Critical Thinking

Objective Questions

1. Two particles executes S.H.M. of same amplitude and frequency along the same straight line. They pass one another when going in opposite directions, and each time their displacement is half of their amplitude. The phase difference between them is **[MP PMT 1999]**

(a) 30° (b) 60°

(c) 90° (d) 120°

2. The displacement of a particle varies with time as $x = 12\sin\omega t - 16\sin^3\omega t$ (in *cm*). If its motion is S.H.M., then its maximum acceleration is

(a) $12\omega^2$ (b) $36\omega^2$

(c) $144\omega^2$ (d) $\sqrt{192}\,\omega^2$

3. A linear harmonic oscillator of force constant $2\times10^6\,N/m$ times and amplitude 0.01 *m* has a total mechanical energy of 160 *joules*. Its **[IIT JEE 1989; CPMT 1995; CBSE PMT 1996; KECT (Med.) 1999; AMU (Engg.) 2000; UPSEAT 2001]**

(a) Maximum potential energy is 100 *J*

(b) Maximum K.E. is 100 *J*

(c) Maximum P.E. is 160 *J*

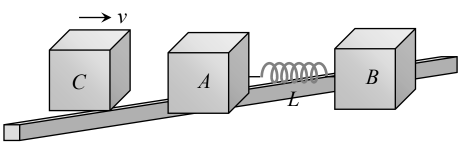
(d) Minimum P.E. is zero

4. A particle of mass *m* is executing oscillations about the origin on the *x*-axis. Its potential energy is $U(x) = k[x]^3$, where *k* is a positive constant. If the amplitude of oscillation is *a*, then its time period *T* is **[IIT-JEE 1998]**

(a) Proportional to $\frac{1}{\sqrt{a}}$ (b) Independent of *a*

(c) Proportional to $\sqrt{a}$ (d) Proportional to $a^{3/2}$

5. 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 figure. A third identical block *C* also of mass *m* moves on the floor with a speed *v* along the line joining *A* and *B* and collides with *A*. Then **[IIT-JEE 1993]**



(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 $v\sqrt{m/K}$

(d) The maximum compression of the spring is $v\sqrt{m/2K}$

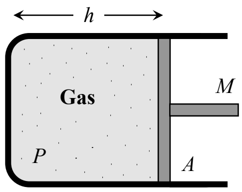
6. A cylindrical piston of mass *M* slides smoothly inside a long cylinder closed at one end, enclosing a certain mass of gas. The cylinder is kept with its axis horizontal. If the piston is disturbed from its equilibrium position, it oscillates simple harmonically. The period of oscillation will be **[IIT-JEE 1981]**

(a) $T = 2\pi\sqrt{\left(\frac{Mh}{PA}\right)}$

(b) $T = 2\pi\sqrt{\left(\frac{MA}{Ph}\right)}$

(c) $T = 2\pi\sqrt{\left(\frac{M}{PAh}\right)}$

(d) $T = 2\pi\sqrt{MPhA}$



7. A sphere of radius *r* is kept on a concave mirror of radius of curvature *R*. The arrangement is kept on a horizontal table (the surface of concave mirror is frictionless and sliding not rolling). If the sphere is displaced from its equilibrium position and left, then it executes S.H.M. The period of oscillation will be

(a) $2\pi\sqrt{\left(\frac{(R-r)1.4}{g}\right)}$ (b) $2\pi\sqrt{\left(\frac{R-r}{g}\right)}$

(c) $2\pi\sqrt{\left(\frac{rR}{a}\right)}$ (d) $2\pi\sqrt{\left(\frac{R}{gr}\right)}$

8. The amplitude of vibration of a particle is given by $a_m = (a_0)/(a\omega^2 - b\omega + c)$; where a_0, a, b and *c* are positive. The condition for a single resonant frequency is

[CPMT 1982]

(a) $b^2 = 4ac$ (b) $b^2 > 4ac$

(c) $b^2 = 5ac$ (d) $b^2 = 7ac$

9. A U tube of uniform bore of cross-sectional area A has been set up vertically with open ends facing up. Now m gm of a liquid of density d is poured into it. The column of liquid in this tube will oscillate with a period T such that

(a) $T = 2\pi\sqrt{\frac{M}{g}}$ (b) $T = 2\pi\sqrt{\frac{MA}{gd}}$

(c) $T = 2\pi\sqrt{\frac{M}{gdA}}$ (d) $T = 2\pi\sqrt{\frac{M}{2Adg}}$

10. A particle is performing simple harmonic motion along x-axis with amplitude 4 *cm* and time period 1.2 *sec*. The minimum time taken by the particle to move from x =2 *cm* to x = + 4 *cm* and back again is given by **[AIIMS 1995]**

(a) 0.6 *sec* (b) 0.4 *sec*

(c) 0.3 *sec* (d) 0.2 *sec*

11. A large horizontal surface moves up and down in SHM with an amplitude of 1 *cm*. If a mass of 10 *kg* (which is placed on the surface) is to remain continually in contact with it, the maximum frequency of S.H.M. will be

[SCRA 1994; AIIMS 1995]

(a) 0.5 *Hz* (b) 1.5 *Hz*

(c) 5 *Hz* (d) 10 *Hz*

12. Due to some force F_1 a body oscillates with period 4/5 *sec* and due to other force F_2 oscillates with period 3/5 *sec*. If both forces act simultaneously, the new period will be

[RPET 1997]

(a) 0.72 *sec* (b) 0.64 *sec*

(c) 0.48 *sec* (d) 0.36 *sec*

13. A horizontal platform with an object placed on it is executing S.H.M. in the vertical direction. The amplitude of oscillation is $3.92 \times 10^{-3} m$. What must be the least period of these oscillations, so that the object is not detached from the platform **[AIIMS 1999]**

(a) 0.1256 *sec* (b) 0.1356 *sec*

(c) 0.1456 *sec* (d) 0.1556 *sec*

14. A particle executes simple harmonic motion (amplitude = A) between $x = -A$ and $x = +A$. The time taken for it to go from 0 to A/2 is T_1 and to go from A/2 to A is T_2. Then

[IIT-JEE (Screening) 2001]

(a) $T_1 < T_2$ (b) $T_1 > T_2$

(c) $T_1 = T_2$ (d) $T_1 = 2T_2$

15. A simple pendulum of length L and mass (bob) 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 the velocity of the bob are T and v respectively. The following relations hold good under the above conditions

[IIT 1986; UPSEAT 1998]

(a) $T\cos\theta = Mg$

(b) $T - Mg\cos\theta = \frac{Mv^2}{L}$

(c) The magnitude of the tangential acceleration of the bob $|a_T| = g\sin\theta$

(d) $T = Mg\cos\theta$

16. Two simple pendulums of length 5 *m* and 20 *m* respectively are given small linear displacement in one direction at the same time. They will again be in the phase when the pendulum of shorter length has completed .... oscillations.

[CBSE PMT 1998; JIPMER 2001, 02]

(a) 5 (b) 1

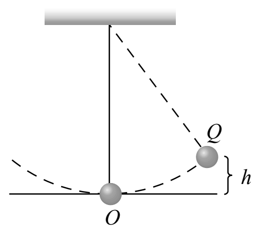
(c) 2 (d) 3

17. The bob of a simple pendulum is displaced from its equilibrium position O to a position Q which is at height h above O and the bob is then released. Assuming the mass of the bob to be m and time period of oscillations to be 2.0 *sec*, the tension in the string when the bob passes through O is

[AMU 1995]

(a) $m(g + \pi\sqrt{2gh})$

(b) $m(g + \sqrt{\pi^2 gh})$



(c) $m\left(g+\sqrt{\frac{\pi^2}{2}gh}\right)$

(d) $m\left(g+\sqrt{\frac{\pi^2}{3}gh}\right)$

18. The metallic bob of a simple pendulum has the relative density ρ. The time period of this pendulum is T. If the metallic bob is immersed in water, then the new time period is given by **[SCRA 1998]**

(a) $T\frac{\rho-1}{\rho}$ (b) $T\frac{\rho}{\rho-1}$

(c) $T\sqrt{\frac{\rho-1}{\rho}}$ (d) $T\sqrt{\frac{\rho}{\rho-1}}$

19. A clock which keeps correct time at 20^oC, is subjected to 40^oC. If coefficient of linear expansion of the pendulum is $12\times10^{-6}/°C$. How much will it gain or loose in time **[BHU 1998]**

(a) 10.3 *seconds / day* (b) 20.6 *seconds / day*

(c) 5 *seconds / day* (d) 20 *minutes / day*

20. 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 **[IIT-JEE (Screening) 2000]**

(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) $2\pi\sqrt{\frac{L}{g\tan\alpha}}$

21. 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) ×1000 *kg/m*^{3}. What relationship between t and t_0 is true **[AIEEE 2004]**

(a) $t=t_0$ (b) $t=t_0/2$

(c) $t=2t_0$ (d) $t=4t_0$

22. 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 **[IIT-JEE (Screening) 1999]**

(a) $(2/3)k$ (b) $(3/2)k$

(c) $3k$ (d) $6k$

23. One end of a long metallic wire of length *L* is tied to the ceiling. The other end is tied to 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 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 **[IIT 1993]**

(a) $2\pi\left(\frac{m}{K}\right)$ (b) $2\pi\left\{\frac{(YA+KL)m}{YAK}\right\}^{1/2}$

(c) $2\pi\frac{mYA}{KL}$ (d) $2\pi\frac{mL}{YA}$

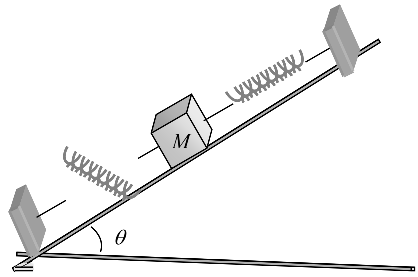
24. On a smooth inclined plane, a body of mass *M* is attached between two springs. The other ends of the springs are fixed to firm supports. If each spring has force constant *K*, the period of oscillation of the body (assuming the springs as massless) is **[NSEP 1994]**

(a) $2\pi\left(\frac{m}{2K}\right)^{1/2}$

(b) $2\pi\left(\frac{2M}{K}\right)^{1/2}$

(c) $2\pi\frac{Mg\sin\theta}{2K}$

(d) $2\pi\left(\frac{2Mg}{K}\right)^{1/2}$



25. A particle of mass *m* is attached to a spring (of spring constant *k*) and has a natural angular frequency 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 **[AIEEE 2004]**

(a) $\frac{m}{\omega_0^2-\omega^2}$ (b) $\frac{1}{m(\omega_0^2-\omega^2)}$

(c) $\frac{1}{m(\omega_1^2+\omega^2)}$ (d) $\frac{m}{\omega_1^2+\omega^2}$

26. A 15 *g* ball is shot from a spring gun whose spring has a force constant of 600 *N/m*. The spring is compressed by 5 *cm*. The greatest possible horizontal range of the ball for this compression is ($g = 10\ m/s^2$)

[DPMT 2004]

(a) 6.0 m (b) 10.0 m

(c) 12.0 m (d) 8.0 m

27. 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 in the spring is

[IIT-JEE (Screening) 2002]

(a) 4 Mg/K (b) 2 Mg/K

(c) Mg/K (d) $Mg/2K$

28. 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 the superposition of .... independent harmonic motions

[IIT 1992]

(a) Two (b) Three

(c) Four (d) Five

29. Three simple harmonic motions in the same direction having the same amplitude a and same period are superposed. If each differs in phase from the next by 45^o, then

[IIT JEE 1999]

(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

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

[AIEEE 2005]

(a) A simple harmonic motion with a period $2\pi/\omega$

(b) A simple harmonic motion with a period π/ω

(c) A periodic but not simple harmonic motion with a period $2\pi/\omega$

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

31. A simple pendulum has time period T_1. The point of suspension is now moved upward according to equation $y = kt^2$ where $k = 1\ m/sec^2$. If new time period is T_2 then ratio $\frac{T_1^2}{T_2^2}$ will be

[IIT-JEE (Screening) 2005]

(a) 2/3 (b) 5/6

(c) 6/5 (d) 3/2

32. A simple pendulum is hanging from a peg inserted in a vertical wall. Its bob is stretched in horizontal position from the wall and is left free to move. The bob hits on the wall the coefficient of restitution is $\frac{2}{\sqrt{5}}$. After how many collisions the amplitude of vibration will become less than 60°

[UPSEAT 1999]

(a) 6 (b) 3

(c) 5 (d) 4

33. A brass cube of side a and density σ is floating in mercury of density ρ. If the cube is displaced a bit vertically, it executes S.H.M. Its time period will be

(a) $2\pi\sqrt{\frac{\sigma a}{\rho g}}$ (b) $2\pi\sqrt{\frac{\rho a}{\sigma g}}$

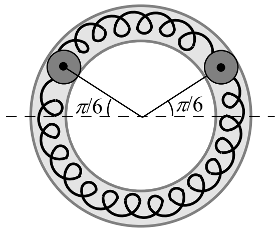
(c) $2\pi\sqrt{\frac{\rho g}{\sigma a}}$ (d) $2\pi\sqrt{\frac{\sigma g}{\rho a}}$

34. Two identical balls A and B each of mass 0.1 kg are attached to two identical massless springs. The spring mass system is constrained to move inside a rigid smooth pipe bent in the form of a circle as shown in the figure. The pipe is fixed in a horizontal plane. The centres of the balls can move in a circle of radius 0.06 m. Each spring has a natural length of $0.06\pi\ m$ and force constant $0.1 N/m$. Initially both the balls are displaced by an angle $\theta = \pi/6$ radian with respect to the diameter PQ of the circle and released from rest. The frequency of oscillation of the ball B is

(a) $\pi\ Hz$

(b) $\frac{1}{\pi}\ Hz$

(c) $2\pi\ Hz$



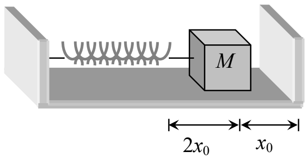
(d) $\frac{1}{2\pi} Hz$

35. 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) $\frac{3}{2}R$

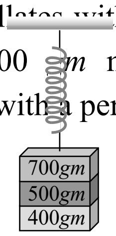
36. One end of a spring of force constant k is fixed to a vertical wall and the other to a block of mass m resting on a smooth horizontal surface. There is another wall at a distance x_0 from the black. The spring is then compressed by $2x_0$ and released. The time taken to strike the wall is



(a) $\frac{1}{6}\pi\sqrt{\frac{k}{m}}$ (b) $\sqrt{\frac{k}{m}}$

(c) $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$ (d) $\frac{\pi}{4}\sqrt{\frac{k}{m}}$

37. Three masses 700g, 500g, and 400g are suspended at the end of a spring a shown and are in equilibrium. When the 700g mass is removed, the system oscillates with a period of 3 seconds, when the 500 gm mass is also removed, it will oscillate with a period of



(a) 1 s

(b) 2 s

(c) 3 s

(d) $\sqrt{\frac{12}{5}}\ s$

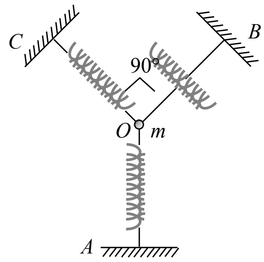
38. A particle of mass m is attached to three identical springs A, B and C each of force constant k a shown in figure. If the particle of mass m is pushed slightly against the spring A and released then the time period of oscillations is

(a) $2\pi\sqrt{\frac{2m}{k}}$

(b) $2\pi\sqrt{\frac{m}{2k}}$

(c) $2\pi\sqrt{\frac{m}{k}}$

(d) $2\pi\sqrt{\frac{m}{3k}}$



39. A hollow sphere is filled with water through a small hole in it. It is then hung by a long thread and made to oscillate. As the water slowly flows out of the hole at the bottom, the period of oscillation will

[MP PMT 1994; KCET 1994; RPET 1996; AFMC 2000; CBSE PMT 2000; CPMT 2001; AIEEE 2005]

(a) Continuously decrease

(b) Continuously increase

(c) First decrease and then increase to original value

(d) First increase and then decrease to original value

40. Two simple pendulums whose lengths are 100 cm and 121 cm are suspended side by side. Their bobs are pulled together and then released. After how many minimum oscillations of the longer pendulum, will the two be in phase again **[DPMT 2005]**

(a) 11 (b) 10

(c) 21 (d) 20

41. The amplitude of a damped oscillator becomes half in one minute. The amplitude after 3 *minute* will be $\frac{1}{X}$ times the original, where X is

[CPMT 1989; DPMT 2002]

(a) 2×3 (b) 2^3

(c) 3^2 (d) 3×2^2

42. Which of the following function represents a simple harmonic oscillation

[AIIMS 2005]

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

(c) $\sin\omega t + \sin 2\omega t$ (d) $\sin\omega t - \sin 2\omega t$

43. A uniform rod of length 2.0 m is suspended through an end and is set into oscillation with small amplitude under gravity. The time period of oscillation is approximately

[AMU (Med.) 2000]

(a) 1.60 *sec* (b) 1.80 *sec*

(c) 2.0 *sec* (d) 2.40 *sec*

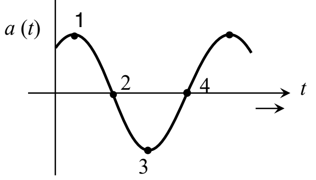
Graphical Questions

1. A particle is executing S.H.M. Then the graph of acceleration as a function of displacement is

(a) A straight line (b) A circle

(c) An ellipse (d) A hyperbola

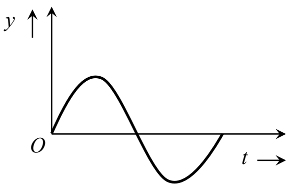
2. The acceleration a of a particle undergoing S.H.M. is shown in the figure. Which of the labelled points corresponds to the particle being at $-x_{max}$ **[AMU (Med.) 2000]**



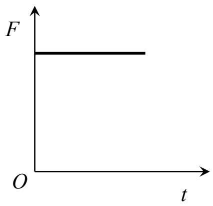
(a) 4 (b) 3

(c) 2 (d) 1

3. The displacement time graph of a particle executing S.H.M. is as shown in the figure



The corresponding force-time graph of the particle is

(a)


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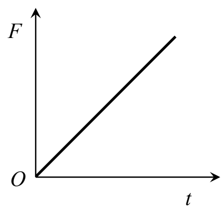

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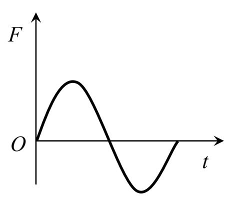

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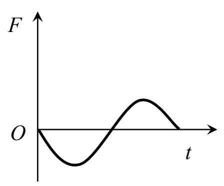
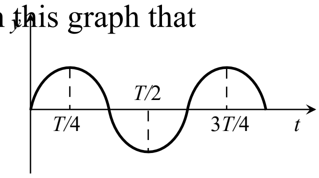


4. The graph shows the variation of displacement of a particle executing S.H.M. with time. We infer from this graph that



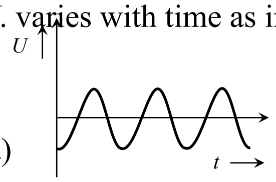
(a) The force is zero at time $3T/4$

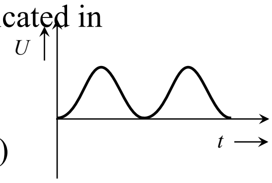
(b) The velocity is maximum at time $T/2$

(c) The acceleration is maximum at time T

(d) The P.E. is equal to total energy at time $T/2$

5. As a body performs S.H.M., its potential energy U. varies with time as indicated in

(a)


(b)


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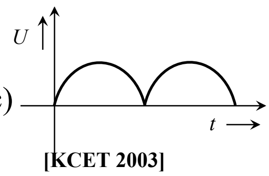

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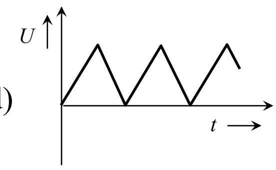
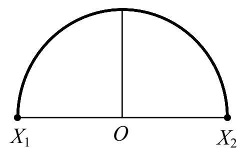


[KCET 2003]

6. A particle of mass m oscillates with simple harmonic motion between points x_1 and x_2, the equilibrium position being O. Its potential energy is plotted. It will be as given below in the graph **[CBSE PMT 2003]**

(a)


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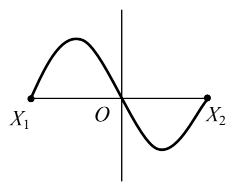
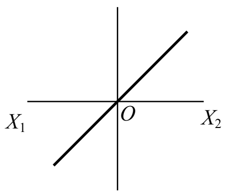
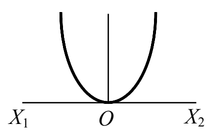
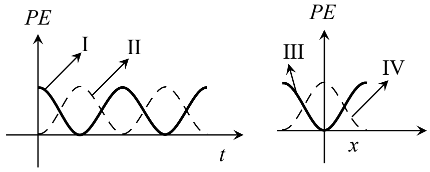


(c)


(d)


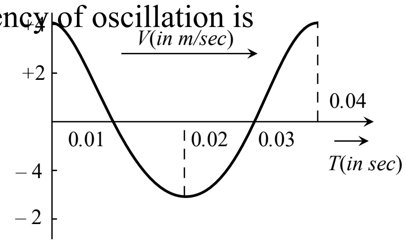
7. For a particle executing S.H.M. the displacement x is given by $x = A\cos\omega t$. Identify the graph which represents the variation of potential energy (P.E.) as a function of time t and displacement x **[IIT JEE (Screening) 2003]**



(a) I, III (b) II, IV

(c) II, III (d) I, IV

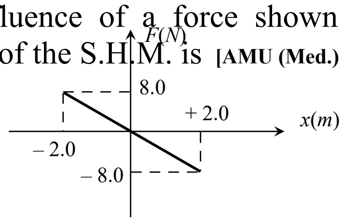
8. The velocity-time diagram of a harmonic oscillator is shown in the adjoining figure. The frequency of oscillation is **[CPMT 1989]**



(a) 25 Hz (b) 50 Hz

(c) 12.25 Hz (d) 33.3 Hz

9. A body of mass 0.01 kg executes simple harmonic motion (S.H.M.) about $x = 0$ under the influence of a force shown below : The period of the S.H.M. is **[AMU (Med.) 2002]**



(a) 1.05 s (b) 0.52 s

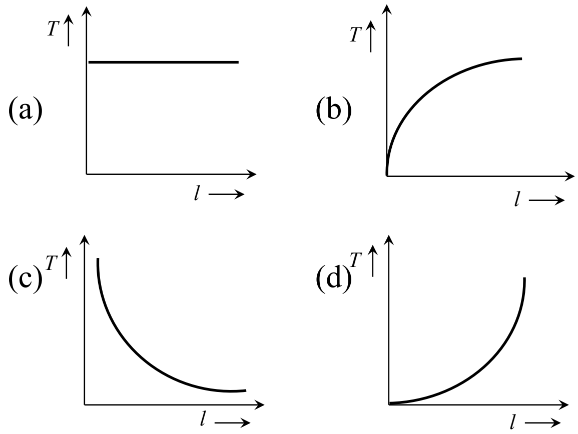
(c) 0.25 s (d) 0.30 s

10. For a simple pendulum the graph between L and T will be. **[CPMT 1992]**

(a) Hyperbola (b) Parabola

(c) A curved line (d) A straight line

11. In case of a simple pendulum, time period versus length is depicted by

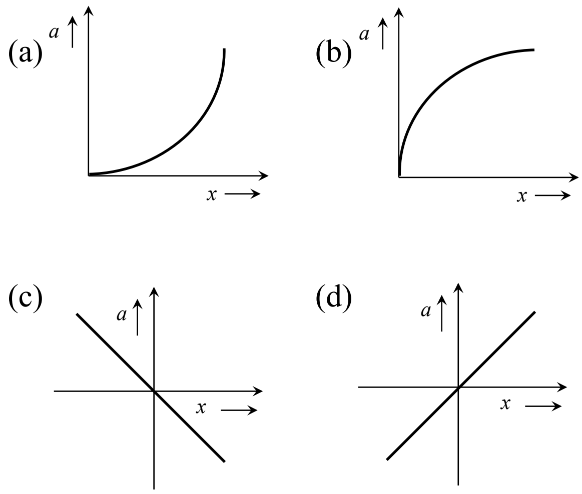


12. Graph between velocity and displacement of a particle, executing S.H.M. is **[DPMT 2005]**

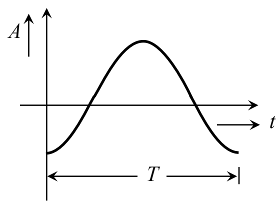
(a) A straight line (b) A parabola

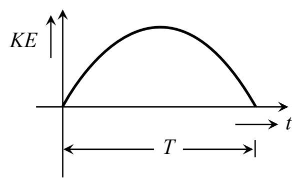
(c) A hyperbola (d) An ellipse

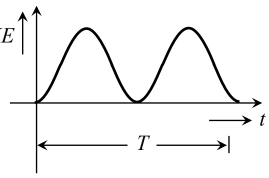
13. The variation of the acceleration a of the particle executing S.H.M. with displacement y is as shown in the figure



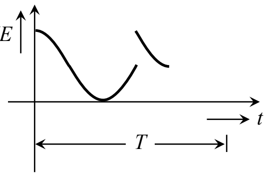
14. Acceleration A and time period T of a body in S.H.M. is given by a curve shown below. Then corresponding graph, between kinetic energy (K.E.) and time t is correctly represented by

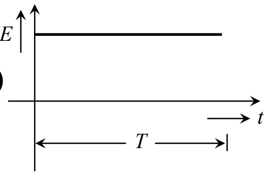




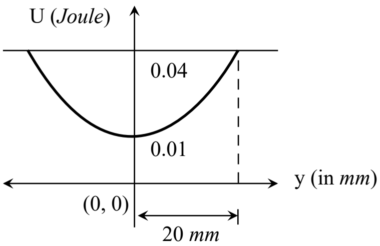
(a) 

(b)

(c) 

(d) 

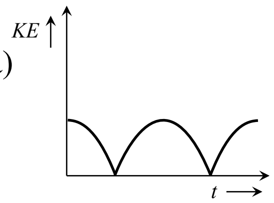
15. The variation of potential energy of harmonic oscillator is as shown in figure. The spring constant is

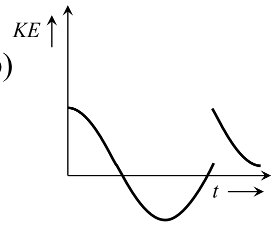


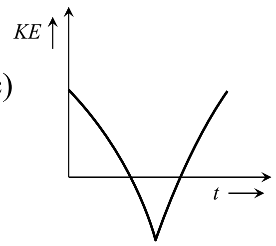
(a) 1×10^2 *N/m* (b) 150 *N/m*

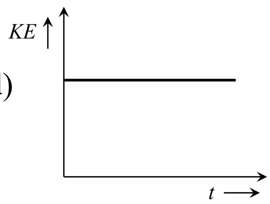
(c) 0.667×10^2 *N/m* (d) 3×10^2 *N/m*

16. A body performs S.H.M. Its kinetic energy *K* varies with time *t* as indicated by graph

(a) 

(b) 

(c) 

(d) 

Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) *If both assertion and reason are true and the reason is the correct explanation of the assertion.*
(b) *If both assertion and reason are true but reason is not the correct explanation of the assertion.*
(c) *If assertion is true but reason is false.*
(d) *If the assertion and reason both are false.*
(e) *If assertion is false but reason is true.*

1. Assertion : All oscillatory motions are necessarily periodic motion but all periodic motion are not oscillatory.
Reason : Simple pendulum is an example of oscillatory motion.

2. Assertion : Simple harmonic motion is a uniform motion.
Reason : Simple harmonic motion is the projection of uniform circular motion.

3. Assertion : Acceleration is proportional to the displacement. This condition is not sufficient for motion in simple harmonic.
Reason : In simple harmonic motion direction of displacement is also considered.

4. Assertion : Sine and cosine functions are periodic functions.
Reason : Sinusoidal functions repeats it values after a definite interval of time.

5. Assertion : The graph between velocity and displacement for a harmonic oscillator is a parabola.
Reason : Velocity does not change uniformly with displacement in harmonic motion.

6. Assertion : When a simple pendulum is made to oscillate on the surface of moon, its time period increases.

Reason : Moon is much smaller as compared to earth.

7. Assertion : Resonance is special case of forced vibration in which the natural frequency of vibration of the body is the same as the impressed frequency of external periodic force and the amplitude of forced vibration is maximum.

Reason : The amplitude of forced vibrations of a body increases with an increase in the frequency of the externally impressed periodic force.

[AIIMS 1994]

8. Assertion : The graph of total energy of a particle in SHM *w.r.t.,* position is a straight line with zero slope.

Reason : Total energy of particle in SHM remains constant throughout its motion.

9. Assertion : The percentage change in time period is 1.5%, if the length of simple pendulum increases by 3%.

Reason : Time period is directly proportional to length of pendulum.

10. Assertion : The frequency of a second pendulum in an elevator moving up with an acceleration half the acceleration due to gravity is 0.612 s^{-1}.

Reason : The frequency of a second pendulum does not depend upon acceleration due to gravity.

11. Assertion : Damped oscillation indicates loss of energy.

Reason : The energy loss in damped oscillation may be due to friction, air resistance etc.

12. Assertion : In a S.H.M., kinetic and potential energies become equal when the displacement is $1/\sqrt{2}$ times the amplitude.

Reason : In SHM, kinetic energy is zero when potential energy is maximum.

13. Assertion : If the amplitude of a simple harmonic oscillator is doubled, its total energy becomes four times.

Reason : The total energy is directly proportional to the square of amplitude of vibration of the harmonic oscillator.

14. Assertion : For an oscillating simple pendulum, the tension in the string is maximum at the mean position and minimum at the extreme position.

Reason : The velocity of oscillating bob in simple harmonic motion is maximum at the mean position.

15. Assertion : The spring constant of a spring is k. When it is divided into n equal parts, then spring constant of one piece is k/n.

Reason : The spring constant is independent of material used for the spring.

16. Assertion : The periodic time of a hard spring is less as compared to that of a soft spring.

Reason : The periodic time depends upon the spring constant, and spring constant is large for hard spring.

17. Assertion : In extreme position of a particle executing S.H.M., both velocity and acceleration are zero.

Reason : In S.H.M., acceleration always acts towards mean position.

18. Assertion : Soldiers are asked to break steps while crossing the bridge.

Reason : The frequency of marching may be equal to the natural frequency of bridge and may lead to resonance which can break the bridge.

[AIIMS 2001]

19. Assertion : The amplitude of oscillation can never be infinite.

Reason : The energy of oscillator is continuously dissipated.

20. Assertion : In S.H.M., the motion is ‘to and fro’ and periodic.

Reason : Velocity of the particle $(v) = \omega\sqrt{k^2 - x^2}$ (where x is the displacement and k is amplitude)

[AIIMS 2002]

21. Assertion : The amplitude of an oscillating pendulum decreases gradually with time

Reason : The frequency of the pendulum decreases with time **[AIIMS 2003]**

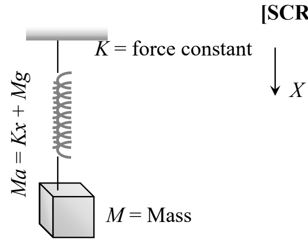
22. Assertion : In simple harmonic motion, the velocity is maximum when acceleration is minimum

Reason : Displacement and velocity of S.H.M. differ is phase by $\pi/2$ **[AIIMS 1999]**

23. Assertion : Consider motion for a mass spring system under gravity, motion of M is not a simple harmonic motion unless Mg is negligibly small.

Reason : For simple harmonic motion acceleration must be proportional to displacement and is directed towards the mean position

[SCRA 1994]



Answers

Displacement of S.H.M. and Phase

1	b,d	2	c	3	d	4	c	5	d
6	c	7	c	8	a	9	a,b,d	10	a
11	c	12	c	13	c	14	c	15	d
16	b	17	d	18	a	19	c	20	a
21	b	22	c	23	b	24	c	25	b
26	a								

Velocity of Simple Harmonic Motion

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

Acceleration of Simple Harmonic Motion

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

Energy of Simple Harmonic Motion

1	d	2	a	3	d	4	a	5	a
6	c	7	c	8	b	9	d	10	c
11	c	12	b	13	a	14	a	15	b
16	b	17	c	18	b	19	d	20	c
21	c	22	c	23	b	24	b	25	a
26	c	27	c	28	a	29	b	30	c
31	c	32	d	33	b	34	b		

Time Period and Frequency

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

Simple Pendulum

1	c	2	a	3	b	4	b	5	b
6	b	7	c	8	c	9	c	10	d
11	d	12	b	13	a	14	d	15	d
16	b	17	b	18	c	19	c	20	c
21	d	22	d	23	c	24	c	25	d
26	a	27	a	28	b	29	d	30	d
31	c	32	c	33	b	34	b	35	a
36	a	37	d	38	b	39	c	40	d
41	a	42	a	43	a	44	b	45	d
46	d	47	b	48	a	49	a	50	a
51	c	52	c	53	c	54	d	55	c
56	b	57	c	58	a	59	c	60	a
61	b								

Spring Pendulum

1	d	2	d	3	b	4	b	5	b
6	c	7	c	8	b	9	a	10	c
11	a	12	b	13	d	14	c	15	a
16	d	17	a	18	d	19	b	20	c
21	c	22	c	23	d	24	a	25	d

26	d	27	b	28	a	29	a	30	a
31	b	32	d	33	b	34	b	35	b
36	d	37	c	38	d	39	b	40	c
41	a	42	b	43	b	44	a	45	b
46	a	47	b	48	d	49	c	50	c
51	b	52	d	53	d	54	a	55	b

Superposition of S.H.M's and Resonance

1	c	2	c	3	c	4	c	5	a
6	c	7	d	8	a	9	b	10	d
11	b	12	c	13	a	14	c		

Critical Thinking Questions

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

Graphical Questions

1	a	2	d	3	d	4	d	5	b
6	d	7	a	8	a	9	d	10	b
11	b	12	d	13	c	14	a	15	b
16	a								

Assertion and Reason

1	b	2	e	3	a	4	a	5	e
6	b	7	c	8	a	9	c	10	c
11	b	12	b	13	a	14	b	15	e
16	a	17	e	18	a	19	a	20	b
21	c	22	b	23	e				

AS Answers and Solutions

Displacement of S.H.M. and Phase

1. (b,d) For S.H.M. displacement $y=a\sin\omega t$ and acceleration $A=-\omega^2 y\sin\omega t$ these are maximum at $\omega t=\frac{\pi}{2}$.

2. (c) $v_{max}=\omega A \Rightarrow v=\frac{\omega A}{2}=\omega\sqrt{A^2-y^2}$

$\Rightarrow A^2-y^2=\frac{A^2}{4} \Rightarrow y^2=\frac{3A^2}{4} \Rightarrow y=\frac{\sqrt{3}A}{2}$

3. (d) Equation of motion is $y=5\sin\frac{2\pi t}{6}$. For $y=2.5\,cm$

$2.5=5\sin\frac{2\pi t}{6} \Rightarrow \frac{2\pi t}{6}=\frac{\pi}{6} \Rightarrow t=\frac{1}{2}\,sec$

and phase $=\frac{2\pi t}{6}=\frac{\pi}{6}$.

4. (c) $y=a\sin(\omega t-\alpha)=a\cos\left(\omega t-\alpha-\frac{\pi}{2}\right)$

Another equation is given $y=\cos(\omega t-\alpha)$

So, there exists a phase difference of $\frac{\pi}{2}=90^\circ$

5. (d) $y=a\sin(\omega t+\phi)$

$=a\sin\left(\frac{2\pi}{T}t+\phi\right) \Rightarrow y=0.5\sin\left(\frac{2\pi}{0.4}t+\frac{\pi}{2}\right)$

$y=0.5\sin\left(5\pi t+\frac{\pi}{2}\right)=0.5\cos 5\pi t$

6. (c) $y=a\sin(2\pi nt+\alpha)$. Its phase at time $t=2\pi nt+\alpha$

7. (c) From given equation $\omega=\frac{2\pi}{T}=0.5\pi \Rightarrow$

$T=4\,sec$

Time taken from mean position to the maximum displacement $=\frac{1}{4}T=1\,sec$.

8. (a) It is required to calculate the time from extreme position.

Hence, in this case equation for displacement of particle can be written as

$x=a\sin(\omega t+\frac{\pi}{2})=a\cos\omega t$

$\Rightarrow \frac{a}{2}=a\cos\omega t \Rightarrow \omega t=\frac{\pi}{3} \Rightarrow \frac{2\pi}{T}.t=\frac{\pi}{3} \Rightarrow$

$t=\frac{T}{6}$

9. (a,b,d) $x=a\sin\omega t\cos\omega t=\frac{a}{2}\sin 2\omega t$

10. (a) $v_{max}=a\omega=a\times\frac{2\pi}{T} \Rightarrow a=\frac{v_{max}\times T}{2\pi}$

$a=\frac{1.00\times10^3\times(1\times10^{-5})}{2\pi}=1.59\,mm$

11. (c)

12. (c)

13. (c) $y = a\sin\frac{2\pi}{T}t \Rightarrow \frac{a}{\sqrt{2}} = a\sin\frac{2\pi}{T}\cdot t$

$\Rightarrow \sin\frac{2\pi}{T}t = \frac{1}{\sqrt{2}} = \sin\frac{\pi}{4} \Rightarrow \frac{2\pi}{T}t = \frac{\pi}{4} \Rightarrow t = \frac{T}{8}$

14. (c)

15. (d) Standard equation of S.H.M. $\frac{d^2y}{dt^2} = -\omega^2 y,$ is not satisfied by $y = a\tan\omega t$.