Q1. A particle of mass 0.50 kg executes simple harmonic motion under force $F=-50\left(\mathrm{Nm}^{-1}\right)x$. The time period of oscillation is $\frac{x}{35}$ s. The value of x is _____. (Given $\pi=\frac{22}{7}$) ***09 Apr 2024 (E)***

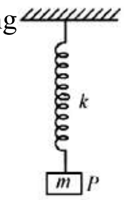
Q2. The position, velocity and acceleration of a particle executing simple harmonic motion are found to have magnitudes of $4\ \mathrm{m}, 2\ \mathrm{ms}^{-1}$ and $16\ \mathrm{ms}^{-2}$ at a certain instant. The amplitude of the motion is $\sqrt{x},\ \mathrm{m}$ where x is ________ ***09 Apr 2024 (M)***

Q3. An object of mass 0.2 kg executes simple harmonic motion along x axis with frequency of $\left(\frac{25}{\pi}\right)$Hz. At the position $x=0.04\ \mathrm{m}$ the object has kinetic energy 0.5 J and potential energy 0.4 J. The amplitude of oscillation is _____cm. ***08 Apr 2024 (E)***

Q4. A particle is doing simple harmonic motion of amplitude $0.06\ \mathrm{m}$ and time period $3.14\ \mathrm{s}$. The maximum velocity of the particle is _______ $\mathrm{cm/s}$. ***06 Apr 2024 (M)***

Q5. The displacement of a particle executing SHM is given by $x=10\sin\left(wt+\frac{\pi}{3}\right)m$. The time period of motion is 3.14 s. The velocity of the particle at $t=0$ is ______$\mathrm{m/s}$. ***04 Apr 2024 (E)***

Q6. In simple harmonic motion, the total mechanical energy of given system is E. If mass of oscillating particle P is doubled then the new energy of the system for same amplitude is:



04 Apr 2024 (E)

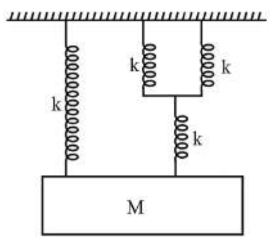
(1) E (2) $E/\sqrt{2}$

(3) $2E$ (4) $E\sqrt{2}$

Q7. A mass m is suspended from a spring of negligible mass and the system oscillates with a frequency f_1. The frequency of oscillations if a mass $9m$ is suspended from the same spring is f_2. The value of $\frac{f_1}{f_2}$ is _____ . ***01 Feb 2024 (E)***

Q8. A particle performs simple harmonic motion with amplitude A. Its speed is increased to three times at an instant when its displacement is $\frac{2A}{3}$. The new amplitude of motion is $\frac{nA}{3}$. The value of n is _____. ***31 Jan 2024 (M)***

Q9. The time period of simple harmonic motion of mass M in the given figure is $\pi\sqrt{\frac{\alpha M}{5K}}$, where the value of α is _______.



31 Jan 2024 (E)

Q10. A simple pendulum is placed at a place where its distance from the earth's surface is equal to the radius of the earth. If the length of the string is 4 m, then the time period of small oscillations will be _________s.
[take $g=\pi^2\ \mathrm{m\ s}^{-2}$]

30 Jan 2024 (E)

Q11. A simple harmonic oscillator has an amplitude A and time period 6π second. Assuming the oscillation starts from its mean position, the time required by it to travel from $x=A$ to $x=\frac{\sqrt{3}}{2}A$ will be $\frac{\pi}{x}$ s, where $x=$ _______. ***29 Jan 2024 (E)***

Q12. When the displacement of a simple harmonic oscillator is one third of its amplitude, the ratio of total energy to the kinetic energy is $\frac{x}{8}$, where $x=$_________. ***29 Jan 2024 (M)***

Q13. A particle executes simple harmonic motion with an amplitude of $4\ \mathrm{cm}$. At the mean position, velocity of the particle is $10\ \mathrm{cm\ s^{-1}}$. The distance of the particle from the mean position when its speed becomes $5\ \mathrm{cm\ s^{-1}}$ is $\sqrt{\alpha}$ cm, where $\alpha=$______. ***27 Jan 2024 (M)***

Q14. In a linear Simple Harmonic Motion (SHM)

(A) Restoring force is directly proportional to the displacement. (B) The acceleration and displacement are opposite in direction. (C) The velocity is maximum at mean position. (D) The acceleration is minimum at extreme points.

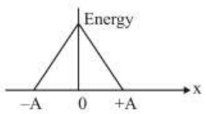
Choose the correct answer from the options given below:

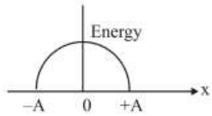
15 Apr 2023 (M)

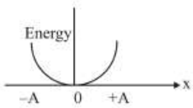
(1) (C) and (D) only
(2) (A), (C) and (D) only
(3) (A), (B) and (C) only
(4) (A), (B) and (D) only

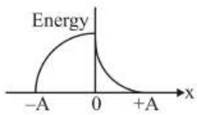
Q15. Which graph represents the difference between total energy and potential energy of a particle executing SHM vs its distance from mean position?

13 Apr 2023 (M)

(1) 

(2) 

(3) 

(4) 

Q16. At a given point of time the value of displacement of a simple harmonic oscillator is given as $y=A\ \cos(30^{\circ})$. If amplitude is $40\ \mathrm{cm}$ and kinetic energy at that time is 200 J, the value of force constant $1.0\times10^{x}\ \mathrm{N\ m^{-1}}$. The value of x is _____.

13 Apr 2023 (M)

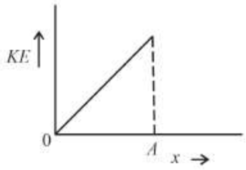
Q17. A particle executes SHM of amplitude A. The distance from the mean position when its kinetic energy becomes equal to its potential energy is: ***13 Apr 2023 (E)***

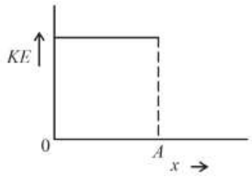
(1) $\frac{1}{\sqrt{2}}A$
(2) $2A$
(3) $\sqrt{2A}$
(4) $\frac{1}{2}A$

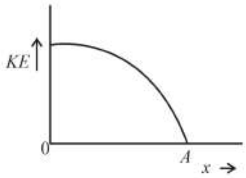
Q18. A particle is executing simple harmonic motion (SHM). The ratio of potential energy and kinetic energy of the particle when its displacement is half of its amplitude will be ***12 Apr 2023 (M)***

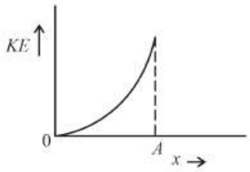
(1) $1\ :\ 1$
(2) $1\ :\ 3$
(3) $2\ :\ 1$
(4) $1\ :\ 4$

Q19. The variation of kinetic energy (KE) of a particle executing simple harmonic motion with the displacement (x) starting from mean position to extreme position (A) is given by ***11 Apr 2023 (M)***

(1)


(2)


(3)


(4)


Q20. A particle executes S.H.M. of amplitude A along x-axis. At $t=0$, the position of the particle is $x=\frac{A}{2}$ and it moves along positive x-axis. The displacement of particle in time t is $x=A\ \sin(\omega t\ +\ \delta)$, then the value δ will be ***10 Apr 2023 (M)***

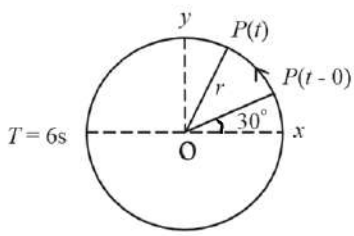
(1) $\frac{\pi}{2}$
(2) $\frac{\pi}{6}$
(3) $\frac{\pi}{3}$
(4) $\frac{\pi}{4}$

Q21. For a periodic motion represented by the equation $y=\sin\omega t+\cos\omega t$ the amplitude of the motion is ***10 Apr 2023 (E)***

(1) 1
(2) 0.5
(3) 2
(4) $\sqrt{2}$

Q22. A rectangular block of mass $5\ \text{kg}$ attached to a horizontal spiral spring executes simple harmonic motion of amplitude $1\ \text{m}$ and time period $3.14\ \text{s}$. The maximum force exerted by spring on block is ___ N. ***10 Apr 2023 (E)***

Q23. For particle P revolving round the centre O with radius of circular path r and regular velocity ω, as shown in below figure, the projection of OP on the x-axis at time t is

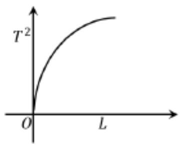


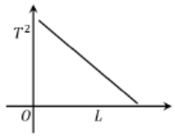
08 Apr 2023 (E)

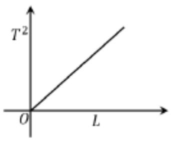
(1) $x(t)=r\ \cos\left(\omega t-\frac{\pi}{6}\right)$
(2) $x(t)=r\ \cos\left(\omega t+\frac{\pi}{6}\right)$
(3) $x(t)=r\ \sin\left(\omega t+\frac{\pi}{6}\right)$
(4) $x(t)=r\ \cos(\omega t)$

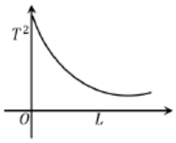
Q24. A simple pendulum with length $100\ \text{cm}$ and bob of mass $250\ \text{g}$ is executing S.H.M of amplitude $10\ \text{cm}$. The maximum tension in the string is found to be $\frac{x}{40}$ N. The value of x is ***06 Apr 2023 (E)***

Q25. Choose the correct length (L) versus square of time period (T_2)) graph for a simple pendulum executing simple harmonic motion. ***01 Feb 2023 (E)***

(1) 

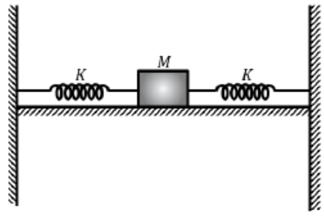
(2) 

(3) 

(4) 

Q26. The amplitude of a particle executing SHM is 3 cm. The displacement at which its kinetic energy will be 25% more than the potential energy is: ______ cm. ***01 Feb 2023 (M)***

Q27. In the figure given below. a block of mass $M = 490$ g placed on a frictionless table is connected with two springs having same spring constant ($K = 2 \text{ N m}^{-1}$). If the block is horizontally displaced through X m then the number of complete oscillations it will make in 14π seconds will be ______.

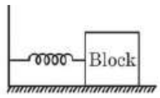


31 Jan 2023 (M)

Q28. The maximum potential energy of a block executing simple harmonic motion is 25 J. A is amplitude of oscillation. At $\frac{A}{2}$, the kinetic energy of the block is ***31 Jan 2023 (M)***

(1) 37.5 J
(2) 9.75 J
(3) 18.75 J
(4) 12.5 J

Q29. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio $\frac{\omega_2}{\omega_1}$ is :



30 Jan 2023 (E)

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

Q30. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 – x^2$. The time period of oscillations is $\frac{x}{7}$ s. The value of x is ______. [Take $\pi = \frac{22}{7}$]

30 Jan 2023 (E)

Q31. The general displacement of a simple harmonic oscillator is $x = A \sin \omega t$. Let T be its time period. The slope of its potential energy (U) – time (t) curve will be maximum when $t = \frac{T}{\beta}$. The value of β is ______.

30 Jan 2023 (M)

Q32. A particle of mass 250 g executes a simple harmonic motion under a periodic force $F = (–25x)$ N. The particle attains a maximum speed of 4 m s^{-1} during its oscillation. The amplitude of the motion is ______cm.

29 Jan 2023 (E)

Q33. Two simple harmonic waves having equal amplitudes of 8 cm and equal frequency of 10 Hz are moving along the same direction. The resultant amplitude is also 8 cm. The phase difference between the individual waves is _____ degree. ***29 Jan 2023 (M)***

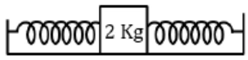
Q34. A particle executes simple harmonic motion between $x=-A$ and $x=+A$. If time taken by particle to go from $x=0$ to $\frac{A}{2}$ is 2 s; then time taken by particle in going from $x=\frac{A}{2}$ to A is: ***25 Jan 2023 (E)***

(1) 3 s (2) 2 s

(3) 1.5 s (4) 4 s

Q35. A mass m attached to free end of a spring executes SHM with a period of 1 s. If the mass is increased by 3 kg the period of oscillation increases by one second, the value of mass m is ________ kg. ***24 Jan 2023 (E)***

Q36. A block of mass 2 kg is attached with two identical springs of spring constant 20 N m^{-1} each. The block is placed on a frictionless surface and the ends of the springs are attached to rigid supports (see figure). When the mass is displaced from its equilibrium position, it executes a simple harmonic motion. The time period of oscillation is $\frac{\pi}{\sqrt{X}}$ in SI unit. The value of X is______.



24 Jan 2023 (M)

Q37. The metallic bob of simple pendulum has the relative density 5. The time period of this pendulum is 10 s. If the metallic bob is immersed in water, then the new time period becomes $5\sqrt{x}$ s. The value of x will be _____ . ***29 Jul 2022 (E)***

Q38. The time 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 : ***29 Jul 2022 (M)***

(1) $2\pi\sqrt{\frac{L}{(g\cos\alpha)}}$ (2) $2\pi\sqrt{\frac{L}{(g\sin\alpha)}}$

(3) $2\pi\sqrt{\frac{L}{g}}$ (4) $2\pi\sqrt{\frac{L}{(g\tan\alpha)}}$

Q39. The potential energy of a particle of mass 4 kg in motion along the x-axis is given by $\mathrm{U}=4(1-\cos 4\mathrm{x})$ J. The time period of the particle for small oscillation $(\sin\theta\simeq\theta)$ $\left(\frac{\pi}{\mathrm{K}}\right)$ s. The value of K is _____ . ***28 Jul 2022 (E)***

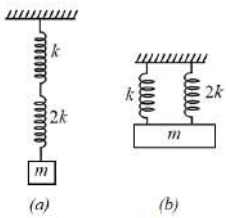
Q40. A mass 0.9 kg, attached to a horizontal spring, executes SHM with an amplitude A_1. When this mass passes through its mean position, then a smaller mass of 124 g is placed over it and both masses move together with amplitude A_2. If the ratio $\frac{A_1}{A_2}$ is $\frac{\alpha}{\alpha-1}$, then the value of α will be _____ . ***27 Jul 2022 (M)***

Q41. When a particle executes simple Harmonic motion, the nature of graph of velocity as function of displacement will be ***26 Jul 2022 (M)***

(1) Circular (2) Ellipitical

(3) Sinusoidal (4) Straight line

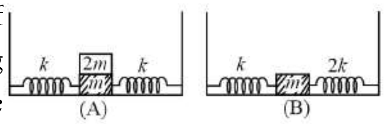
Q42. As per given figures, two springs of spring constants K and 2 K are connected to mass m. If the period of oscillation in figure (a) is 3 s, then the period of oscillation in figure (b) will be $\sqrt{x}$ s. The value of x is _____ .



26 Jul 2022 (E)

Q43. Two waves executing simple harmonic motion travelling in the same direction with same amplitude and frequency are superimposed. The resultant amplitude is equal to the $\sqrt{3}$ times of amplitude of individual motions. The phase difference between the two motions is (degree) ***25 Jul 2022 (E)***

Q44. In figure (A), mass $2m$ is fixed on mass m which is attached to two springs of spring constant k. In figure (B), mass m is attached to two spring of spring constant k and $2k$. If mass m in (A) and (B) are displaced by distance x horizontally and then released, then time period T_1 and T_2 corresponding to (A) and (B) respectively follow the relation.



25 Jul 2022 (M)

(1) $\frac{T_1}{T_2}=\frac{3}{\sqrt{2}}$ (2) $\frac{T_1}{T_2}=\sqrt{\frac{3}{2}}$
(3) $\frac{T_1}{T_2}=\sqrt{\frac{2}{3}}$ (4) $\frac{T_1}{T_2}=\frac{\sqrt{2}}{3}$

Q45. The motion of a simple pendulum executing S.H.M. is represented by the following equation $y=A\sin(\pi t+\phi)$, where time is measured in second. The length of pendulum is ***29 Jun 2022 (E)***
(1) 97.23 cm (2) 25.3 cm
(3) 99.4 cm (4) 406.1 cm

Q46. A body is performing simple harmonic with an amplitude of 10 cm. The velocity of the body was tripled by air Jet when it is at 5 cm from its mean position. The new amplitude of vibration is $\sqrt{x}$ cm. The value of x is _____ . ***29 Jun 2022 (M)***

Q47. The equation of a particle executing simple harmonic motion is given by $x=\sin\pi\left(t+\frac{1}{3}\right)$ m. At $t=1$ s, the speed of particle will be (Given: $\pi=3.14$) ***27 Jun 2022 (E)***
(1) 157 cm s^{-1} (2) 0 cm s^{-1}
(3) 272 cm s^{-1} (4) 314 cm s^{-1}

Q48. The displacement of simple harmonic oscillator after 3 seconds starting from its mean position is equal to half of its amplitude. The time period of harmonic motion is ***27 Jun 2022 (M)***
(1) 12 s (2) 8 s
(3) 36 s (4) 6 s

Q49. A particle executes simple harmonic motion. Its amplitude is 8 cm and time period is 6 s. The time it will take to travel from its position of maximum displacement to the point corresponding to half of its amplitude, is _____ s ***27 Jun 2022 (E)***

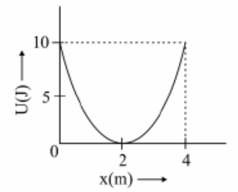
Q50. Time period of a simple pendulum in a stationary lift is T. If the lift accelerates with $\frac{g}{6}$ vertically upwards then the time period will be
(Where $g=$ acceleration due to gravity) ***26 Jun 2022 (M)***
(1) $\sqrt{\frac{6}{5}}T$ (2) $\sqrt{\frac{5}{6}}T$
(3) $\sqrt{\frac{6}{7}}T$ (4) $\sqrt{\frac{7}{6}}T$

Q51. Two massless springs with spring constants 2k and 9k, carry 50 g and 100 g masses at their free ends. These two masses oscillate vertically such that their maximum velocities are equal. Then, the ratio of their respective amplitudes will be : ***24 Jun 2022 (E)***

(1) 3 : 2 (2) 1 : 2

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

Q52. A mass of 5 kg is connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system. What is the value of acceleration due to gravity on the planet where these experiments are performed ?



01 Sep 2021 (E)

(1) $4 \mathrm{~m} \mathrm{~s}^{-2}$ (2) $8 \mathrm{~m} \mathrm{~s}^{-2}$

(3) $5 \mathrm{~m} \mathrm{~s}^{-2}$ (4) $10 \mathrm{~m} \mathrm{~s}^{-2}$

Q53. A particle of mass 1 kg is hanging from a spring of force constant $100 \mathrm{~N} \mathrm{~m}^{-1}$. The mass is pulled slightly downward and released so that it executes free simple harmonic motion with time period T. The time when the kinetic energy and potential energy of the system will become equal, is $\frac{T}{n}$. The value of n is ________.

31 Aug 2021 (M)

Q54. For a body executing S.H.M. :

(a) Potential energy is always equal to its $K.E.$

(b) Average potential and kinetic energy over any given time interval are always equal.

(c) Sum of the kinetic and potential energy at any point of time is constant.

(d) Average $K.E.$ in one time period is equal to average potential energy in one time period.

Choose the most appropriate option from the options given below : ***31 Aug 2021 (E)***

(1) (c) and (d) (2) only (c)

(3) only (b) (4) (b) and (c)

Q55. A bob of mass m suspended by a thread of length ℓ undergoes simple harmonic oscillations with time period T. If the bob is immersed in a liquid that has density $\frac{1}{4}$ times that of the bob and the length of the thread is increased by $\left(\frac{1}{3}\right)^{rd}$ of the original length, then the time period of the simple harmonic oscillations will be:

31 Aug 2021 (E)

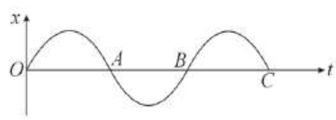
(1) $\frac{3}{4} T$ (2) $\frac{4}{3} T$

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

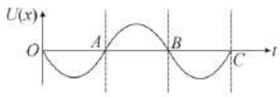
Q56. Two simple harmonic motion, are represented by the equations $y_1=10 \sin \left(3 \pi t+\frac{\pi}{3}\right) ;\ y_2=5\left(\sin 3 \pi t+\sqrt{3} \cos 3 \pi t\right)$. Ratio of amplitude of y_1 to $y_2=x: 1$. The value of x is

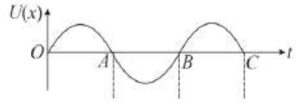
27 Aug 2021 (E)

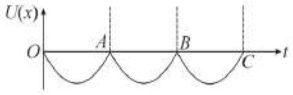
Q57. The variation of displacement with time of a particle executing free simple harmonic motion is shown in the figure. The potential energy $U(x)$ versus time (t) plot of the particle is correctly shown in figure:

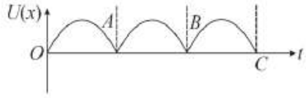


27 Aug 2021 (M)

(1) 

(2) 

(3) 

(4) 

Q58. Two simple harmonic motions are represented by the equations $x_1 = 5\sin\left(2\pi t + \frac{\pi}{4}\right)$ and $x_2 = 5\sqrt{2}\left(\sin 2\pi t + \cos 2\pi t\right)$. The amplitude of the second motion is _____ times the amplitude in the first motion. ***26 Aug 2021 (E)***

Q59. A particle starts executing simple harmonic motion (SHM) of amplitude a and total energy E. At any instant, its kinetic energy is $\frac{3E}{4}$, then its displacement y is given by: ***27 Jul 2021 (M)***

(1) $y = a$
(2) $y = \frac{a}{\sqrt{2}}$
(3) $y = \frac{a\sqrt{3}}{2}$
(4) $y = \frac{a}{2}$

Q60. A particle executes simple harmonic motion represented by displacement function as $x(t) = A\sin(\omega t + \phi)$. If the position and velocity of the particle at $t = 0$ s are 2 cm and 2ω cm s^{-1} respectively, then its amplitude is $x\sqrt{2}$ cm where the value of x is ***27 Jul 2021 (E)***

Q61. An object of mass 0.5 kg is executing simple harmonic motion. It amplitude is 5 cm and time period (T) is 0.2 s. What will be the potential energy of the object at an instant $\mathrm{t} = \frac{\mathrm{T}}{4}$ s starting from mean position. Assume that the initial phase of the oscillation is zero. ***27 Jul 2021 (E)***

(1) 0.62 J
(2) 6.2×10^{-3} J
(3) 1.2×10^{3} J
(4) 6.2×10^{3} J

Q62. Two identical tennis balls each having mass m and charge q are suspended from a fixed point by threads of length l. What is the equilibrium separation when each thread makes a small angle θ with the vertical? ***27 Jul 2021 (M)***

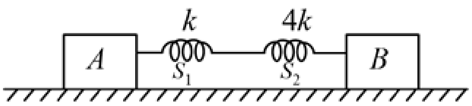
(1) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{2}}$
(2) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$
(3) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{\frac{1}{3}}$
(4) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{\frac{1}{3}}$

Q63. In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position. ***25 Jul 2021 (E)***

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

Q64. A pendulum bob has a speed of 3 m s^{-1} at its lowest position. The pendulum is 50 cm long. The speed of bob, when the length makes an angle of 60° to the vertical will be $\left(g = 10 \text{ m s}^{-2}\right)$ ______ m s^{-1}. ***25 Jul 2021 (M)***

Q65. In the reported figure, two bodies A and B of masses 200 g and 800 g are attached with the system of springs. Springs are kept in a stretched position with some extension when the system is released.



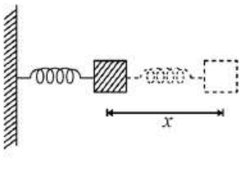
The horizontal surface is assumed to be frictionless. The angular frequency will be _______ rad s^{-1} when $k = 20 \text{ N m}^{-1}$.

25 Jul 2021 (M)

Q66. T_0 is the time period of a simple pendulum at a place. If the length of the pendulum is reduced to $\frac{1}{16}$ times of its initial value, the modified time period is ***22 Jul 2021 (M)***

(1) T_0
(2) $8\pi T_0$
(3) $4T_0$
(4) $\frac{1}{4}T_0$

Q67. The motion of a mass on a spring, with spring constant K is as shown in figure. The equation of motion is given by, $x(t) = A\sin\omega t + B\cos\omega t$ with $\omega = \sqrt{\frac{K}{m}}$.
Suppose that at time $t = 0$, the position of mass is $x(0)$ and velocity $v(0)$, then its displacement can also be represented as $x(t) = C\cos(\omega t - \phi)$, where C and ϕ are



22 Jul 2021 (M)

(1) $C = \sqrt{\frac{2\mathrm{v}(0)^2}{\omega^2} + x(0)^2}$, $\phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$
(2) $C = \sqrt{\frac{2\mathrm{v}(0)^2}{\omega^2} + x\left(0\right)^2}$, $\phi = \tan^{-1}\left(\frac{x(0)\omega}{2\mathrm{v}(0)}\right)$
(3) $C = \sqrt{\frac{\mathrm{v}(0)^2}{\omega^2} + x\left(0\right)^2}$, $\phi = \tan^{-1}\left(\frac{x(0)\omega}{v(0)}\right)$
(4) $C = \sqrt{\frac{\mathrm{v}(0)^2}{\omega^2} + x\left(0\right)^2}$, $\phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

Q68. A particle is making simple harmonic motion along the X-axis. If at a distances x_1 and x_2 from the mean position the velocities of the particle are v_1 and v_2, respectively. The time period of its oscillation is given as:

20 Jul 2021 (E)

(1) $T = 2\pi\sqrt{\frac{x_2^2+x_1^2}{v_1^2-v_2^2}}$
(2) $T = 2\pi\sqrt{\frac{\mathrm{x}_2^2+\mathrm{x}_1^2}{v_1^2+v_2^2}}$
(3) $T = 2\pi\sqrt{\frac{x_2^2-x_1^2}{v_1^2+v_2^2}}$
(4) $T = 2\pi\sqrt{\frac{x_2^2-x_1^2}{v_1^2-v_2^2}}$

Q69. A particle performs simple harmonic motion with a period of 2 second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is $\frac{1}{a}$ s. The value of a to the nearest integer is ***18 Mar 2021 (M)***

Q70. The function of time representing a simple harmonic motion with a period of $\frac{\pi}{\omega}$ is: ***18 Mar 2021 (E)***

(1) $\sin(\omega t) + \cos(\omega t)$
(2) $\cos(\omega t) + \cos(2\omega t) + \cos(3\omega t)$
(3) $\sin^2(\omega t)$
(4) $3\cos\left(\frac{\pi}{4} - 2\omega t\right)$

Q71. For what value of displacement the kinetic energy and potential energy of a simple harmonic oscillation become equal? ***17 Mar 2021 (M)***

(1) $x = 0$
(2) $x = \pm A$
(3) $x = \pm\frac{A}{\sqrt{2}}$
(4) $x = \frac{A}{2}$

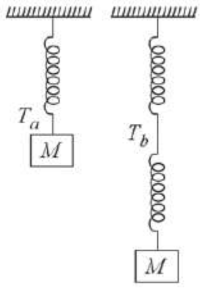
Q72. Two particles A and B of equal masses are suspended from two massless springs of spring constants K_1 and K_2 respectively.If the maximum velocities during oscillations are equal, the ratio of the amplitude of A and B is ***17 Mar 2021 (E)***

(1) $\frac{K_2}{K_1}$
(2) $\frac{K_1}{K_2}$
(3) $\sqrt{\frac{K_1}{K_2}}$
(4) $\sqrt{\frac{K_2}{K_1}}$

Q73. A block of mass $1 \mathrm{~kg}$ attached to a spring is made to oscillate with an initial amplitude of $12 \mathrm{~cm}$. After 2 minutes the amplitude decreases to $6 \mathrm{~cm}$. Determine the value of the damping constant for this motion. (take $\ln 2=0.693$) ***17 Mar 2021 (E)***

(1) $1.16 \times 10^{-2} \mathrm{~kg} \mathrm{~s}^{-1}$
(2) $3.3 \times 10^{2} \mathrm{~kg} \mathrm{~s}^{-1}$
(3) $1.16 \times 10^{2} \mathrm{~kg} \mathrm{~s}^{-1}$
(4) $5.7 \times 10^{-3} \mathrm{~kg} \mathrm{~s}^{-1}$

Q74. Consider two identical springs each of spring constant k and negligible mass compared to the mass M as shown. Fig. 1 shows one of them and Fig. 2 shows their series combination. The ratios of time period of oscillation of the two SHM is $\frac{T_b}{T_a}=\sqrt{x}$, where value of x is ______. (Round off to the Nearest Integer)



17 Mar 2021 (M)

Q75. Time period of a simple pendulum is T inside a lift when the lift is stationary. If the lift moves upwards with an acceleration $\frac{g}{2}$, the time period of pendulum will be : ***16 Mar 2021 (M)***

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

Q76. The amplitude of a mass-spring system, which is executing simple harmonic motion decreases with time. If mass $=500 \mathrm{~g}$, Decay constant $=20 \mathrm{~g} \mathrm{~s}^{-1}$ then how much time is required for the amplitude of the system to drop to half of its initial value? $(\ln 2=0.693)$ ***16 Mar 2021 (E)***

(1) $34.65 \mathrm{~s}$
(2) $17.32 \mathrm{~s}$
(3) $0.034 \mathrm{~s}$
(4) $15.1 \mathrm{~s}$

Q77. Given below are two statements:
Statement I: A second's pendulum has a time period of 1 second.
Statement II: It takes precisely one second to move between the two extreme positions. In the light of the above statements,
choose the correct answer from the options given below

26 Feb 2021 (E)

(1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are true
(3) Both Statement I and Statement II are False
(4) Statement I is true but Statement II is false

Q78. A particle executes S.H.M., the graph of velocity as a function of displacement is : ***26 Feb 2021 (E)***

(1) a circle
(2) a helix
(3) a parabola
(4) an ellipse

Q79. A particle executes S.H.M. with amplitude A and time period T. The displacement of the particle when its speed is half of maximum speed is $\frac{\sqrt{x} A}{2}$. The value of x is ***26 Feb 2021 (E)***

Q80. Assume that a tunnel is dug along a chord of the earth, at a perpendicular distance $\frac{R}{2}$ from the earth's centre, where R is the radius of the earth. The wall of the tunnel is frictionless. If a particle is released in this tunnel, it will execute a simple harmonic motion with a time period: ***26 Feb 2021 (M)***

(1) $\frac{1}{2\pi}\sqrt{\frac{g}{R}}$ (2) $2\pi\sqrt{\frac{R}{g}}$

(3) $\frac{g}{2\pi R}$ (4) Image is virtual, opposite side of convex mirror.

Q81. Time period of a simple pendulum is T. The time taken to complete $\frac{5}{8}$ oscillations starting from mean position is $\frac{\alpha}{12}T$. The value of α is ______. ***26 Feb 2021 (E)***

Q82. If the time period of a two meter long simple pendulum is 2 s, the acceleration due to gravity at the place where pendulum is executing S.H.M. is: ***25 Feb 2021 (M)***

(1) $2\pi^2\ \mathrm{m\ s^{-2}}$ (2) $16\ \mathrm{m\ s^{-2}}$

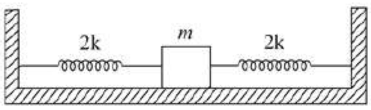
(3) $\pi^2\ \mathrm{m\ s^{-2}}$ (4) $9.8\ \mathrm{m\ s^{-2}}$

Q83. $Y = A\sin(\omega t + \phi_0)$ is the time-displacement equation of a SHM. At $t = 0$ the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative x-direction. Then the initial phase angle ϕ_0 will be: ***25 Feb 2021 (E)***

(1) $\frac{2\pi}{3}$ (2) $\frac{\pi}{6}$

(3) $\frac{5\pi}{6}$ (4) $\frac{\pi}{3}$

Q84. Two identical springs of spring constant $2k$ are attached to a block of mass m and to fixed support (see figure). When the mass is displaced from equilibrium position on either side, it executes simple harmonic motion. The time period of oscillations of this system is :

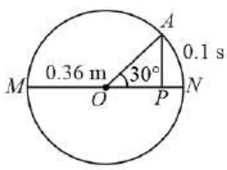


25 Feb 2021 (E)

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

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

Q85. The point A moves with a uniform speed along the circumference of a circle of radius 0.36 m and covers 30° in 0.1 s. The perpendicular projection P from A on the diameter MN represents the simple harmonic motion of P. The restoration force per unit mass when P touches M will be :



25 Feb 2021 (E)

(1) 0.49 N (2) 9.87 N

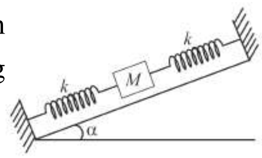
(3) 50 N (4) 100 N

Q86. When a particle executes SHM, the nature of graphical representation of velocity as a function of displacement is: ***24 Feb 2021 (E)***

(1) straight line (2) elliptical

(3) circular (4) parabolic

Q87. In the given figure, a body of mass M is held between two massless springs, on a smooth inclined plane. The free ends of the springs are attached to firm supports. If each spring has spring constant k, the frequency of oscillation of given body is:

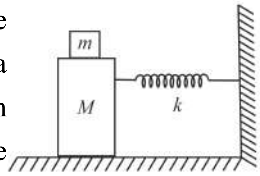


24 Feb 2021 (E)

(1) $\frac{1}{2\pi}\sqrt{\frac{2k}{Mg\sin\alpha}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{k}{Mg}\sin\alpha}$

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

Q88. In the given figure, a mass M is attached to a horizontal spring which is fixed on one side to a rigid support. The spring constant of the spring is k. The mass oscillates on a frictionless surface with time period T and amplitude A. When the mass is in equilibrium position, as shown in the figure, another mass m is gently fixed upon it. The new amplitude of oscillation will be:



24 Feb 2021 (M)

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

Q89. An object of mass m is suspended at the end of a massless wire of length L and area of cross-section, A. Young modulus of the material of the wire is Y. If the mass is pulled down slightly its frequency of oscillation along the vertical direction is : ***06 Sep 2020 (M)***

(1) $f=\frac{1}{2\pi}\sqrt{\frac{mL}{YA}}$
(2) $f=\frac{1}{2\pi}\sqrt{\frac{YA}{mL}}$
(3) $f=\frac{1}{2\pi}\sqrt{\frac{mA}{VL}}$
(4) $f=\frac{1}{2\pi}\sqrt{\frac{YL}{mA}}$

Q90. When a particle of mass m is attached to a vertical spring of spring constant k and released, its motion, is described by $\mathrm{y}(\mathrm{t})=\mathrm{y}_0\sin^2\omega\mathrm{t}$, where 'y' is measured from the lower end of upstretched spring. Then ω is :

06 Sep 2020 (E)

(1) $\frac{1}{2}\sqrt{\frac{\mathrm{g}}{\mathrm{y}_0}}$
(2) $\sqrt{\frac{\mathrm{g}}{\mathrm{y}_0}}$
(3) $\sqrt{\frac{\mathrm{g}}{2\mathrm{y}_0}}$
(4) $\sqrt{\frac{2\mathrm{g}}{\mathrm{y}_0}}$

Q91. A ring is hung on a nail. It can oscillate, without slipping or sliding (i) in its plane with a time period T_1 and (ii) back and forth in a direction perpendicular to its plane, with a period T_2. The ratio $\frac{T_1}{T_2}$ will be :

05 Sep 2020 (E)

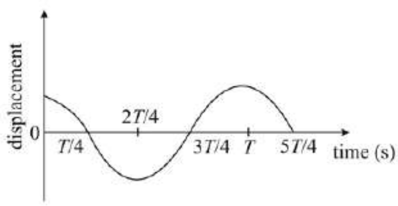
(1) $\frac{2}{\sqrt{3}}$
(2) $\frac{2}{3}$
(3) $\frac{3}{\sqrt{2}}$
(4) $\frac{\sqrt{2}}{3}$

Q92. A block of mass m attached to a massless spring is performing oscillatory motion of amplitude 'A' on a frictionless horizontal plane. If half of the mass of the block breaks off when it is passing through its equilibrium point, the amplitude of oscillation for the remaining system become fA. The value of f is:

03 Sep 2020 (E)

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

Q93. The displacement time graph of a particle executing SHM is given in figure: (sketch is schematic and not to scale). Which of the following statements is/are true for this motion?



(A) The force is zero at $t=\frac{3T}{4}$
(B) The magnitude of acceleration is maximum at $t=T$
(C) The speed is maximum at $t=\frac{T}{4}$
(D) The $P.E.$ is equal to $K.E.$ of the oscillation at $t=\frac{T}{2}$

02 Sep 2020 (E)

(1) (A), (B) and (C)
(2) (B), (C) and (D)
(3) (A), (B) and (D)
(4) (A) and (D)

Q94. The displacement of a damped harmonic oscillator is given by $x(\mathrm{t}) = \mathrm{e}^{-0.1\mathrm{t}} \cos(10\pi\mathrm{t} + \varphi)$. Here t is in seconds. The time taken for its amplitude of vibration to drop to half of its initial value is close to:

10 Apr 2019 (M)

(1) 27 s
(2) 4 s
(3) 13 s
(4) 7 s

Q95. A simple pendulum oscillating in air has period T . The bob of the pendulum is completely immersed in a non-viscous liquid. The density of the liquid is $\frac{1}{16}$th of the material of the bob. If the bob is inside liquid all the time, its period of oscillation in this liquid is: ***09 Apr 2019 (M)***

(1) $2\mathrm{T}\sqrt{\frac{1}{10}}$
(2) $2\mathrm{T}\sqrt{\frac{1}{14}}$
(3) $4\mathrm{T}\sqrt{\frac{1}{15}}$
(4) $4\mathrm{T}\sqrt{\frac{1}{14}}$

Q96. A damped harmonic oscillator has a frequency of 5 oscillations per second. The amplitude drops to half its value for every 10 oscillations. The time it will take to drop to $\frac{1}{1000}$ of the original amplitude is close to:

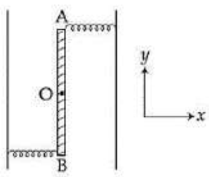
08 Apr 2019 (E)

(1) 50 s
(2) 100 s
(3) 20 s
(4) 10 s

Q97. A simple harmonic motion is represented by: $y = 5\left(\sin 3\pi t + \sqrt{3}\cos 3\pi t\right)$ cm. The amplitude and time period of the motion are: ***12 Jan 2019 (E)***

(1) 5 cm, $\frac{2}{3}$ s
(2) 10 cm, $\frac{2}{3}$ s
(3) 5 cm, $\frac{3}{2}$ s
(4) 10 cm, $\frac{3}{2}$ s

Q98. Two light identical springs of spring constant k are attached horizontally at the two ends of a uniform horizontal rod AB of length l and mass m. The rod is pivoted at its center 'O' and can rotate freely in horizontal plane. The other ends of the two springs are fixed to rigid supports as shown in figure. The rod is gently pushed through a small angle and released. The frequency of resulting oscillation is:



12 Jan 2019 (M)

(1) $\frac{1}{2\pi}\sqrt{\frac{3k}{m}}$
(2) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$
(3) $\frac{1}{2\pi}\sqrt{\frac{6\mathrm{k}}{m}}$
(4) $\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$

Q99. A particle undergoing simple harmonic motion has time dependent displacement given by $x(t) = \mathrm{A}\sin\frac{\pi t}{90}$. The ratio of kinetic to potential energy of this particle at $\mathrm{t} = 210$ s will be ***11 Jan 2019 (M)***

(1) $\frac{1}{9}$
(2) 1
(3) 2
(4) $\frac{1}{3}$

Q100. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1. If the length of the pendulum is doubled and it performs simple harmonic motion with the same amplitude as in the first case, its maximum kinetic energy is K_2 ***11 Jan 2019 (E)***

(1) $K_2 = 2K_1$ (2) $\mathrm{K}_2 = \frac{\mathrm{K}_1}{2}$
(3) $\mathrm{K}_2 = \frac{\mathrm{K}_1}{4}$ (4) $K_2 = K$

Q101. A simple pendulum of length $1\ \mathrm{m}$ is oscillating with an angular frequency $10 \mathrm{rad/s}$. The support of the pendulum starts oscillating up and down with a small angular frequency of $1 \mathrm{rad/s}$ and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by : ***11 Jan 2019 (E)***
(1) $10^{-3} \mathrm{rad/s}$ (2) $1 \mathrm{rad/s}$
(3) $10^{-1} \mathrm{rad/s}$ (4) $10^{-5} \mathrm{rad/s}$

Q102. A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are T_h and T_c respectively, then: ***10 Jan 2019 (E)***
(1) $T_h = 2T_c$ (2) $T_h = T_c$
(3) $T_h = 0.5T_c$ (4) $T_h = 1.5T_c$

Q103. A particle executes simple harmonic motion with an amplitude of 5 cm . When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in seconds is: ***10 Jan 2019 (E)***
(1) $\frac{8\pi}{3}$ (2) $\frac{3}{8}\pi$
(3) $\frac{4\pi}{3}$ (4) $\frac{7}{3}\pi$

Q104. A cylindrical plastic bottle of negligible mass is filled with $310\, ml$ of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency ω. If the radius of the bottle is $2.5\, cm$ then ω is close to: (density of water $= 10^3 kg/m^3$) ***10 Jan 2019 (E)***
(1) 5.00 rad $\sec^{-1}$ (2) 2.50 rad $\sec^{-1}$
(3) 7.9 rad $\sec^{-1}$ (4) 3.75 rad $\sec^{-1}$

Q105. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x -axis, about $x = 0$. When its potential Energy (PE) equal kinetic energy (KE), the position of the particle will be: ***09 Jan 2019 (E)***
(1) A (2) $\frac{A}{2}$
(3) $\frac{A}{2\sqrt{2}}$ (4) $\frac{A}{\sqrt{2}}$

Q106. A rod of mass M and length $2L$ is suspended at its middle by a wire. It exhibits torsional oscillations. If two masses, each of mass m, are attached at a distance $L/2$ from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio m/M is close to ***09 Jan 2019 (E)***
(1) 0.17 (2) 0.77
(3) 0.57 (4) 0.37

ANSWER KEYS

1. (22)	**2.** (17)	**3.** (6)	**4.** (12)	**5.** (10)	**6.** (1)	**7.** (3)	**8.** (7)
9. (12)	**10.** (8)	**11.** (2)	**12.** (9)	**13.** (12)	**14.** (3)	**15.** (2)	**16.** (4)
17. (1)	**18.** (2)	**19.** (3)	**20.** (2)	**21.** (4)	**22.** (20)	**23.** (2)	**24.** (99)
25. (3)	**26.** (2)	**27.** (20)	**28.** (3)	**29.** (2)	**30.** (88)	**31.** (8)	**32.** (40)
33. (120)	**34.** (4)	**35.** (1)	**36.** (5)	**37.** (5)	**38.** (1)	**39.** (2)	**40.** (16)
41. (2)	**42.** (2)	**43.** (60)	**44.** (1)	**45.** (3)	**46.** (700)	**47.** (1)	**48.** (3)
49. (1)	**50.** (3)	**51.** (1)	**52.** (1)	**53.** (8)	**54.** (1)	**55.** (2)	**56.** (1)
57. (4)	**58.** (2)	**59.** (4)	**60.** (2)	**61.** (1)	**62.** (2)	**63.** (2)	**64.** (2)
65. (10)	**66.** (4)	**67.** (4)	**68.** (4)	**69.** (6)	**70.** (4)	**71.** (3)	**72.** (4)
73. (1)	**74.** (2)	**75.** (4)	**76.** (1)	**77.** (1)	**78.** (4)	**79.** (3)	**80.** (2)
81. (7)	**82.** (1)	**83.** (3)	**84.** (1)	**85.** (2)	**86.** (2)	**87.** (4)	**88.** (4)
89. (2)	**90.** (3)	**91.** (1)	**92.** (4)	**93.** (1)	**94.** (4)	**95.** (3)	**96.** (3)
97. (2)	**98.** (3)	**99.** (4)	**100.** (1)	**101.** (1)	**102.** (2)	**103.** (1)	**104.** (3)
105. (4)	**106.** (4)						