Additional Problems For Self Practice (APSP)

PART-I : PRACTICE TEST PAPER

Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions :

1. The test is of **1 hour** duration and max. marks 120.
2. The test consists **30** questions, **4 marks** each.
3. Only one choice is correct **1 mark** will be deducted for incorrect response. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
4. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 3 above.

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1. The time period of a particle in simple harmonic motion is equal to the smallest time between the particle acquiring a particular velocity $\vec{v}$. The value of v is
(1) v_{max} (2) 0
(3) between 0 and v_{max} (4) between 0 and $-v_{max}$

2. The magnitude of average acceleration in half time period from equilibrium position in a simple harmonic motion is
(1) $\frac{2A\omega^2}{\pi}$ (2) $\frac{A\omega^2}{2\pi}$ (3) $\frac{A\omega^2}{\sqrt{2}\pi}$ (4) Zero

3. A body is executing simple harmonic motion. At a displacement x, its potential energy is E_1 and at a displacement y, its potential energy is E_2. The potential energy E at a displacement (x + y) is
(1) $E_1 + E_2$ (2) $\sqrt{E_1^2 + E_2^2}$ (3) $E_1 + E_2 + 2\sqrt{E_1 \; E_2}$ (4) $\sqrt{E_1 \; E_2}$

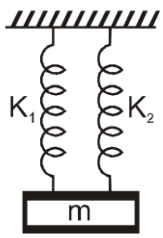
4. An infinite number of springs having force constants as K, 2K, 4K, 8K, ... ∞ respectively are connected in series; then equivalent spring constant is
(1) K (2) 2K (3) $\frac{K}{2}$ (4) ∞

5. In SHM restoring force is F = –kx, where k is force constant, x is displacement and A is aplitude of motion, then total energy depends upon :
(1) k, A and M (2) k, x, M (3) k, A (4) k, x

6. Equations of two progressive waves are given by $y_1 = a \sin(\omega t + \varphi_1)$ and $y_2 = a \sin(\omega t + \varphi_2)$. If amplitude and time period of resultant wave are same as that of both the waves, then $(\varphi_1 - \varphi_2)$ is :
(1) $\frac{\pi}{3}$ (2) $\frac{2\pi}{3}$ (3) $\frac{\pi}{6}$ (4) $\frac{\pi}{4}$

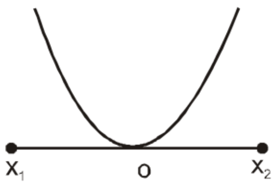
7. Two springs A and B have force constants k_A and k_B such that $k_B = 2k_A$. The four ends of the springs are streched by the same force. If energy stored in spring A is E, then energy stored in spring B is :
(1) $\frac{E}{2}$ (2) 2E (3) E (4) 4E

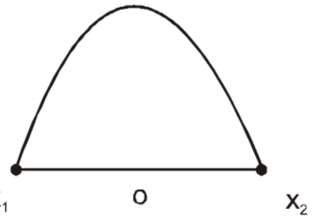
8. A mass is suspended separately by two springs of spring constant k_1 and k_2 in successive order. The time periods of oscillations in the two cases are T_1 and T_2 respectively. If the same mass by suspended by connecting the two springs in parallel, (as shown in figure) then the time period of oscillations is T. The correct relation is :

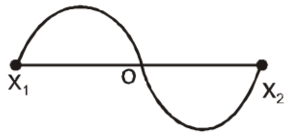


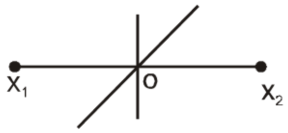
(1) $t_0^2 = t_1^2 + t_2^2$ (2) $t_0^{-2} = t_1^{-2} + t_2^{-2}$
(3) $t_0^{-1} = t_1^{-1} + t_2^{-1}$ (4) $t_0 = t_1 + t_2$

9. 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 :-

(1) 

(2) 

(3) 

(4) 

10. The potential energy of a simple harmonic oscillator when the particle is half way to its end point is :-

(1) $\frac{2}{3}E$ (2) $\frac{1}{8}E$ (3) $\frac{1}{4}E$ (4) $\frac{1}{2}E$

11. The time period of a mass suspended from a spring is T. If the spring is cut into four equal parts and the same mass is suspended from one of the parts, then the new time period will be :-

(1) $\frac{T}{4}$ (2) T (3) $\frac{T}{2}$ (4) 2T

12. Which one of the following statements is true for the speed 'v' and the acceleration 'a' of a particle executing simple harmonic motion

(1) Value of a is zero, whatever may be the value of 'v'
(2) When 'v' is zero , a is zero
(3) When 'v' is maximum, a is zero
(4) When 'v' is maximum, a is maximum

13. Two springs of spring constants k_1 and k_2 are joined in series. The effective spring constant of the combination is given by :-

(1) $\frac{(k_1+k_2)}{2}$ (2) $k_1 + k_2$ (3) $\frac{k_1K_2}{(k_1+K_2)}$ (4) $\sqrt{k_1k_2}$

14. A rectangular block of mass m and area of cross section A floats in a liquid of density ρ If it is given a small vertical displacement from equilibrium it undergoes oscillation with a time period T. Them :

(1) $T \propto \sqrt{\rho}$ (2) $T \propto \frac{1}{\sqrt{A}}$ (3) $T \propto \frac{1}{\rho}$ (4) $T \propto \frac{1}{\sqrt{m}}$

15. The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively :-

(1) K_0 and K_0 (2) 0 and $2K_0$ (3) $\frac{K_0}{2}$ and K_0 (4) K_0 and $2K_0$

16. The phase difference between the instantaneous velocity and acceleration of a particle executing simple harmonic motion is :-

(1) Zero (2) $0.5\ \pi$ (3) π (4) $0.707\ \pi$

17. Two simple harmonic motions of angular frequency 100 and 1000 rad s^{-1} have the same displacement amplitude. The ratio of their maximum acceleration is

(1) 1 : 10 (2) $1 : 10^2$ (3) $10 : 10^3$ (4) $10 : 10^4$

18. A point performs simple harmonic oscillation of period T and the equation of motion is given by x = a sin (ωt + π/6). After the elapse of what fraction of the time period the velocity of the point will be equal to half of its maximum velocity

(1) $\frac{T}{8}$ (2) $\frac{T}{6}$ (3) $\frac{T}{3}$ (4) $\frac{T}{12}$

19. A particle executing SHM has amplitude 0.01 m and frequency 60 Hz. The maximum acceleration of the particles is

(1) $60\,\pi^2$ m/s^2 (2) $80\,\pi^2$ m/s^2 (3) $120\,\pi^2$ m/s^2 (4) $144\,\pi^2$ m/s^2

20. The time period of vibrating spring due to a mass m is T. For twice of its mass, the new time period will be :

(1) $\sqrt{2}$ T (2) $2\sqrt{2}$ T (3) 4T (4) 5T

21. The amplitude of a particle executing SHM is made three-fourth keeping its time period constant. Its total energy will be :

(1) $\frac{E}{2}$ (2) $\frac{3}{4}$E (3) $\frac{9}{16}$E (4) none of these

22. The velocity of simple pendulum is maximum at :

(1) extremes (2) half displacement (3) mean position (4) every where

23. A body is executing SHM. which of the following properties remains same at each point of its path during motion ?

(1) Acceleration (2) velocity (3) phase (4) Total energy

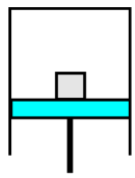
24. The displacement equation of a particle is x = 3 sin 2t +4 cos 2t, where x is in metre and t in second. The amplitude and maximum velocity will be respectively :

(1) 5m, 10 m/s (2) 3m, 2 m/s (3) 4m, 2 m/s (4) 3m, 4 m/s

25. A spring executes SHM with mass of 10 kg attached to it. The force constant of spring is 10 N /m. If at any instant its velocity is 40 cm/sec, the displacement will be (where amplitude is 0.5 m) :

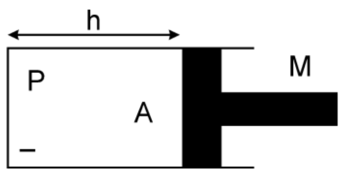
(1) 0.09 m (2) 0.3 m (3) 0.03 m (4) 0.9 m

26. A block of mass m is resting on a piston which is moving vertically with a SHM of period 1 s. The minimum amplitude of motion at which the block and piston separate is :



(1) 0.25 m (2) 0.52 m
(3) 2.5 m (4) 0.15 m

27. A cylindrical piston of mass M slides smoothly inside a long cylinder closed at one end, enclosing a certain mass of a 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 (process is isothermal)

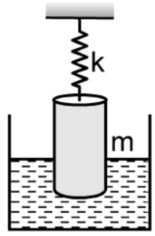


(1) $T = 2\pi\sqrt{\frac{Mh}{PA}}$ (2) $T = 2\pi\sqrt{\frac{MA}{Ph}}$

(3) $T = 2\pi\sqrt{\frac{M}{PAh}}$ (4) $T = 2\pi\sqrt{MPhA}$

28. A U-tube contains mercury of total length 2ℓ as shown and is disturbed so that it oscillates back and fourth from arm to arm. If we neglect friction, the period of oscillation is:

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



29. A uniform cylinder of mass m and length ℓ having area of cross-section a is suspended lengthwise with the help of a massless spring of constant k. The cylinder is half submerged in a liquid of density ρ. A small push and release makes it vibrate with small amplitude. The frequency of oscillation is :

(1) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{ka\rho g}{m}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{m+a\rho g}{k}}$ (4) $\frac{1}{2\pi}\sqrt{\frac{k+a\rho g}{m}}$

30. Two simple pendulums of length 0.5 m and 2.0 m respectively are given small linear displacement in one direction at the same time. They will again be in the same phase when the pendulum of shorter length has completed oscillations :

(1) 5 (2) 1 (3) 2 (4) 3

Practice Test (JEE-Main Pattern)

OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART - II : PRACTICE QUESTIONS

1. A mass m is vertically suspended from a spring of negligible mass; system oscillates with a frequency n. What will be the frequency of the system, if a mass 4 m is suspended from the same spring ?

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

2. 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 oscillations with a time period T. If the mass is increased by m, then the time period becomes $\left(\frac{5}{4}T\right)$. The ratio of $\frac{m}{M}$ is -

(1) 9/16 (2) 25/16 (3) 4/5 (4) 5/4

3. A particle free to move along the x-axis has potential energy given by U(x) = k[$1-e^{-x^2}$] for $-\infty < x < +\infty$, where k is a positive constant of appropriate dimensions. Then

(1) at point away from the origin, the particle is in unstable equilibrium.

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

(3) if its total mechanical energy is k/2, it has its minimum kinetic energy at the origin.

(4) for small displacements from x = 0, the motion is simple harmonic.

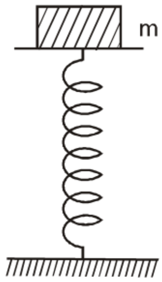
4. The magnitude of average acceleration in half time period from equilibrium position in a simple harmonic motion is

(1) $\frac{2A\omega^2}{\pi}$ (2) $\frac{A\omega^2}{2\pi}$ (3) $\frac{A\omega^2}{\sqrt{2}\pi}$ (4) Zero

5. A body is executing simple harmonic motion. At a displacement x, its potential energy is E_1 and at a displacement y, its potential energy is E_2. The potential energy E at a displacement (x + y) is

(1) $E_1 + E_2$ (2) $\sqrt{E_1^2 + E_2^2}$ (3) $E_1 + E_2 + 2\sqrt{E_1E_2}$ (4) $\sqrt{E_1E_2}$

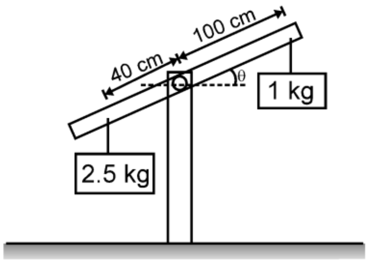
6. A mass of 2.0 kg is put on a flat pan attached to a vertical spring fixed on the ground as shown in the figure. The mass of the spring and the pan is negligible. When pressed slightly and released the mass executes a simple harmonic motion.The spring constant is 200N/m. What should be the minimum amplitude of the motion so that the mass gets detached from the pan (Take g = 10 m/s^2)



(1) 4.0 cm (2) 8.0 cm

(3) 10.0 cm (4) Any value less than 12.0 cm

7. A straight rod of negligible mass is mounted on a frictionless pivot and masses 2.5 kg and 1 kg are suspended at distances 40 cm and 100 cm respectively from the pivot as shown. The rod is held at an angle θ with the horizontal and released.



(1) The rod executes periodic motion about horizontal position after the release.

(2)The rod remains stationary after the release.

(3) The rod comes to rest in vertical position with 2.5 kg mass at the lowest point

(4) The rod executes periodic motion about vertical position after the release.

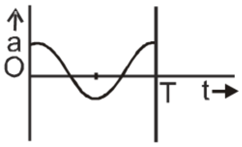
8. The oscillation of a body on a smooth horizontal surface is represented by the equation,

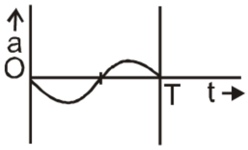
$X = A \cos (\omega t)$

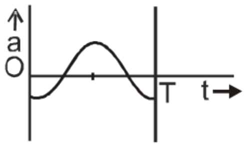
where X = displacement at time t

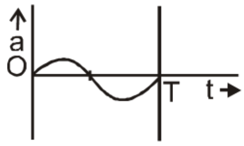
ω = frequency of oscillation

Which one of the following graph shows correctly the variation 'a' with 't' ?

(1) 

(2) 

(3) 

(4) 

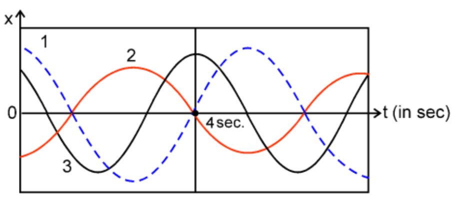
Here a = acceleration at time t

T = time period

9. A metre stick swinging about its one end oscillates with frequency f_0. If the bottom half of the stick was cut off, then its new oscillation frequency will be :

(1) f_0 (2) $\sqrt{2}\,f_0$ (3) $2f_0$ (4) $2\sqrt{2}\,f_0$

10. Graph shows the x(t) curves for three experiments involving a particular spring- block system oscillating in SHM. The kinetic energy of the system is largest at t = 4 sec. for the situation :



(1) 1 (2) 2

(3) 3 (4)Same in all

11. The velocity v of a particle of mass m moving along a straight line changes with time 't' as $\frac{d^2v}{dt^2} = -Kv$ where 'K' is a positive constant. Which of the following statement is correct :

(1) The particle does not perform SHM

(2) The particle performs SHM with time period $2\pi\sqrt{\frac{m}{K}}$

(3) The particle performs SHM with frequency $\frac{\sqrt{K}}{2\pi}$

(4) The particle performs SHM with time period $\frac{2\pi}{K}$

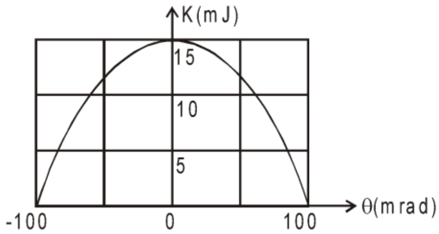
12. A street car moves rectilinearly from station A (here car stops) to the next station B (here also car stops) with an acceleration varying according to the law f = a - bx, where a and b are positive constants and x is the distance from station A. The distance between the two stations & the maximum velocity are respectively

(1) $x = \frac{2a}{b}$; $v_{max} = \frac{a}{\sqrt{b}}$ (2) $x = \frac{a}{b}$; $v_{max} = \frac{a}{2\sqrt{b}}$

(3) $x = \frac{2a}{b}$; $v_{max} = \frac{2a}{\sqrt{b}}$ (4) $x = \frac{a}{2b}$; $v_{max} = \frac{a}{\sqrt{b}}$

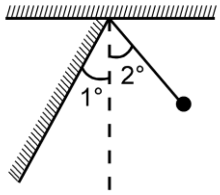
13. Figure shows the kinetic energy K of a simple pendulum versus its angle θ from the vertical. The pendulum bob has mass 0.2 kg. The length of the pendulum is equal to (g = 10 m/s^2).

(1) 2.0 m (2) 1.8 m
(3) 1.5 m (4) 1.2 m



14. A simple pendulum of length 1 m is allowed to oscillate with amplitude 2º. It collides elastically with a wall inclined at 1º to the vertical. Its time period will be: (use g = π^2)

(1) 2/3 sec (2) 4/3 sec
(3) 2 sec (4) none of these



Comprehension # 1

A 2kg block hangs without vibrating at the bottom end of a spring with a force constant of 400 N/m. The top end of the spring is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of 5 m/s^2 when the acceleration suddenly ceases at time t = 0 and the car moves upward with constant speed. (g = 10 m/s^2)

15✍. What is the angular frequency of oscillation of the block after the acceleration ceases?

(1) $10\sqrt{2}$ rad/s (2) 20 rad/s (3) $20\sqrt{2}$ rad/s (4) 32 rad/s

16✍. The amplitude of the oscillations is :

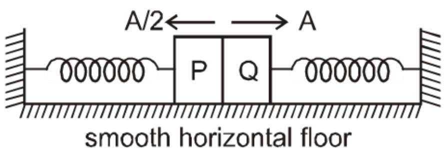
(1) 7.5 cm (2) 5 cm (3) 2.5 cm (4) 1 cm

17✍. The initial phase angle observed by a rider in the elevator, taking upward direction to be positive and positive extreme position to have π/2 phase constant, is equal to

(1) zero (2) π/2 rad (3) π rad (4) 3π/2 rad

Comprehension # 2

Two identical blocks P and Q have mass m each. They are attached to two identical springs (of spring constant k) initially unstretched . Both the blocks are initially in contact as shown. Now the left spring (attached with block P) is compressed by $\frac{A}{2}$ and the right spring (attached with block Q) is compressed by A. Both the blocks are then released simultaneously.



18. The speed of block P just before P and Q are about to collide for the first time.

(1) $\sqrt{\frac{k}{m}}\frac{A}{2}$ (2) $\sqrt{\frac{k}{m}}\ A$ (3) $\sqrt{\frac{k}{2m}}A$ (4) None of these

19. The speed of block Q just before P and Q are about to collide for the first time.

(1) $\sqrt{\frac{k}{m}}\frac{A}{2}$ (2) $\sqrt{\frac{k}{m}}\ A$ (3) $\sqrt{\frac{k}{2m}}\ A$ (4) None of these

20. After what time when they were released from rest, shall the blocks collide for the first time.

(1) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$ (2) $\pi\sqrt{\frac{m}{k}}$ (3) $\frac{\pi}{3}\sqrt{\frac{m}{k}}$ (4) None of these

APSP Answers

PART-I

1.	(1)	**2.**	(1)	**3.**	(3)	**4.**	(3)	**5.**	(3)	**6.**	(2)	**7.**	(1)
8.	(2)	**9.**	(1)	**10.**	(3)	**11.**	(3)	**12.**	(3)	**13.**	(3)	**14.**	(2)
15.	(1)	**16.**	(2)	**17.**	(2)	**18.**	(4)	**19.**	(4)	**20.**	(1)	**21.**	(3)
22.	(3)	**23.**	(4)	**24.**	(1)	**25.**	(2)	**26.**	(1)	**27.**	(1)	**28.**	(4)
29.	(4)	**30.**	(3)										

PART - II

1.	(3)	**2.**	(1)	**3.**	(4)	**4.**	(1)	**5.**	(3)	**6.**	(3)	**7.**	(2)
8.	(3)	**9.**	(2)	**10.**	(1)	**11.**	(3)	**12.**	(1)	**13.**	(3)	**14.**	(2)
15.	(1)	**16.**	(3)	**17.**	(4)	**18.**	(1)	**19.**	(2)	**20.**	(1)		