09 - OSCILLATIONS

(Answers at the end of all questions)

1) Two simple harmonic motions are represented by the equations $y_1 = 0.1 \sin(100\pi t + \pi/3)$ and $y_2 = 0.1 \cos \pi t$. The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

(a) $\pi/3$ (b) $-\pi/6$ (c) $\pi/6$ (d) $-\pi/3$ [AIEEE 2005]

2) The function $\sin^2(\omega t)$ represents

(a) a periodic, but not simple harmonic, motion with a period π/ω

(b) a periodic, but not simple harmonic, motion with a period of $2\pi/\omega$

(c) a simple harmonic motion with a period π/ω

(d) a simple harmonic motion with a period $2\pi/\omega$ [AIEEE 2005]

3) The bob of a simple pendulum is a spherical hollow ball filled with water. A plugged hall near the bottom of the oscillating bob gets suddenly unplugged. During observation, till water is coming out, the time-period of the oscillation would

(a) first decrease and then increase to the original value

(b) first increase and then decrease to the original value

(c) increase towards a saturation value (d) remain unchanged [AIEEE 2005]

4) If a simple harmonic motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$, its time period is

(a) $\frac{2\pi}{\sqrt{\alpha}}$ (b) $\frac{2\pi}{\alpha}$ (c) $2\pi\sqrt{\alpha}$ (d) $2\pi\alpha$ [AIEEE 2005]

5) The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $(4/3) \times 1000$ kg/m^3, what relationship between t and t_0 is true ?

(a) $t = t_0$ (b) $t = t_0/2$ (c) $t = 2t_0$ (d) $t = 4t_0$ [AIEEE 2004]

6) A particle at the end of a spring executes simple harmonic motion with a period t_1, while the corresponding period for another spring is t_2. If the period of oscillation with the two springs in series is T, then

(a) $T = t_1 + t_2$ (b) $T^2 = t_1^2 + t_2^2$

(c) $T^{-1} = t_1^{-1} + t_2^{-1}$ (d) $T^{-2} = t_1^{-2} + t_2^{-2}$ [AIEEE 2004]

7) The total energy of a particle executing simple harmonic motion

(a) $\propto x$ (b) $\propto x^2$ (c) is independent of x (d) $\propto \sqrt{x}$

where x is the displacement from the mean position. [AIEEE 2004]

8) A particle of mass m is attached to a spring (of spring constant k) and has a natural angular frequency of ω_0. An external force F (t) proportional to $\cos \omega t$ ($\omega \neq \omega_0$) is applied to the oscillator. The time displacement of the oscillator will be proportional to

(a) $m/(\omega_0^2 - \omega^2)$ (b) $F_t/m(\omega_0^2 - \omega^2)$

(c) $1/m(\omega_0^2 - \omega^2)$ (d) $m/(\omega_0^2 + \omega^2)$ [AIEEE 2004]

(Answers at the end of all questions)

9) In forced oscillation of a particle, if the amplitude is maximum for a frequency ω_1 of the force while the energy is maximum for a frequency ω_2 of the force, then
(a) $\omega_1 = \omega_2$ (b) $\omega_1 > \omega_2$ (c) $\omega_1 < \omega_2$ (d) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large [AIEEE 2004]

10) The displacement of a particle varies according to the relation $x = 4 (\cos \pi t + \sin \pi t)$. The amplitude of the particle is
(a) 8 (b) - 4 (c) 4 (d) $4\sqrt{2}$ [AIEEE 2003]

11) 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 S.H.M. of time-period T. If the mass is increased by m, the time-period becomes 5T / 3. The ratio m / M is
(a) 5 / 3 (b) 3 / 5 (c) 16 / 9 (d) 25 / 9 [AIEEE 2003]

12) A body executes simple harmonic motion. The potential energy (P. E.), kinetic energy (K. E.) and total energy (T. E.) are measured as a function of displacement x. Which of the following statements is true ?
(a) T. E. is zero when x is zero (b) P. E. is maximum when x is zero
(c) K. E. is maximum when x is zero (d) K. E. is maximum when x is maximum
[AIEEE 2003]

13) Two particles A and B of equal masses are suspended from two massless springs of spring constants k_1 and k_2 respectively. If maximum velocities during oscillation are equal, the ratio of amplitudes of A and B is
(a) k_1 / k_2 (b) k_2 / k_1 (c) $\sqrt{(k_1 / k_2)}$ (d) $\sqrt{(k_2 / k_1)}$ [AIEEE 2003, IIT 1988]

14) Length of a simple pendulum executing simple harmonic motion is increased by 21 %. The percentage increase in the time-period of the pendulum of increased length is
(a) 10 % (b) 11 % (c) 21 % (d) 42 % [AIEEE 2003]

15) One of the two clocks on the earth is controlled by a pendulum and other by a spring. If both the clocks are taken to the moon, then which clock will have the same time-period on the earth ?
(a) spring clock (b) pendulum clock (c) both (d) none [AIEEE 2002]

16) If a spring of force constant k is cut into three equal parts, then force constant of each part will be
(a) k / 3 (b) k (c) 3 k (d) 6 k [AIEEE 2002]

17) Two springs having spring constants of 25 N / m and 16 N / m stretched by forces F_1 and F_2 have equal potential energy. The ratio of the forces F_1 and F_2 is
(a) 4 / 5 (b) 5 / 4 (c) 16 / 25 (d) 25 / 16 [AIEEE 2002]

18) Time period of a simple pendulum is T_1. When point of suspension of the pendulum is moving upwards following the equation $y = k t^2$ (where $k = 1 \ m/s^2$, y is the displacement of point of suspension), its time period becomes T_2. Then T_1^2 / T_2^2 is equal to
(a) 5 / 6 (b) 6 / 5 (c) 1 (d) 4 / 5 [IIT 2005]

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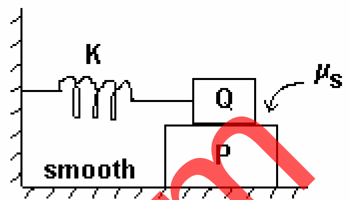
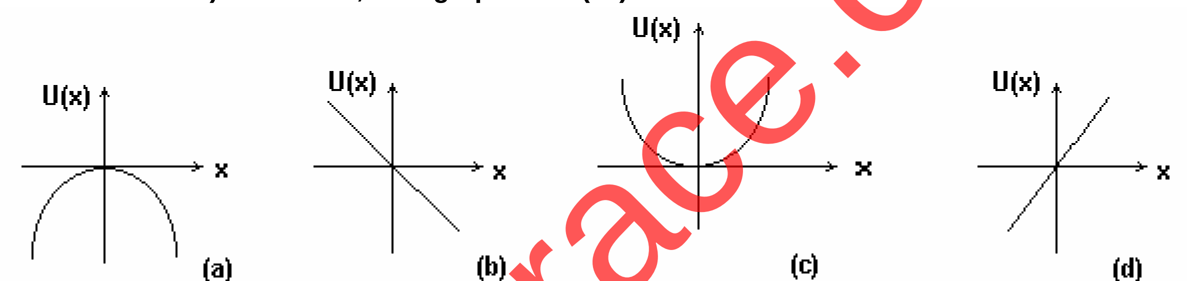
(Answers at the end of all questions)

19) A block P of mass m is placed on a frictionless horizontal surface. Another block Q of same mass is kept on P and connected to the wall with the help of a spring of spring constant K as shown in the figure. μ_s is the coefficient of friction between P and Q. The blocks move together performing SHM of amplitude A. The maximum value of the frictional force between P and Q is



(a) KA (b) KA / 2 (c) zero (d) $\mu_s mg$ [IIT 2004]

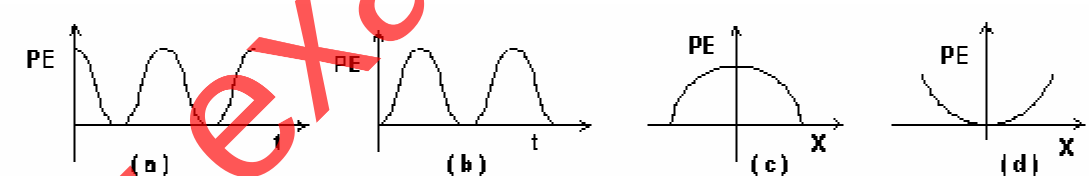
20) A particle is placed at the origin and a force F = k x is acting on it (where k is a positive constant). If U = 0, the graph of U(x) vs. x will be



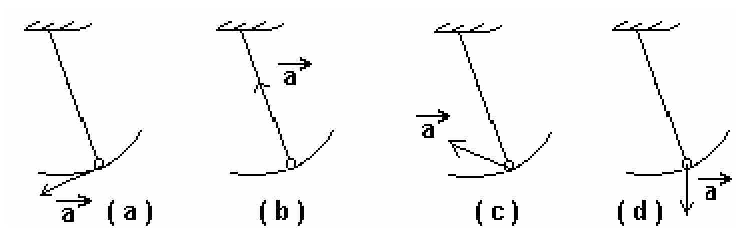
[IIT 2004]

21) For a particle executing SHM, the displacement x is given by $x = A \cos \omega t$. Identify the graph which represents the variation of potential energy (PE) as a function of time t and displacement x.

[IIT 2003]



22) A simple pendulum is oscillating without damping. When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly shown in



[IIT, 2002]

23) An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension of the spring is

(a) 4 Mg / k (b) 2 Mg / k (c) Mg / k (d) Mg / 2k [IIT 2002]

24) A particle executes simple harmonic motion between x = - A and x = A. The time taken by it to go from 0 to A / 2 is T_1 and to go from A / 2 to A is T_2. Then

(a) $T_1 < T_2$ (b) $T_1 > T_2$ (c) $T_1 = T_2$ (d) $T_1 = 2T_2$ [IIT 2001]

(Answers at the end of all questions)

25) A simple pendulum has a time period T_1 when on the earth's surface, and T_2 when taken to a height R above the earth's surface where R is the radius of the earth. The value of T_2 / T_1 is

(a) 1 (b) $\sqrt{2}$ (c) 4 (d) 2 [IIT 2001]

26) The period of oscillation of a simple pendulum of length L suspended from the roof of a vehicle which moves without friction, down an inclined plane of inclination α, is given by

(a) $2\pi\sqrt{\frac{L}{g \cos\alpha}}$ (b) $2\pi\sqrt{\frac{L}{g \sin\alpha}}$ (c) $2\pi\sqrt{\frac{L}{g}}$ (d) $2\pi\sqrt{\frac{L}{g \tan\alpha}}$ [IIT 2000]

27) A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(a) 2 k / 3 (b) 3 k / 2 (c) 3 k (d) 6k [IIT 1999]

28) Three simple harmonic motions in the same direction having the same amplitude and same period are superposed. If each differ in phase from the next by 45°, then

(a) the resultant amplitude is ($1 + \sqrt{2}$ a)

(b) the phase of the resultant motion relative to the first is 90°

(c) the energy associated with the resulting motion is ($3 + 2\sqrt{2}$) times the energy associated with any single motion

(d) the resulting motion is not simple harmonic [IIT 1999]

29) A particle free to move along the x-axis has potential energy given by $U(x) = K(1 - e^{-x^2})$ for $-\infty \leq x \leq \infty$ where K is a positive constant of appropriate dimensions, then

(a) at points away from the origin, the particle is in unstable equilibrium

(b) for any finite non-zero value of x, there is a force directed away from the origin

(c) if its total mechanical energy is K / 2, it has its minimum kinetic energy at the origin

(d) for small displacements from x = 0, the motion is simple harmonic [IIT 1999]

30) A particle of mass m is executing oscillations about the origin on x-axis. Its potential energy is given by $U(x) = k\,|x|^3$, where k is a positive constant. If the amplitude of oscillation is a, then its time period T is

(a) proportional to $1/\sqrt{a}$ (b) independent of a

(c) proportional to $\sqrt{a}$ (d) proportional to $a^{3/2}$ [IIT 1998]

31) One end 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 the Young's modulus of the wire are A and Y respectively. If the mass is slightly pulled down and released, it will oscillate with a time period T equal to

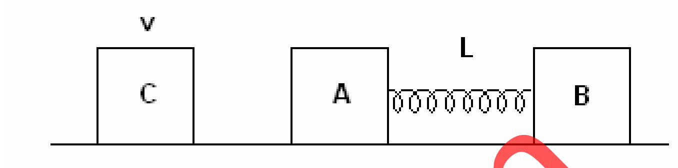
(a) $2\pi\sqrt{\frac{m}{K}}$ (b) $2\pi\sqrt{\frac{m(YA + KL)}{YAK}}$ (c) $2\pi\sqrt{\frac{mYA}{KL}}$ (d) $2\pi\sqrt{\frac{mL}{YA}}$ [IIT 1993]

32) The displacement y of a particle executing periodic motion is given by $y = 4 \cos^2 (t/2) \sin(1000t)$. This expression may be considered to be a result of superposition of the following number of harmonic motions.

(a) two (b) three (c) four (d) five [IIT 1992]

(Answers at the end of all questions)

33) Two blocks A and B, each of mass m are connected by a massless spring of natural length L and spring constant K. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length as shown in the figure. A third identical block also of mass m moves on the floor with the speed v along the line joining A and B, and collides with A. Then



(a) the kinetic energy of the A - B system, at maximum compression of the spring, is zero

(b) the kinetic energy of the A - B system, at maximum compression of the spring, is $mv^2/4$

(c) the maximum compression of the spring is $v\sqrt{\frac{m}{K}}$

(d) the maximum compression of the spring is $v\sqrt{\frac{m}{2K}}$ [IIT 1993]

34) A highly rigid cubical block A of small mass M and side L is fixed rigidly on to another cubical block B of the same dimensions and of low modulus of rigidity η such that the lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface. A small force F is applied perpendicular to one of the side faces of A. After the force is withdrawn, block A executes small oscillations the time period of which is given by

(a) $2\pi\sqrt{M\eta L}$ (b) $2\pi\sqrt{M\eta/L}$ (c) $2\pi\sqrt{ML/\eta}$ (d) $2\pi\sqrt{M/\eta L}$ [IIT 1991]

35) A uniform cylinder of length L and mass M having cross-sectional area A is suspended with its length vertical, from a fixed point by a massless spring, such that it is half submerged in a liquid of density ρ at equilibrium position. When the cylinder is given a small downward push and released, it starts oscillating vertically with small amplitude. If the force-constant of the spring is k, the frequency of oscillation of the cylinder is

(a) $\frac{1}{2\pi}\sqrt{\frac{k - A\rho g}{M}}$ (b) $\frac{1}{2\pi}\sqrt{\frac{k + A\rho g}{M}}$ (c) $\frac{1}{2\pi}\sqrt{\frac{k + \rho g L^2}{M}}$ (d) $\frac{1}{2\pi}\sqrt{\frac{k + A\rho g}{A\rho g}}$

[IIT 1990]

36) Two bodies M and N of equal masses are suspended from two separate massless springs of spring constants 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 of N is

(a) k_1 / k_2 (b) $\sqrt{k_1/k_2}$ (c) k_2 / k_1 (d) $\sqrt{k_2/k_1}$ [IIT 1988]

37) A particle executes simple harmonic motion with a frequency, f. The frequency with which its kinetic energy oscillates is

(a) f / 2 (b) f (c) 2f (d) 4f [IIT 1987]

38) The period of a simple harmonic oscillator is 2 sec. The ratio of its maximum velocity and maximum acceleration is

(a) π (b) $1 / \pi$ (c) 2π (d) 4 [GSEB March 1996]

(Answers at the end of all questions)

39) A simple pendulum of length L and mass (of bob) M is oscillating in a plane about a vertical line between angular limits $-\phi$ and $+\phi$. For an angular displacement θ ($|\theta| < \phi$), the tension in the string and the velocity of the bob are T and V respectively. The following relations hold good under the above conditions:

(a) $T \cos\theta = mg$ (b) $T - mg\cos\theta = \frac{MV^2}{L}$ (c) $T = mg\cos\theta$

(d) the magnitude of the tangential acceleration of the bob $|a_T| = g\sin\theta$ [IIT 1986]

40) At a point where reference particle meets the simple harmonic oscillator, the velocity of the oscillator is

(a) $A\omega$ (b) $1/A\omega$ (c) $A\omega^2$ (d) zero [GSEB March 1996]

41) A body is suspended at the end of a spring kept vertical. The periodic time on increasing its mass

(a) will decrease (b) may decrease or increase
(c) will remain constant (d) will increase [GSEB Oct. 1996, March 1997]

42) The initial phase of a particle performing S.H.M. is $\pi/4$. What will be its phase at the end of 10 oscillations ?

(a) 20π (b) $81\pi/4$ (c) 80π (d) $25\pi/4$ [GSEB Oct. 1996]

43) When the velocity of S. H. Oscillator becomes half its maximum velocity, then the displacement will be

(a) $3A/2$ (b) $(3/2)\sqrt{A}$ (c) $\sqrt{3}A/2$ (d) $3A/\sqrt{2}$ [GSEB March 1997]

44) A particle is performing S.H.M. Its amplitude is ‘A’. Its potential and kinetic energy become equal at the displacement y. The displacement, y, in terms of amplitude ‘A’ is

(a) A (b) $A/\sqrt{2}$ (c) $A\sqrt{2}$ (d) $A/2$ [GSEB Oct. 1997]

45) For a particle performing S.H.M., the ratio of its displacement and ____________ at any point is constant.

(a) velocity (b) mass (c) periodic time (d) acceleration [GSEB Oct. 1997]

46) S.H. Oscillator is at the positive end at t = 0. Then after T / 4 second, its phase will be __________ radian.

(a) $3\pi/2$ (b) 2π (c) π (d) $\pi/2$ [GSEB March 1998]

47) Graph of potential energy vs. displacement of a S.H. Oscillator is

(a) parabolic (b) hyperbolic (c) elliptical (d) linear [GSEB March 1998]

48) If the frequency of the particle executing S.H.M. is n, the frequency of its kinetic energy becoming maximum is

(a) n / 2 (b) n (c) 2 n (d) 4 n

49) When a 10 g mass is attached to a spring of length 10 cm, it stretches by 1 cm. Now, if it is pulled down till its length becomes 12 cm, the potential energy stored in it is

(a) 2×10^{-3} J (b) 10^{-3} J (c) 4×10^{-2} J (d) 2×10^{-2} J (take $g = 10\ m/s^2$)

50) In the case of damped oscillations, which of the following statements is not true ?

(a) amplitude decreases (b) periodic time increases
(c) energy of oscillator decreases (d) amplitude never becomes zero

(Answers at the end of all questions)

51) In the case of forced oscillations, which of the following statements is not true ?
(a) frequency equals that of external periodic force
(b) amplitude depends upon the damping coefficient
(c) amplitude tends to infinity at resonance
(d) higher the damping coefficient, lower is the amplitude at resonance

52) The time-period of S.H.O. is 16 sec. Starting from mean position, its velocity is 0.4 m /s after 2 sec. Its amplitude is
(a) 0.36 m (b) 0.72 m (c) 1.44 m (d) 2.88 m

53) Total energy of S.H.O. is E. Then its kinetic energy at half the amplitude is
(a) 3 E / 4 (b) E / 4 (c) E / 2 (d) $E\sqrt{3}/4$

54) Two S.H.M.s are given by $y_1 = 10 \sin(\omega t + \phi)$ and $y_2 = 5(\sin \omega t + \sqrt{3} \cos \omega t)$. The ratio of their amplitudes is
(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) $\sqrt{2} : 1$

55) When a mass is attached to a spring, its length is increased by 20 cm. It is further lowered and released. The time-period of its S.H.M. is
(a) $2\pi/7$ sec (b) 2π sec (c) 4π sec (d) data is not enough

56) For a S.H.O., time-period is 12 sec. Initially it is on + Y- axis at a displacement A / 2 where A is its amplitude. After reaching the uppermost point it moves down and is on - Y-axis at a distance $\sqrt{3}$ A / 2 from the equilibrium point. Time taken by it for this displacement is (a) 6 sec (b) 7 sec (c) 8 sec (d) 9 sec

57) A pendulum suspended from the ceiling of a train has a period T when the train is at rest. If the train accelerates with uniform acceleration a, the time-period of oscillations of the pendulum becomes
(a) T (b) $T\sqrt{[g/\sqrt{(a^2+g^2)}]}$ (c) $T\sqrt{[g/(g+a)]}$ (d) $T\sqrt{[g/(g-a)}$

58) In damped oscillations, the directions of the restoring force and the resistive force
(a) are the same (b) are opposite
(c) may be same or opposite (d) have no relation with each other

59) In damped oscillations, the angular frequency of the oscillator
(a) keeps on decreasing (b) keeps on increasing
(c) remains the same (d) fluctuates

60) In damped oscillations, the oscillator
(a) stops oscillating after a short time (b) stops oscillating after a long time
(c) never stops oscillating
(d) stops after time that depends upon its damping coefficient

61) In forced oscillations, a force of 50 N and frequency of $6/\pi$ Hz is applied to the oscillator having mass of 4 kg. If the angular frequency of the natural oscillations of the system is 13 rad / sec, the amplitude of oscillations is
(a) 1 m (b) 2.5 m (c) 3 m (d) 4 m

62) A spring having spring constant k is cut into two parts of equal lengths and both the pieces are joined in parallel. A block of mass, m, is attached to the lower end of the two springs. What is the equivalent spring constant of the system ?
(a) k (b) 2 k (c) 3 k (d) 4 k

09 - OSCILLATIONS

(Answers at the end of all questions)

63) A pendulum of length 10 cm is suspended from the roof of a vehicle which moves without friction down an inclined plane of inclination 60 ° with the horizontal. The time-period of oscillations of the pendulum will be

(a) $2\pi / 7$ sec (b) 2π sec (c) π sec (d) $\pi / 7$ sec

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
b	a	b	a	c	b	c	b	a	d	c	c	d	a	a	c	b	b	b	a	a,d

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
a,d	c	b	a	d	a	b	a,c	d	a	b	b	b,d	d	b	d	c	b	b,c	d	b	b

43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
c	b	d	c	a	c	b	b	c	c	d	a	a	a	b	c	c	c	b	d	a