1. Two particles executing SHM of same frequency and same amplitude meet at $x = +\frac{\sqrt{3}A}{2}$, while moving in opposite directions. Phase difference between the particles is :-

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3}$ (3) $\frac{5\pi}{6}$ (4) $\frac{2\pi}{3}$

2. A particle is executing SHM with time period T Starting from mean position, time taken by it to complete $\frac{5}{8}$ oscillations is,

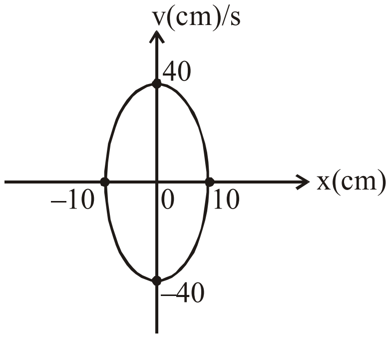
(1) $\frac{T}{12}$ (2) $\frac{T}{6}$ (3) $\frac{5T}{12}$ (4) $\frac{7T}{12}$

3. A particle executes simple harmonic motion according to equation $4\frac{d^2x}{dt^2} + 320x = 0$. Its time period of oscillation is :-

(1) $\frac{2\pi}{5\sqrt{3}}$s (2) $\frac{\pi}{3\sqrt{2}}$s

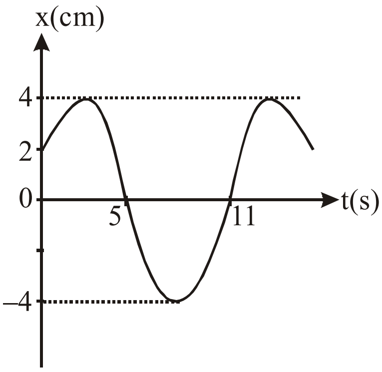
(3) $\frac{\pi}{2\sqrt{5}}$s (4) $\frac{2\pi}{\sqrt{3}}$s

4. The plot of velocity (v) versus displacement (x) of a particle executing simple harmonic motion is shown in figure. The time period of oscillation of particle is :-



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

5. Figure shows the position-time graph of an object in SHM. The correct equation representing motion is :-



(1) $2\sin\left(\frac{2\pi}{5}t + \frac{\pi}{6}\right)$

(2) $4\sin\left(\frac{\pi}{5}t + \frac{\pi}{6}\right)$

(3) $4\sin\left(\frac{\pi}{6}t + \frac{\pi}{3}\right)$

(4) $4\sin\left(\frac{\pi}{6}t + \frac{\pi}{6}\right)$

6. A particle executes SHM according to equation $x = 10(\text{cm})\cos\left[2\pi t + \frac{\pi}{2}\right]$, where t is in seconds. The magnitude of the velocity of the particle at t = $\frac{1}{6}$ s will be :-

(1) 24.7 cm/s (2) 20.5 cm/s

(3) 28.3 cm/s (4) 31.4 cm/s

7. A particle of mass m in a unidirectional potential field have potential energy $U(x) = \alpha + 2\beta x^2$, where α and β are positive constants. Find its time period of oscillations.

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

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

8. A particle executing S.H.M. has angular frequency 6.28 s^{-1} and amplitude 10 cm find (a) the time period (b) the maximum speed (c) the maximum acceleration (d) the speed when the displacement is 6 cm from the mean position (e) the speed at t = 1/6 s. Assume that the motion starts from rest at t = 0 & x = A.

9. A body makes angular SHM of amplitude $\frac{\pi}{10}$ rad. and time period 0.05 s. If the body is at displacement $\theta = \frac{\pi}{10}$ rad. at t = 0, then write the equation giving the angular displacement as a function of time

10. The vertical motion of a ship at sea is described by the equation $\frac{d^2x}{dt^2} = -4x$, where x is the vertical height of the ship (in metre) above its mean position. If it oscillates through a height of 1m then find maximum vertical speed and maximum vertical acceleration.

11. The phase difference between two SHMs $Y_1 = 10\sin(10\pi t + \pi/3)$ and $Y_2 = 12\sin(8\pi t + \pi/4)$ at t = 0.5s is ___ :-

12. A small mass executes linear SHM about O with amplitude a and period T. Its displacement from O at time T/8 after passing through O is :-

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

13. In SHM, the phase difference between the displacement and acceleration is :-

(1) 0 (2) $\pi/2$ (3) π (4) 2π

14. The acceleration of a particle moving along x-axis is a = – 100 x + 50. It is released from x = 2. Here 'a' and 'x' are in S.I units. The motion of particle will be :-

(1) periodic, oscillatory but not SHM
(2) periodic but not oscillatory
(3) oscillatory but not periodic
(4) simple harmonic

15. The acceleration of a certain simple harmonic oscillator is given by

$a = -(35.28\ m/s^2)\cos 4.2t$

The amplitude of the simple harmonic motion is

(1) 2.0 m (2) 8.4 m
(3) 16.8 m (4) 17.64 m

ANSWERS

1. 2 **2.** 4 **3.** 3 **4.** 1 **5.** 4 **6.** 4 **7.** 3

8. [1s, $0.628\frac{m}{s}$, $4\frac{m}{s^2}$, $50.2\frac{cm}{s}$, $-54.4\frac{cm}{s}$] **9.** [$\theta = \frac{\pi}{10}\cos 40\pi t$] **10.** [2 m/s, –4 m/s^2]

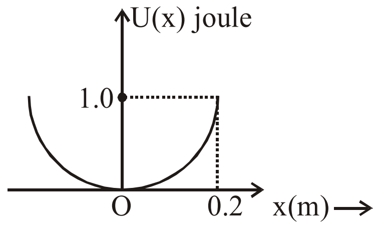
11. 195° **12.** 4 **13.** 3 **14.** 4 **15.** 1

Oscillations (Energy & spring pendulum) — RACE # 02

1. If particle is executing simple harmonic motion with time period T, then the time period of its total mechanical energy is :-

(1) Zero (2) T /2 (3) 2T (4) Infinite

2. A particle of mass 4kg moves simple harmonically such that its PE (U) varies with position x, as shown. The period of oscillations is :-

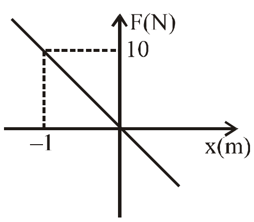


(1) $\frac{2\pi}{25}$ s (2) $\frac{\pi\sqrt{2}}{5}$ s (3) $\frac{4\pi}{5}$ s (4) $\frac{2\pi\sqrt{2}}{5}$ s

3. When a mass m attached to a spring it oscillates with period 4s. When an additional mass of 2 kg is attached to a spring, time period increases by 1s. The value of m is :-

(1) 3.5 kg (2) 8.2 kg (3) 4.7 kg (4) 2.6 kg

4. F-x and x – t graph of a particle in SHM are as shown in figure match the following



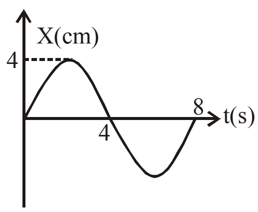


Table-1	Table-2
(A) Mass of the particle	(p) $\frac{\pi}{2}$ SI unit
(B) Maximum kinetic energy of particle	(q) $\left(\frac{160}{\pi^2}\right)$ SI units
(C) Angular fequency of particle	(r) (8.0×10^{-3}) SI unit
	(s) None

5. A linear harmonic oscillator of force constant 2×10^6 Nm^{-1} and amplitude 0.01 m has a total mechanical energy of 160 J. Its :-

(1) maximum potential energy is 100 J

(2) maximum kinetic energy is 100 J

(3) maximum potential energy is 160 J

(4) maximum potential energy is zero

6. A particle is moving on x–axis has potential energy $U = 2 - 20x + 5x^2$ joules. The particle is released at x = – 3. The maximum value of 'x' will be [x is in meters and U is in joules]:-

(1) 5 m (2) 3 m (3) 7 m (4) 8 m

7. The potential energy of a particle executing SHM changes from maximum to minimum in 5 s. Then the time period of SHM is :-

(1) 5 s (2) 10 s (3) 15 s (4) 20 s

8. A particle of mass m performs SHM along a straight line with frequency f and amplitude A:-

(1) The average kinetic energy of the particle is zero

(2) The average potential energy is $m\pi^2f^2A^2$

(3) The frequency of oscillation of kinetic energy is 2f

(4) Velocity function leads acceleration in phase by $\pi/2$

9. Which of the following is correct about a SHM, along a straight line ?

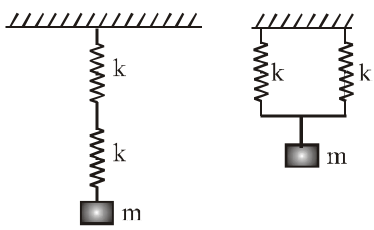
(1) Ratio of acceleration to velocity is constant.

(2) Ratio of acceleration to potential energy is constant.

(3) Ratio of acceleration to displacement from the mean position is constant.

(4) Ratio of acceleration to kinetic energy is constant.

10. Two identical springs of constant k are connected in series and parallel as shown in figure. A mass' m' is suspended from them. The ratio of their frequencies of vertical oscillations will be :-



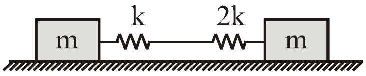
(1) 2 : 1 (2) 1 : 1 (3) 1 : 2 (4) 4 : 1

11. A force of 6.4N stretches a vertical spring by 0.1m. The mass that must be suspended from the spring so that it oscillates with a time period of $\pi/4$ second :-

(1) $\frac{\pi}{4}$ kg (2) $\frac{4}{\pi}$ kg

(3) 1 kg (4) 10 kg

12. A system is shown in the figure. The time period for small oscillations of the two blocks will be :-



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

(3) $2\pi\sqrt{\frac{3m}{4k}}$ (4) $2\pi\sqrt{\frac{3m}{8k}}$

13. A mass M is suspended with a light spring. An additional mass m added displaces the spring further by a distance x. Now, the combined mass will oscillate on the spring with period :

(1) $T = 2\pi\sqrt{\frac{mg}{x(M+m)}}$

(2) $T = 2\pi\sqrt{\frac{(M+m)x}{mg}}$

(3) $T = \frac{\pi}{2}\sqrt{\frac{m}{x(M+m)}}$

(4) $T = 2\pi\sqrt{\frac{M+m}{mgx}}$

ANSWERS

1. 4	**2.** 4	**3.** 1	**4.** [A-q, B-r, C-s]	**5.** 2,3	**6.** 3	**7.** 4	**8.** 2,3
9. 3	**10.** 3	**11.** 3	**12.** 3	**13.** 2			

Oscillations (Simple pendulum and types of SHM) — RACE # 03

1. Two pendulums of length 1.21 m and 1.0 m starts vibrating. At some instant, the two are in the mean position in same phase. After how many vibrations of the longer pendulum, the two will be in phase ?

(1) 10 (2) 11

(3) 20 (4) 21

2. The time period of oscillations of a simple pendulum is 1 minute. If its length is increased by 44%, then its new time period of oscillations will be :-

(1) 96s (2) 58s

(3) 82s (4) 72s

3. A 100 g mass stretches a particular spring by 9.8 cm, when suspended vertically from it. How large a mass must be attached to the spring if the period of vibration is to be 6.28 s?

(1) 1000g (2) 10^5g

(3) 10^7g (4) 10^4g

4. In forced oscillations, a particle oscillates simple harmonically with a frequency equal to:-

(1) Frequency of driving force

(2) Natural frequency of body

(3) Difference of frequency of driving force and natural frequency

(4) Mean of frequency of driving force and natural frequency

5. A simple pendulum of length 40 cm oscillates with an angular amplitude of 0.04 rad. Find

(a) The time period

(b) The linear amplitude of the bob

(c) The speed of the bob when the string makes 0.02 rad with the vertical

(d) The angular acceleration when the bob is in momentary rest (take g = 10 m/s^2)

6. The time period and the amplitude of a simple pendulum are 4 seconds and 0.20 meter respectively. If the displacement is 0.1 meter at time t = 0, the equation of its displacement is represented by :-

(1) $y = 0.2 \sin (0.5\pi t)$

(2) $y = 0.1 \sin (0.5\pi t + \frac{\pi}{6})$

(3) $y = 0.1 \sin \left(\pi t + \frac{\pi}{6}\right)$

(4) $y = 0.2 \sin \left(0.5\pi t + \frac{\pi}{6}\right)$

7. A simple pendulum of length 1m is attached to the ceiling of an elevator which is accelerating upward at the rate of 1m/s^2. Its frequency is approximately :-

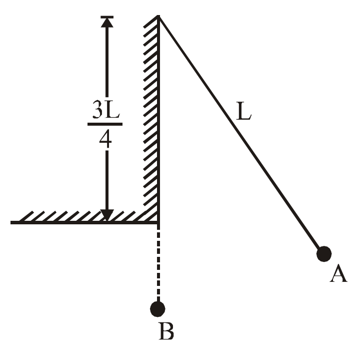
(1) 2 Hz

(2) 1.5 Hz

(3) 5 Hz

(4) 0.5 Hz

8. A pendulum has period T for small oscillations. An obstacle is placed directly beneath the pivot, so that only the lowest one quarter of the string can follow the pendulum bob when it swings in the left of its resting position as shown in the figure. The pendulum is released from rest at a certain point A. The time taken by it to return to that point is :-



(1) T (2) T/2 (3) 3T/4 (4) T/4

9. The bob of a simple pendulum is a spherical hollow ball filled with water. A plugged hole near the bottom of the oscillating bob gets suddenly unplugged. During observation, the time period of oscillation would :-

(1) remain unchanged

(2) increase towards a saturation value

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

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

10. Choose the correct statement :-

(1) Time period of a simple pendulum depends on amplitude.

(2) Time shown by a spring watch varies with acceleration due to gravity g.

(3) In a simple pendulum, time period varies linearly with the length of the pendulum.

(4) The graph between length of the pendulum and time period is a parabola.

11. A simple pendulum has a time period T in vacuum. Its time period when it is completely immersed in a liquid of density $\frac{1}{8}$th of material of the bob is :-

(1) $\sqrt{\frac{7}{8}}T$ (2) $\sqrt{\frac{5}{8}}T$ (3) $\sqrt{\frac{3}{8}}T$ (4) $\sqrt{\frac{8}{7}}T$

12. The time period of a simple pendulum in a stationary train is T. The time period of a mass attached to a spring is also T. The train accelerates at the rate 5 m/s^2 . If the new time periods of the pendulum and spring be T_P and T_S respectively, then :-

(1) $T_P = T_S$ (2) $T_P > T_S$

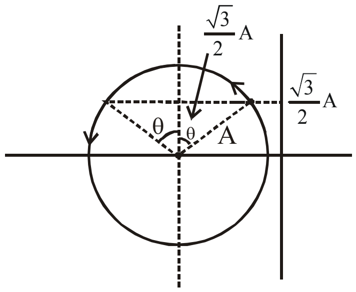
(3) $T_P < T_S$ (4) Cannot be predicted

ANSWERS

1. 1	**2.** 4	**3.** 4	**4.** 1	**5.** [1.26 s, 1.6 cm, 6.8 cm/s, 1 rad/s^2]		
6. 4	**7.** 4	**8.** 3	**9.** 3	**10.** 4	**11.** 4	**12.** 3

Oscillations (Kinematics of SHM) : RACE # 01 SOLUTION

1.



$\cos\theta = \frac{\sqrt{3}A/2}{A} = \frac{\sqrt{3}}{2} \Rightarrow \theta = 30°$

Phase difference = 2θ = 60°

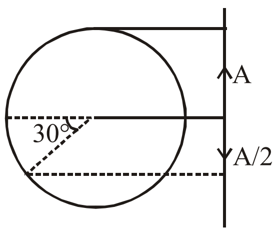
OR

$x_1 = A \sin \omega t$ & $x_2 = A \sin(\omega t + \phi)$

Here $x_1 = x_2 = \frac{\sqrt{3}A}{2}$

$\Rightarrow \omega t = \frac{\pi}{3}$ & $\omega t + \phi = \frac{2\pi}{3} \Rightarrow \phi = \frac{\pi}{3}$

2. $\frac{5}{8}$ (4A) = 2.5 A = 2A + 0.5 A



total angle travelled

$= 180° + 30° = 210° \times \frac{\pi}{180} = \frac{7\pi}{6}$

$t = \frac{7\pi}{6} \times \frac{T}{2\pi} = \frac{7}{12}T$

OR

$\because \frac{5}{8}$ oscillation $= \frac{1}{2}$ oscillation $+ \frac{1}{8}$ oscillation

(from mean position)

$\therefore$ Time taken $= \frac{T}{2} + \frac{T}{12} = \frac{7T}{12}$

3. $\frac{d^2x}{dt^2} + \frac{320}{4}x = 0$

$\frac{d^2x}{dt^2} + 80x = 0$

so $\omega^2 = 80$

$\omega = \sqrt{80} = 4\sqrt{5}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{4\sqrt{5}} = \frac{\pi}{2\sqrt{5}}$ s

4. $v_{max} = A\omega = 40$ cm/s

Here A = 10 so ω = 4

$T = \frac{2\pi}{4} = \frac{\pi}{2}$ s

5. From diagram

amplitude = 4 cm, Time period T = 12 s

Let equation be $x = A \sin(\omega t + \phi)$

At t = 0, x = 2 so $2 = 4\sin(\phi) \Rightarrow \phi = \frac{\pi}{6}$

$\Rightarrow x = 4 \sin\left(\frac{2\pi}{12}t + \frac{\pi}{6}\right)$

6. $v = -10(2\pi)\sin(2\pi t + \frac{\pi}{2})$

At $t = \frac{1}{6}$

$v = -20\pi \sin\left(\frac{\pi}{3} + 90°\right) = -20\pi \cos\frac{\pi}{3}$

$= -20\pi \frac{1}{2} = 10\pi \Rightarrow v = 31.4$ cm/s

7. $F = -\frac{dU}{dx} = -(0 + 4\beta x)$

$ma = -4\beta x \quad \Rightarrow a = -\frac{4\beta}{m}x = -\omega^2 x$

$T = 2\pi\sqrt{\frac{m}{4\beta}} \quad \Rightarrow$

$\boxed{T = \pi\sqrt{\frac{m}{\beta}}}$

8. (a) $T = \frac{2\pi}{\omega} = \frac{2\pi}{6.28} = 1$s

(b) $v_{max} = A\omega = (10 \text{ cm})(6.28)$
$= 62.8$ cm/s $= 0.628$ m/s

(c) $a_{max} = \omega^2 A = (6.28)^2(0.1) = 4$m/s^2

(d) $v = \omega\sqrt{A^2 - x^2}$

$= 6.28\sqrt{100 - 36} = 8 \times 6.28 = 50.2$ cm/s

(e) $v = -\omega A \cos(\omega t + 90°) = -\omega A \sin \omega t$

$= -\omega A \sin\left(\frac{2\pi}{6}\right) = -54.4$ cm/s

9. $\theta = \theta_0 \sin(\omega t + 90°)$

$$\theta = \frac{\pi}{10} \cos\left(\frac{2\pi}{0.05}t\right)$$

$$\theta = \frac{\pi}{10}\cos(40\pi t)$$

10. $\frac{d^2x}{dt^2} = -4x \Rightarrow \omega^2 = 4$ or $\omega = 2$

A=1m. Maximum speed = $A\omega$ = 2m/s

Maximum acceleration $= -\omega^2 A = -4(1)$

$= -4\ m/s^2$

11. at t = 0.5 sec

$\phi_1 = (5\pi + \pi/3)$ & $\phi_2 = (4\pi + \pi/4)$

$\Delta\phi = \phi_1 - \phi_2 = 195°$

12. $y = a \sin \omega t$

$$= a \sin\left(\frac{2\pi}{T}\times\frac{T}{8}\right) = \frac{a}{\sqrt{2}}$$

13. $a \propto -x$

$\therefore \Delta\phi = \pi$

14. The equation a = – 100x + 50 (a = – kx form) itself shows that the particle performs SHM.

Hence (4)

15. Given $\omega^2 A = 35.28$

$\omega = 4.2$

1. Total mechanical energy always remains constant.

So $\omega = 0$, $T = \dfrac{2\pi}{\omega} = \text{Infinite}$

2. $\dfrac{1}{2}KA^2 = \dfrac{1}{2}K(0.2)^2 = 1$

$K = \dfrac{2}{(0.2)^2} = \dfrac{2\times100}{4} = 50$

$\omega = \sqrt{K/m}$

$= \sqrt{\dfrac{50}{4}} = \dfrac{5}{2}\sqrt{2} = \dfrac{5}{\sqrt{2}}$

$T = \dfrac{2\pi}{\omega} = \dfrac{2\sqrt{2}\pi}{5}s$

3. $T = 2\pi\sqrt{\dfrac{m}{k}}$

$4 = 2\pi\sqrt{\dfrac{m}{k}}$ ..(1)

$5 = 2\pi\sqrt{\dfrac{m+2}{k}}$ ..(2)

so eq^n (2)/(1)

$\dfrac{5}{4} = \sqrt{\left(\dfrac{m+2}{k}\right)\dfrac{k}{m}}$

$\Rightarrow \dfrac{25}{16} = \dfrac{m+2}{m} \Rightarrow m = 3.5$ kg

4. By F–x graph

$\dfrac{dF}{dx} = -10$

$F = -10x \Rightarrow a = -\dfrac{10}{m}x$

$\omega^2 = \dfrac{10}{m}$ ..(1)

By x – t graph

T = 8s

$\omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{8} = \dfrac{\pi}{4} \Rightarrow \omega = \dfrac{\pi}{4}s^{-1}$

from (1) $m = \dfrac{10}{\omega^2} = \dfrac{10}{\pi^2}\times16 = \dfrac{160}{\pi^2}$

$(K.E.)_{max} = \dfrac{1}{2}kA^2$

$= \dfrac{1}{2}m\omega^2A^2 = \dfrac{1}{2}\cdot\dfrac{160}{\pi^2}\cdot\dfrac{\pi^2}{16}(4\times10^{-2})^2 = 8\times10^{-3}$

5. $k = 2\times10^6$ N/m, A = 0.01m, M.E. = 160 J

Max K.E. $= \dfrac{1}{2}KA^2 = 100J$

Max P.E. = 160

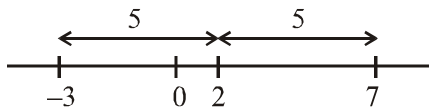
6. $U = 2 - 20x + 5x^2$

$F = -\dfrac{dU}{dx} = 20 - 10x$

At equilibrium position ; F = 0

$20 - 10x = 0 \Rightarrow x = 2$

Since particle is released at x = – 3, therefore amplitude of particle is 5



It will oscillate about x = 2 with an amplitude of 5.

$\therefore$ maximum value of x will be 7

7. P.E is maximum at extreme position and minimum at mean position.

Time to go from extreme position to mean position is, $t = \dfrac{T}{4}$; where T is time period of SHM

$\therefore T = 4t = 20s$

9. $V = \pm\omega\sqrt{A^2 - x^2}$, $PE = \dfrac{1}{2}kx^2$

$a = -\omega^2x$,

$KE = \dfrac{1}{2}m\omega^2\left(A^2 - x^2\right) = \dfrac{1}{2}k\left(A^2 - x^2\right)$

Ratio of acceleration to displacement

$= \dfrac{-\omega^2x}{x} = -\omega^2$ (consant)

10. $f = \frac{1}{2\pi}\sqrt{\frac{k_{eq}}{m}}$

$\frac{f_1}{f_2} = \sqrt{\frac{k/2}{2k}} = \frac{1}{2}$

11. Spring constant $k = \frac{6.4}{0.1} = 64\ N/m$.

Now $T = 2\pi\sqrt{\frac{m}{k}}$ or $\frac{\pi}{4} = 2\pi\sqrt{\frac{m}{64}}$ $\therefore$ m = 1 kg

$f = \frac{1}{2\pi}\sqrt{\frac{k_{eq}}{M}}$ $= \frac{1}{2\pi}\sqrt{\frac{4k}{M}}$

12. Both the spring are in series

$\therefore\ k_{eq} = \frac{k(2k)}{k+2k} = \frac{2k}{3}$

Time period

$T = 2\pi\sqrt{\frac{\mu}{k_{eq}}}$ where $\mu = \frac{m_1 m_2}{m_1 + m_2}$

Here $\mu = \frac{m}{2}$ $\therefore\ T = 2\pi\sqrt{\frac{m}{2}\cdot\frac{3}{2k}}$ $= 2\pi\sqrt{\frac{3m}{4k}}$

1. $nT_1 = (n+1)\,T_2$

$$\Rightarrow (n)\,2\pi\sqrt{\frac{1.21}{g}} = (n+1)\,2\pi\sqrt{\frac{1}{g}}$$

$$\Rightarrow \frac{11n}{10} = n+1 \Rightarrow 11n = 10n + 10 \Rightarrow n = 10$$

2. $T = 60s = 2\pi\sqrt{\frac{\ell}{g}}$

$\ell' = 1.44\,\ell$

$$T' = 2\pi\sqrt{\frac{1.44\ell}{g}} = \sqrt{1.44} \times 2\pi\sqrt{\frac{\ell}{g}}$$

$$= \frac{12}{10}\times 60 = 72 \text{ sec.}$$

3. $mg = Kx$

$$K = \frac{mg}{x} = \frac{100\times10^{-3}\times 9.8}{9.8\times 10^{-2}} = 10$$

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow m = \frac{T^2k}{4\pi^2}$$

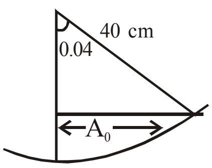
$$= \frac{6.28\times6.28\times10}{4\pi^2} = 10\text{kg} = 10^4\text{g}$$

5. (a) $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$= 2\pi\sqrt{\frac{40\times10^{-2}}{10}}$$

$$= \frac{2\pi\times2}{10} = \frac{4\times3.14}{10} = 1.26\text{s}$$

(b) $\sin\left(0.04\times\frac{180}{\pi}\right) = \frac{A_0}{40}$



$$\Rightarrow A_0 = 40\sin\left(0.04\times\frac{180}{\pi}\right)$$

$$\Rightarrow A_0 = 1.6 \text{ cm}$$

(c) Angular velocity

$$= \omega\sqrt{\theta_0^2 - \theta^2}$$

$$= \frac{2\pi}{1.26}\sqrt{(0.04)^2 - (0.02)^2}$$

$$= \frac{2\pi}{1.26}.\frac{\sqrt{12}}{100} = 0.172 \text{ rad/s}$$

linear speed = ℓ (angular velocity)
= 40 (0.172)
= 6.8 cm/s

(d) $\alpha = \omega^2\,\theta_0$

$$= \left(\frac{2\pi}{1.26}\right)^2.(0.04)$$

$$= 1 \text{ rad/s}^2$$

6. $T = 4 \text{ sec} \Rightarrow \omega = \frac{2\pi}{T} = \frac{\pi}{2} = 0.5\pi$

$A = 0.2\text{m}$

at $t = 0$, $x = 0.1\text{ m} = \frac{A}{2}$

$\therefore\ \Delta\phi = \pi/6$

7. $f = \frac{1}{2\pi}\sqrt{\frac{g+1}{1}} \approx \frac{1}{2\pi}\times1 = \frac{1}{2}\text{Hz}$

8. Time taken by the pendulum to move from A to B and from B to A is $\frac{T}{2}$.

Time period of oscillation $\propto \sqrt{L}$.

$$\therefore\ \frac{T_1}{T} = \sqrt{\frac{L/4}{L}} = \frac{1}{2} \text{ or } T_1 = \frac{T}{2}$$

Time taken to complete half the oscillation = $\frac{T}{4}$.

Total time period of oscillation

$$= \frac{T}{2} + \frac{T}{4} = \frac{3T}{4}.$$

9. $T = 2\pi\sqrt{\frac{l}{g}}$

As initially centre of mass goes down and then comes to its original position, therefore, effective length of pendulum first increases and then decreases to the original value. So, will be the time period.

11. Let $T = 2\pi\sqrt{\frac{l}{g}}$

Let V be the volume of the mass
$V \times \rho \times g$ is acting downwards

$V \times \frac{\rho}{8} \times g$ is acting upwards
Inside the liquid, the effective force downwards

$= V\rho g \times \frac{7}{8}$, i.e., effective g is $\frac{7}{8}g$

$\therefore\ T' = 2\pi\sqrt{\frac{l}{(7/8)g}}$ or $T' = 2\pi\sqrt{\frac{8l}{7g}} = \sqrt{\frac{8}{7}}T.$

12. $T_P = 2\pi\sqrt{\frac{\ell}{\sqrt{g^2+s^2}}} < T$

$T_S = 2\pi\sqrt{\frac{m}{k}} = T$