck into a suspended sand bag of mass 0.5 kg. The sand bag oscillates with an amplitude of 0.05 m. If the time period of the oscillation is 'π' seconds, calculate the velocity of the bullet. Assume that the whole system works as a ballistic pendulum.

12. A small bob of mass 50 g oscillates as a simple pendulum, with an amplitude 5 cm and period 2 s. find the velocity of the bob and the tension in the supporting thread, when the velocity of the bob is maximum. [Take g = 9.8 m/s^2]

13. The maximum tension in the string of an oscillating pendulum is double the minimum tension. Find the angular amplitude.

14. A simple pendulum of length 30.5 cm is suspended from the ceiling of an elevator takes $\frac{\pi}{3}$ second to complete one oscillation. Find the acceleration of the elevator.

15. Time period of a block when suspended from the upper plate of a parallel plate capacitor by a spring of stiffness k is T. When block is uncharged. Find the time period of oscillation if a charge q is given to the block.



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ADVANCE LEVEL - II

1. A sphere of radius R is suspended by a string. The length of the string from the centre of the sphere to the point of suspension is l. (l > > R). Find the time period of pendulum.

2. 10^{-4}kg O_2 is content in a non-conducting cylindrical vessel of cross-sectional area 29.15 x 10^{-5} m^2 and volume 10^{-3} m^3. It is closed by frictionless non-conducting piston which is free to move in vertical direction. If the piston is slightly depressed and then released so that the piston will execute S.H.M. Find the frequency of oscillation ($\gamma = 1.4$).

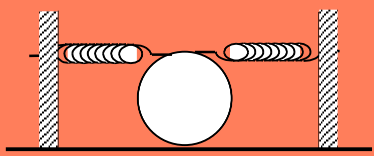
3. A particle in S.H.M. crosses its equilibrium position at time t=2 sec. When the motion advances by one second more, its velocity is found to be $\pi/3$ m/s.If the frequency of the motion is 1/6 s^{-1}, find:
(a) Amplitude of the motion
(b) the velocity of the particle at t = 4s.

4. A simple pendulum of length '*l*' and bob of mass '*m*' is suspended from the roof of a car, which is in uniform speed 'v' along a horizontal circular track of radius '*r*'. Find the frequency of small angular oscillations of the pendulum inside the car.

5. A closed circular wire hung on a nail in a wall undergoes small oscillations of amplitude 2^o and time period 2s. Find
(a) the radius of the circular wire,
(b) the speed and acceleration of the particle farthest away from the point of suspension it goes through the its mean position
(c) the acceleration of this particle when it is at the extreme position. Take $g = \pi^2 m/s^2$

6. A cylindrical test tube of thin wall and of mass 1 kg, with a piece of lead of 1 kg fixed at its inside bottom, floats vertically in a liquid. When the tube is slightly depressed and released, it oscillates vertically with period 1s. If some extra copper beads are put into the tube, which still floats vertically and oscillates with a period of 1.5 s, find the mass of the copper beads in the tube.

7. A uniform solid cylinder of mass M performs small oscillations under to springs of force constant k_1 and k_2. Find the time period of the oscillation, if there is no sliding anywhere.

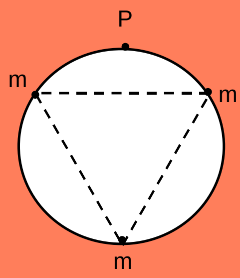


8. A meter stick swinging from one end oscillates with a frequency f_o. What would be the frequency, in terms of f_o, if the bottom third of the stick were cut off?

9. A point mass m is suspended at the end of a massless wire of length *l* and cross section A. If Y is the Young's modulus of elasticity for the wire, obtain the frequency of oscillation for the simple harmonic motion along the vertical line.

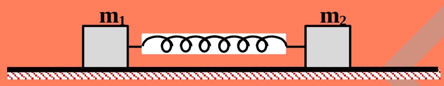
10. A pendulum is formed by pivoting a long thin rod of length L and mass m about a point on the rod which is a distance d above the center of the rod.
(a) Find the small-amplitude period of this pendulum in terms of d, L, m and g.
(b) Show that the period has a minimum value when $d = L/\sqrt{12} = 0.289$ L.

11. Three particles of the same mass m are fixed to a uniform circular hoop of mass M and radius a at the corners of n equivocator triangle. The hoop is free to move in a vertical plane about the point on the circumference opposite to one of the masses. Find the equivalent length of a simple pendulum.

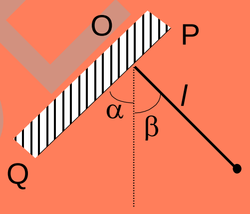


12. One and of a long metallic wire of length L is tied to the ceiling. The other end is tied to a massless spring of spring constant K. A mass m hangs freely from the free end of the spring. The area of cross section and Young's modules of the wire are a and Y respectively. Find the time period with which the mass m will oscillate if it is slightly pulled down and released.

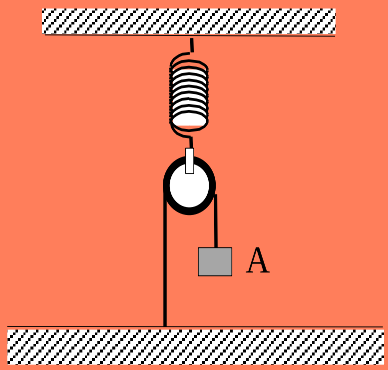
13. Suppose that the spring in figure has a force constant k = 252 N/m. Let m_1 = 1.13 kg and m_2 = 3.24 kg. Calculate the period of oscillation of the two - body system.



14. A ball is suspended by a thread of length 'l' at the point O on the wall PQ, which is inclined to the vertical by an angle α (fig.). The thread with the ball is now displaced through a small angleβ, away from the vertical and also away from the wall. If the ball is released, find the period of oscillation of pendulum, when
(a) $\beta < \alpha$ and (b) $\beta > \alpha$.
Assume the collision on the wall is perfectly elastic.



15. In the figure, the spring has force constant 5000 N/m. The pulley is light and smooth. The spring and the string are light. The mass of the suspended block A is of mass 1 kg. If the block is slightly displaced vertically down from its equilibrium position and released, find the period of its vertical oscillations.



MAINS LEVEL- I

1. A particle moves in x-y plane according to the equation

$\vec{r} = (\hat{i} + 2\hat{j})A\cos\omega t$ the motion of the particle is

(A) on a straight line
(B) on an ellipse
(C) periodic
(D) simple harmonic

2. Which of the following quantities are always positive in a simple harmonic motion

(A) $\vec{F}.\vec{a}$
(B) $\vec{v}.\vec{r}$
(C) $\vec{a}.\vec{r}$
(D) $\vec{F}.\vec{r}$

3. The magnitude of average acceleration in half time period in a simple harmonic motion is

(A) $\frac{2A\omega^2}{\pi}$
(B) $\frac{A\omega^2}{2\pi}$
(C) $\frac{A\omega^2}{\sqrt{2}\pi}$
(D) Zero

4. A particle performs S.H.M. with time period T the time period taken for the displacement to change value from half the amplitude to the maximum displacement is

(A) $\frac{T}{2}$
(B) $\frac{T}{4}$
(C) $\frac{T}{6}$
(D) $\frac{T}{8}$

5. Two pendulums begin to swing simultaneously. During first fifteen oscillations of the first pendulum the other pendulum makes only ten swings. The ratio between the lengths of these pendulum is

(A) $\frac{4}{9}$
(B) $\frac{2}{3}$
(C) $\frac{5}{9}$
(D) $\frac{2}{15}$

6. If a simple harmonic motion is given by y = sin ωt + cos ωt, where y is in cm. Which of the following statement (s) is /are true.

(A) the amplitude is 1 cm.
(B) the amplitude is $\sqrt{2}$ cm.
(C) time is measured from y = 1 cm
(D) Time is measured from y = 0 cm

7. A small block oscillates back and forth on a smooth concave surface of radius R. The time period of small oscillation is

(A) $T = 2\pi\sqrt{\frac{R}{g}}$
(B) $T = 2\pi\sqrt{\frac{2R}{g}}$
(C) $T = 2\pi\sqrt{\frac{R}{2g}}$
(D) None of these

8. A simple pendulum with a brass bob has a time period T. The bob is now immersed in a non-viscos liquid and made to oscillate. The density of the liquid is (1/8)th that of the brass the time period of pendulum will be

(A) $\sqrt{\frac{8}{7}}T$ (B) $\frac{8}{7}T$

(C) $\frac{8^2}{7^2}T$ (D) T

9. A particle of mass 10 gm lies in a potential field v = $(50\ x^2 + 100)$ J/kg. The value of frequency of oscillations in Hz is

(A) 502 MHz (B) $\frac{100}{2\pi}$

(C) $\frac{\pi 10}{3}$ (D) none of these.

10. When two mutually perpendicular simple harmonic motions of same frequency, amplitude and phase are superimposed

(A) the resulting motion is uniform circular motion.

(B) the resulting motion is a linear simple harmonic motion along a straight line inclined equally to the straight lines of motion of component ones.

(C) the resulting motion is an elliptical motion, symmetrical about the lines of motion of the components.

(D) the two S.H.M. will cancel each other.

11. An object of mass 0.2 kg executes simple harmonic motions along x-axis with a freqency of $\left(\frac{25}{M}\right)$ Hz. At the position x = 0.04 m the object has kinetic energy of 0.2 J and potential energy 0.45J. the amplitude of oscillation is

(A) 0.06 M (B) 0.08 M

(C) .10 M (D) None of these

12. The maximum velocity of a body undergoing S.H.M.is 0.2 m/s and its acceleration at .1 m from the mean position is .4 ms^{-2} the amplitude of the S.H.M. is

(A) 0.25 m, (B) 0.3 m

(C) 0.1 m (D) 1.05 m

13. For a particle undergoing SHM, the velocity is plotted against displacement. The curve will be

(A) A straight line (B) A parabola

(C) A circle (D) An ellipse

14. A particle undergoes SHM with a time period of 2 seconds. In how much time will it travel from its mean position to a displacement equal to half of its amplitude?

(A) $\frac{1}{2}$s (B) $\frac{1}{3}$s

(C) $\frac{1}{4}$s (D) $\frac{1}{6}$s

15. A pendulum suspended from the roof of an elevator at rest has a time period T_1, when the elevator moves up with an acceleration a its time period becomes T_2 when the elevator moves down with an acceleration a, its time period becomes T_3 then

(A) $T_1 = \sqrt{T_2 T_3}$

(B) $T_1 = \sqrt{T_2^2 + T_3^2}$

(C) $T_1 = \dfrac{T_2 T_3 \sqrt{2}}{\sqrt{T_2^2 + T_3^2}}$

(D) None of these..

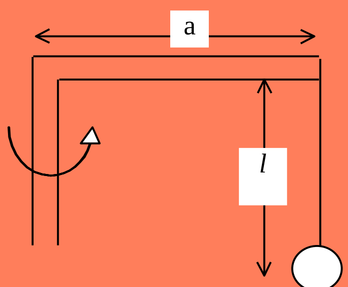
MAINS LEVEL- II

1. A simple pendulum of length L and mass M is oscillating in a plane about a vertical line between angular limits $-\phi$ and $+\phi$. For an angular displacement $\theta(|\theta| < \phi)$ the tension in the string and velocity of the bob are T and v respectively. The following relations hold good under the above condition.
(A) $T \cos\theta = Mg$
(B) $T - Mg\cos\theta = \frac{Mv^2}{L}$
(C) The magnitude of tangential acceleration of he bob $|a_T| = g\sin\theta$
(D) $T = Mg\cos\phi$

2. For a simple pendulum the graph between L & T will be a :
(A) hyperbola
(B) parabola
(C) straight line
(D) curved line

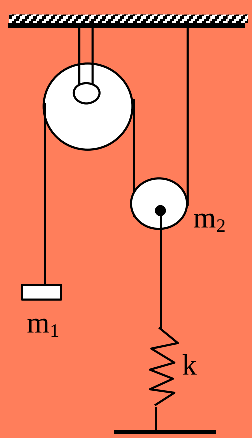
3. A simple pendulum of length L has been setup inside a railway wagon sliding down a frictionless inclined plane having an angle of inclination θ with the horizontal. What will be its time period of oscillation as recorded by an observer inside the wagon?
(A) $2\pi\sqrt{L/g\cos\theta}$
(B) $2\pi\sqrt{L/g}$
(C) $2\pi\sqrt{L/g\sin\theta}$
(D) $2\pi\sqrt{L\cos\theta/g}$

4. How many revolutions per second must the apparatus of shown figure make about a vertical axis in order that cord make an angle with the vertical $(0 < \theta < \pi/2)$



(A) $\frac{1}{2\pi}\sqrt{\frac{g\tan\theta}{a+\ell\sin\theta}}$
(B) $\frac{1}{2\pi}\sqrt{\frac{g\sec\theta}{a+\ell\cos\theta}}$
(C) $\frac{1}{2\pi}\sqrt{\frac{g\sin\theta}{a+2\ell\tan\theta}}$
(D) $\frac{1}{2\pi}\sqrt{\frac{g\tan\theta}{a+\ell\cos\theta}}$

5. The period of the free oscillations of the system shown here if mass m is pulled down a little and force constant of the spring is k and masses of the fixed pulley is negligible.



(A) $T = 2\pi\sqrt{\frac{M_1+M_2}{k}}$
(B) $T = \pi\sqrt{\frac{M_1+4M_2}{k}}$
(C) $T = 2\pi\sqrt{\frac{M_2+4M_1}{k}}$
(D) $T = \pi\sqrt{\frac{M_2+3M_1}{k}}$

6. The period of small oscillations of a simple pendulum of length l if its point of suspension O moves with a constant acceleration $\alpha = \alpha_1 \hat{i} + \alpha_2 \hat{j}$ with respect to earth is

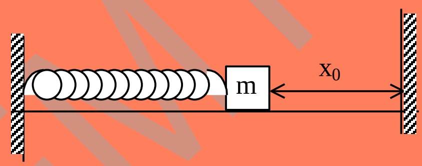
(A) $T = 2\pi\sqrt{\dfrac{\ell}{\{(g+\alpha_2)^2+\alpha_1^2\}^{1/2}}}$ (B) $T = 2\pi\sqrt{\dfrac{\ell}{\{(g+\alpha_1)^2+\alpha_2^2\}^{1/2}}}$

(C) $T = 2\pi\sqrt{\dfrac{\ell}{g}}$ (D) $T = 2\pi\sqrt{\dfrac{\ell}{\{g^2+\alpha_1^2\}^{1/2}}}$

7. One end of a spring of force constant is fixed to a vertical wall and the other to a body of mass m resting on a smooth horizontal surface. There is another wall at a distance x_0 from the body the spring is then compressed by $2x_0$ and released. The time taken to strike the wall is

(A) $\dfrac{1}{6}\pi\sqrt{\dfrac{k}{m}}$ (B) $\sqrt{\dfrac{k}{m}}$

(C) $\dfrac{2\pi}{3}\sqrt{\dfrac{m}{k}}$ (D) $\dfrac{\pi}{4}\sqrt{\dfrac{k}{m}}$



8. Two bodies M and N of equal masses are suspended from two separate spring of the spring s constant k_1 and k_2 respectively. If the two bodies oscillate vertically such that their maximum velocities are equal, the ratio of the amplitude of vibration of m to that on N is

(A) $\dfrac{k_2}{k_1}$ (B) $\sqrt{\dfrac{k_2}{k_1}}$

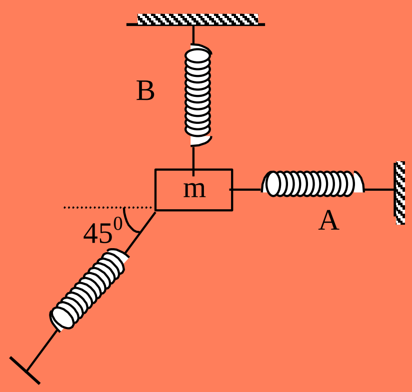
(C) $\dfrac{k_1}{2}$ (D) $\sqrt{\dfrac{k_1}{k_2}}$

9. A simple pendulum has a time period T. What will be the percentage of change in its time period if its amplitude is decrease by 5%:

(A) 6% (B) 3 %

(C) 1.5 % (D) It will remain unchanged

10. A particle of mass m is attached to three springs A, B and C of equal force constant k, the particle is pushed slightly against the spring C and released, the time period oscillation will be



(A) $2\pi\sqrt{\dfrac{m}{k}}$ (B) $2\pi\sqrt{\dfrac{m}{2k}}$

(C) $2\pi\sqrt{\dfrac{m}{3k}}$ (D) $2\pi\sqrt{\dfrac{2k}{m}}$

11. A particle moves on x-axis according to the equation $x = x_0 \sin^2 \omega t$, the motion is simple harmonic

(A) with amplitude x_0
(B) with amplitude $x_0/2$
(C) with time period (π/ω)
(D) with time period $(\pi/3)$

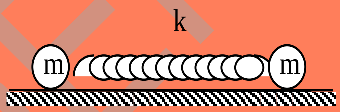
12. A pendulum clock that keeps correct time on the earth is taken to the moon it will run

(A) at correct rate
(B) 6 time faster
(C) $\sqrt{6}$ times faster
(D) $\sqrt{6}$ times slowly

13. A disc of radius R and mass M is pivoted at the rim and is set for small oscillations. If simple pendulum has to have the same period as that of the disc, the length of the simple pendulum should be

(A) $\frac{5}{4}R$
(B) $\frac{2}{3}R$
(C) $\frac{3}{4}R$
(D) $\frac{3}{2}R$

14. The identical particles each of mass m are inter-connected by a light spring of stiffness k, the time period if small oscillation is equal to



(A) $2\pi\sqrt{\frac{m}{k}}$
(B) $\pi\sqrt{\frac{m}{k}}$
(C) $2\pi\sqrt{\frac{2m}{k}}$
(D) $\pi\sqrt{\frac{2m}{k}}$

15. The period of a simple pendulum hanging from the roof of the earth's satellite is equal to

(A) T
(B) zero
(C) infinite
(D) none of these

ANSWER KEY

ADVANCE LEVEL - I

1. (a) A = 2 cm (b) T = 4 s (c) V_{max} = 3.142 cm/s (d) 4.93 cm/s^2
2. (a) 12.56s, (b) 10 cm
3. $y_1 = 2 \sin 1000t$, $y_2 = \sin 1001t$, $y_3 = \sin 999t$
4. $\dfrac{2\pi t}{\cos^{-1}\left(\dfrac{b}{2a}\right)}$
5. A_{max} = 0.248 m, v_{max} = 1.56 m
6. (a) 495 N/m (b) 1.57cm (c) 1.55Hz
7. $2\pi\sqrt{\dfrac{2l}{3g}}$
8. (a) $k_1 + k_2$ (b) $\dfrac{k_1k_2}{k_1+k_2}$ (c) $k_1 + k_2$
9. 1.125 cm
10. (a) 1.40 sec, (b) 0.0964 m, (c) 0.207
11. 5.1 m/s
12. 5π cm/s, 49125 dyne
13. $\cos^{-1}\left(\dfrac{3}{4}\right)$
14. 1.22 m/s
15. T

ADVANCE LEVEL - II

1. $T = 2\pi\sqrt{\dfrac{l}{g}\left(1+\dfrac{R^2}{5l^2}\right)}$
2. 0.32 Hz
3. 2m, $-\pi/3$ m/s
4. $\dfrac{1}{2\pi}\sqrt{\dfrac{\left(g^2+\dfrac{v^4}{r^2}\right)^{1/2}}{\ell}}$
5. (a) 50 cm , (b) 11 cm/s, 1.2 cm/s^2 towards the point of suspension
   (c) 34 cm/s^2 towards the mean position.
6. 2.5 kg
7. $T = 2\pi\sqrt{\dfrac{3M}{2(k_1+k_2)}}$
8. 1.22 f_o
9. $\dfrac{1}{2\pi}\sqrt{\dfrac{A.y}{m\ell}}$
10. $2\pi\sqrt{(L^2+12d^2)/12gd}$
11. 2a
12. $T = 2\pi\sqrt{\dfrac{m(AY+KL)}{AYK}}$
13. 0.36s
14. (a) $T = 2\pi\sqrt{\dfrac{l}{g}}$ (b) $T = 2\sqrt{\dfrac{l}{g}}\left[\dfrac{\pi}{2}+\sin^{-1}\dfrac{\alpha}{\beta}\right]$
15. 0.177 s

MAINS LEVEL - I

1.	A, C, D	2.	A
3.	A	4.	C
5.	A	6.	B, D
7.	A	8.	A
9.	B	10.	B
11.	B	12.	C
13.	D	14.	B
15.	C		

MAINS LEVEL- II

1.	B, C	2.	B
3.	A	4.	A
5.	C	6.	A
7.	C	8.	B
9.	D	10.	B
11.	B, C	12.	C
13.	D	14.	D
15.	C		