DPP – 4 (SHM)

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Q 1. The S.H.M. of a particle is given by the equation y = 3 sin ωt + 4 cos ωt. The amplitude is
(a) 7 (b) 1
(c) 5 (d) 12

Q 2. Two simple harmonic motions are represented by the equation $y_1 = 10\,\text{Sin}(4\pi t + \frac{\pi}{4})$ and $y_2 = 5(\text{Sin}\,3\pi t + \sqrt{3}\,\text{Cos}\,3\pi t)$. Their amplitudes are in the ratio
(a) 1 : 1 (b) 2 : 1
(c) $2 : \sqrt{3}$ (d) $\sqrt{3} : 2$

Q 3. The displacement of a particle executing simple harmonic motion is given by $y = A_0 + A\sin\omega t + B\cos\omega t$. Then the amplitude of its oscillation is given by:
(a) $A_0 + \sqrt{A^2 + B^2}$ (b) $\sqrt{A^2 + B^2}$
(c) $\sqrt{A_0^2 + (A^2 + B^2)}$ (d) A + B

Q 4. Two mutually perpendicular simple harmonic vibrations have same amplitude, frequency and phase. When they superimpose, the resultant form of vibration will be
(a) A circle (b) An ellipse
(c) A straight line (d) A parabola

Q 5. A particle is subjected to two simple harmonic motions in the same direction having equal amplitude and equal frequency. If the resultant amplitude is equal to the amplitude of individual motions, what is the phase difference between the motions.
(a) $\frac{2\pi}{3}$ rad (b) $\frac{3\pi}{2}$ rad
(c) $\frac{\pi}{3}$ rad (d) $\frac{\pi}{2}$ rad

Q 6. A simple pendulum has a hollow sphere containing mercury suspended by means of a wire. If a little mercury is drained off, the period of the pendulum will
(a) Remains unchanged (b) Increase
(c) Decrease (d) Become erratic

Q 7. A man measures the period of a simple pendulum inside a stationary lift and finds it to be T s. If the lift accelerates upwards with an acceleration g / 4, then the period of the pendulum will be
(a) T (b) $\frac{T}{4}$
(c) $\frac{2T}{\sqrt{5}}$ (d) $\frac{2T}{5}$

Q 8. A simple pendulum is attached to the roof of a lift. If time period of oscillation, when the lift is stationary is T. Then frequency of oscillation, when the lift falls freely, will be

(a) zero (b) T

(c) $\frac{1}{T}$ (d) none of these

Q 9. A particle is subjected to two mutually perpendicular simple harmonic motions such that its X and y coordinates are given by X = 2 sin ωt, y = 2 sin (ωt + $\frac{\pi}{4}$) The path of the particle will be:

(a) An ellipse (b) A straight line

(c) A parabola (d) A circle

Q 10. If the length of simple pendulum is increased by 300%, then the time period will be increased by

(a) 100 % (b) 200 %

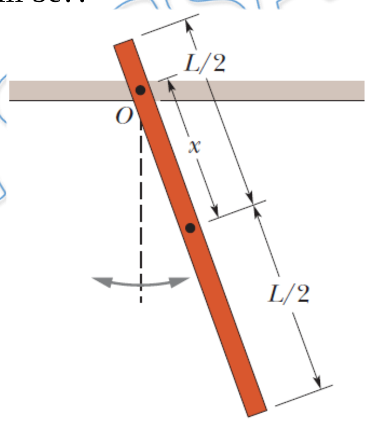
(c) 300 % (d) 400 %

Q 11. Two pendulums of lengths 200 cm and 220.50 cm start oscillating at the same instant. They are in the mean position and in the same phase. After how many vibrations of the shorter pendulum, the two will be in the same phase in the mean position?

(a) 12 (b) 21

(c) 27 (d) 33

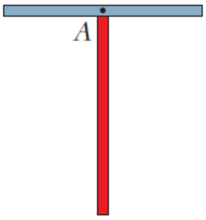
Q 12. In figure, a stick of length L oscillates as a physical pendulum. What value of distance x between the sticks center of mass and its pivot point O gives the least period and minimum time period will be??



(a) x = $\frac{L}{\sqrt{12}}$, and T = $2\pi\sqrt{\frac{L}{\sqrt{3}g}}$ (b) x = $\frac{L}{\sqrt{3}}$, and T = $2\pi\sqrt{\frac{L}{\sqrt{12}g}}$

(c) x = $\frac{L}{\sqrt{12}}$, and T = $2\pi\sqrt{\frac{L}{\sqrt{2}g}}$ (d) x = $\frac{L}{\sqrt{3}}$, and T = $2\pi\sqrt{\frac{L}{\sqrt{2}g}}$

Q 13. A physical pendulum consists of two l meter-long and of mass m, sticks joined together as shown in figure. What is the pendulum's period of oscillation about a pin inserted through point A at the center of the horizontal stick?



(a) $2\pi\sqrt{\frac{5L}{6g}}$ (b) $2\pi\sqrt{\frac{6L}{5g}}$

(c) $2\pi\sqrt{\frac{2L}{3g}}$ (d) $2\pi\sqrt{\frac{3L}{2g}}$

Q 14. A ring of radius r is suspended from a point on its circumference. Determine its angular frequency of small oscillations

(a) $\sqrt{\frac{3g}{2r}}$ (b) $\sqrt{\frac{g}{3r}}$

(c) $\sqrt{\frac{g}{2r}}$ (d) $\sqrt{\frac{2g}{3r}}$

Q 15. A simple pendulum of length L is suspended from the roof of a train. If the train moves in a horizontal direction with an acceleration 'a' then the period of the simple pendulum is given by

(a) $2\pi\sqrt{\frac{l}{\sqrt{g^2-a^2}}}$ (b) $2\pi\sqrt{\frac{l}{g+a}}$

(c) $2\pi\sqrt{\frac{l}{\sqrt{g^2+a^2}}}$ (d) $2\pi\sqrt{\frac{l}{g-a}}$

Q 16. A ball of radius a is made to oscillate in a smooth bowl of radius b then time period of vibration of ball is (b>a)

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

(c) $2\pi\sqrt{\frac{b+a}{g}}$ (d) $2\pi\sqrt{\frac{a}{g}}$

Q 17. The length of the second pendulum on the surface of earth is 1 m. The length of seconds pendulum on the surface of moon, where g is $1/6^{th}$ value of g on the surface of earth, is

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

(c) $\frac{1}{36}$ m (d) 36 m

Q 18. If the length of second's pendulum is decreased by 2%, how many seconds it will gain per day

(a) 3927 sec (b) 3727 sec

(c) 3427 sec (d) 864 sec

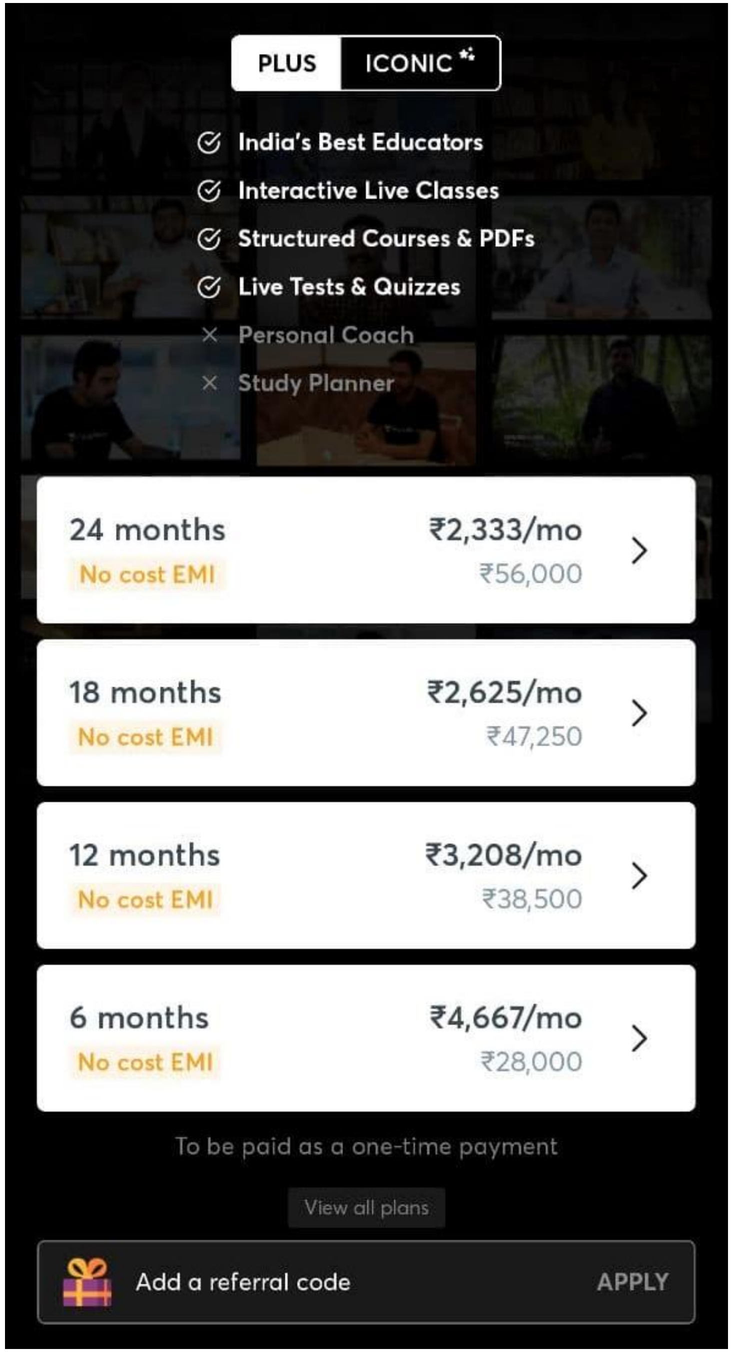
Q 19. A simple pendulum executing S.H.M. is falling freely along with the support. Then

(a) Its periodic time decreases (b) Its periodic time increases

(c) It does not oscillate at all (d) None of these

Answer Key

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



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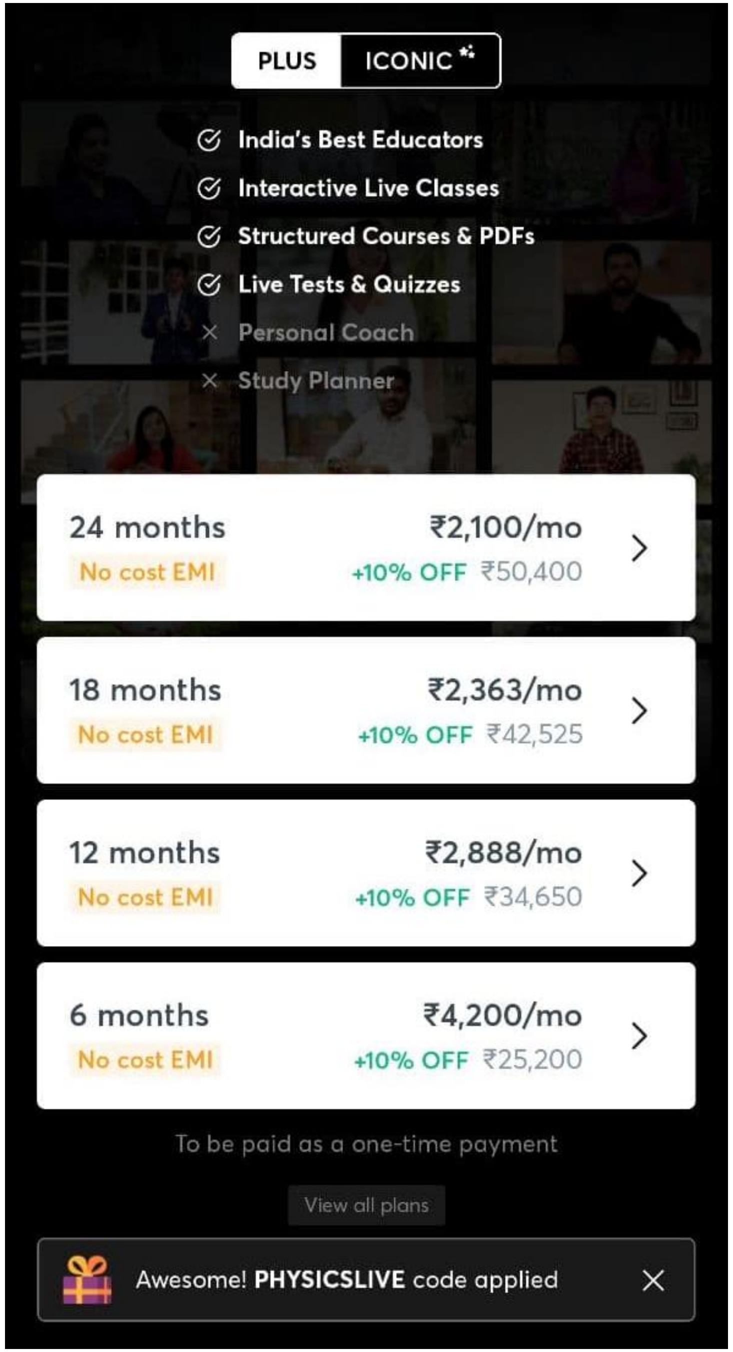

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NEET & JEE Main
Physics DPP - Solution

DPP-4 SHM: Superposition of S.H.M., Angular S.H.M.,Simple Pendulum, Physical Pendulum

By Physicsaholics Team

Solution: 1

$$y = 3\sin\omega t + 4\cos\omega t$$

$$y = A_1\sin\omega t + A_2\cos\omega t$$

$$A_1 = 3, \quad A_2 = 4$$

$$A = \sqrt{3^2 + 4^2}$$

$$A = \sqrt{9 + 16} = \sqrt{25}$$

$$\boxed{A = 5\text{ m}}$$ Ans.

Ans. c

Solution: 2

$y_1 = 10\sin(4\pi t + \frac{\pi}{4})$; $A_1 = 10$

$y_2 = 5[\sin(3\pi t) + \sqrt{3}\cos(3\pi t)]$

$y_2 = [5\sin(3\pi t) + 5\sqrt{3}\cos(3\pi t)]$

$A_2 = \sqrt{5^2 + (5\sqrt{3})^2}$

$= 5\sqrt{1+3}$

$= 5\sqrt{4}$

$A_2 = 10$

$\Rightarrow \frac{A_1}{A_2} = \frac{10}{10} = \frac{1}{1}$

$\Rightarrow \boxed{\frac{A_1}{A_2} = \frac{1}{1}}$ Ans.

Ans. a

Solution: 3

$y = A_0 + A\sin\omega t + B\cos\omega t$

$y - A_0 = A\sin\omega t + B\cos\omega t$

Amplitude; $a = \sqrt{A^2 + B^2}$ Ans.

and particle is performing SHM about point $y = A_0$

Ans. b

Solution: 4

$y_1 = A \sin\omega t$

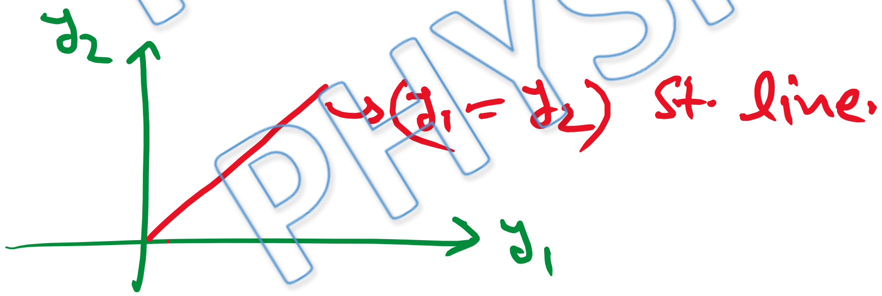
$y_2 = A \sin\omega t$

$\because$ Amplitude (A), frequency (ω) and Phase all are same.

$\Rightarrow \dfrac{y_1}{A} = \dfrac{y_2}{A}$

$y_1 = y_2$

$\because y_1$ & y_2 are $\perp$



Ans. c

Solution: 5

$y_1 = A \sin \omega t$

$y_2 = A \sin(\omega t + \phi)$

$\because$ given; $A =$ same

& line of SHM is same

$A_{net} = \sqrt{A^2 + A^2 + 2(A)(A)\cos\phi}$

given; $A_{net} = A$

$A = \sqrt{A^2 + A^2 + 2A^2\cos\phi}$

$A = \sqrt{A^2(2 + 2\cos\phi)}$

$A = A\sqrt{2(1+\cos\phi)}$

$1 = \sqrt{2}\sqrt{1 + 2\cos^2\frac{\phi}{2} - 1}$

$\sqrt{2}\sqrt{2}\cos\phi/2 = 1$

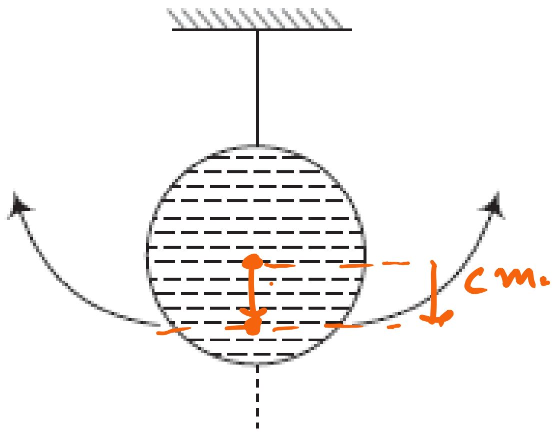
$\cos\phi/2 = \frac{1}{2}$

$\phi/2 = \frac{\pi}{3}$

$\boxed{\phi = \frac{2\pi}{3}}$ Ans.

Ans. a

Solution: 6



when mercury is drained off; com of sphere is shifted down

so; l_{eff} is increased

and for simple pendulum

$$T = 2\pi\sqrt{\frac{l_{eff}}{g}}$$

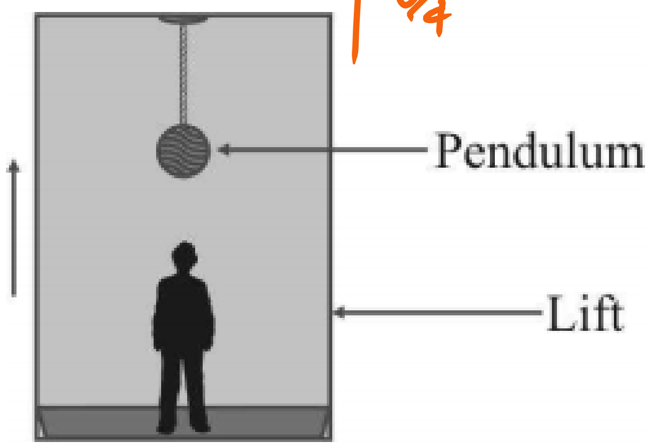
$$T \propto \sqrt{l}$$

if $l \uparrow$

$T \uparrow$ Ans.

Ans. b

Solution: 7



$\uparrow g/4$

in stationary lift:

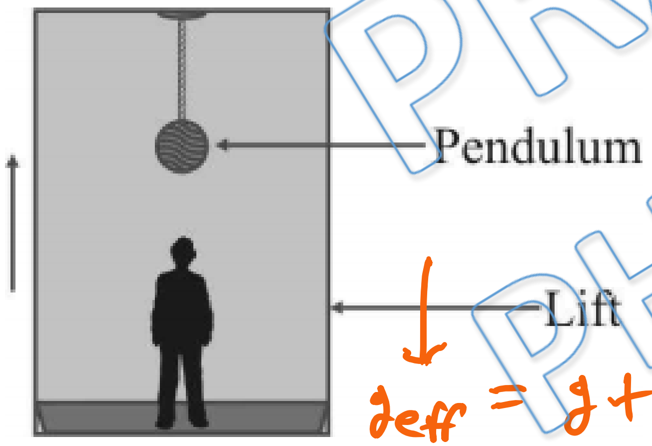
$g_{eff} = g$

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

in accelerated lift:

$g_{eff} = \frac{5g}{4}$

w.r.t. lift



$g_{eff} = g + \frac{g}{4} = \frac{5g}{4}$

$T' = 2\pi\sqrt{\frac{l}{5g/4}} = 2\pi\sqrt{\frac{l}{g}} \times \sqrt{\frac{4}{5}}$

$T' = T \times \sqrt{\frac{4}{5}} = T \times \frac{2}{\sqrt{5}}$

$\boxed{T' = \frac{2T}{\sqrt{5}}}$ Ans

Ans. c

Solution: 8

in stationary lift

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

if lift is falling freely

$$g_{eff} = 0$$

so, $T' = 2\pi\sqrt{\frac{l}{g_{eff}}}$

$$\frac{1}{f'} = 2\pi\sqrt{\frac{l}{g_{eff}}}$$

$$f' = \frac{1}{2\pi}\sqrt{\frac{g_{eff}}{l}}$$

$\because g_{eff} = 0$

so; $\boxed{f' = 0}$

Ans. a

Solution: 9

$$x = 2\sin\omega t$$

$$y = 2\sin\left(\omega t + \frac{\pi}{4}\right)$$

$x \perp y$

$x = 2\sin\omega t$

$\sin\omega t = \frac{x}{2}$

$\cos\omega t = \sqrt{1 - \sin^2\omega t}$

$$\boxed{\cos\omega t = \sqrt{1 - \frac{x^2}{4}}}$$

$y = 2\sin\left(\omega t + \frac{\pi}{4}\right)$

$= 2\left[\sin\omega t \cos\frac{\pi}{4} + \cos\omega t \sin\frac{\pi}{4}\right]$

$y = 2\left(\frac{\sin\omega t + \cos\omega t}{\sqrt{2}}\right)$

$y = \sqrt{2}\left(\sin\omega t + \cos\omega t\right)$

$y = \sqrt{2}\left(\frac{x}{2} + \sqrt{1 - \frac{x^2}{4}}\right)$

$y = \frac{x}{\sqrt{2}} + \frac{\sqrt{4 - x^2}}{\sqrt{2}}$

$\left(y - \frac{x}{\sqrt{2}}\right)^2 = \left(\frac{\sqrt{4 - x^2}}{\sqrt{2}}\right)^2$

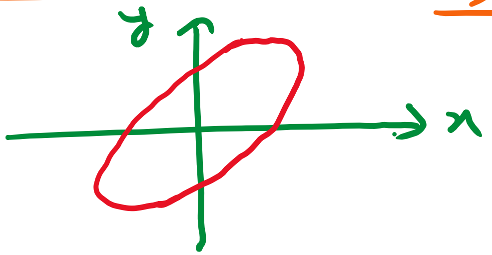
$y^2 + \frac{x^2}{2} - 2(y)\left(\frac{x}{\sqrt{2}}\right) = \frac{4 - x^2}{2}$

$y^2 + \frac{x^2}{2} - \sqrt{2}xy = 2 - \frac{x^2}{2}$

$y^2 + x^2 - \sqrt{2}xy = 2$

$$\boxed{x^2 + y^2 - \sqrt{2}xy - 2 = 0}$$ Ans

eq^n of ellipse



Ans. a

Solution: 10

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

$$\frac{\Delta T}{T}\% = 100\%$$

if $l' = l + 3l$

$$l' = 4l$$

$$T' = 2\pi\sqrt{\frac{l'}{g}} = 2\pi\sqrt{\frac{4l}{g}}$$

$$T' = 2\left(2\pi\sqrt{\frac{l}{g}}\right)$$

$$T' = 2T$$

$$\frac{\Delta T}{T}\% = \frac{2T - T}{T} \times 100 = \frac{T}{T} \times 100$$

Ans. a

Solution: 11

$l_1 = 200\,cm$
$= 2\,m$

$l_2 = 220.5\,cm$
$= 2.205\,m$

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

$T \propto \sqrt{l}$ $\left(\because l_1 < l_2 \Rightarrow T_1 < T_2\right)$

$\frac{T_1}{T_2} = \sqrt{\frac{l_1}{l_2}}$

$\frac{T_1}{T_2} = \sqrt{\frac{200}{220.5}}$

$\frac{T_1}{T_2} = \sqrt{\frac{2000}{2205}}$

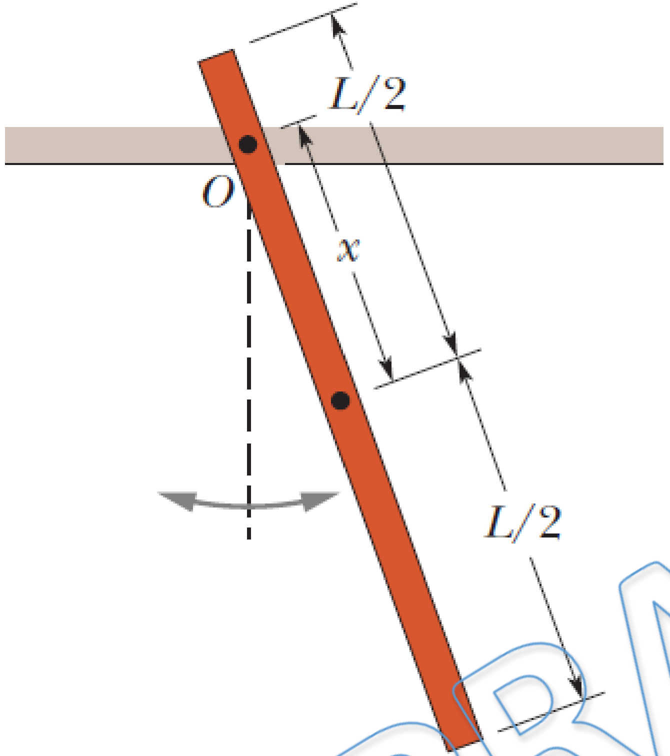
$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{400}{441}}$

$\frac{T_1}{T_2} = \frac{20}{21}$

$$\boxed{21T_1 = 20T_2}$$

Ans. b

Solution: 12



MoI of Rod about Point 'O':

$$I_o = \frac{ml^2}{12} + mx^2$$

& Time period of a physical pendulum

$$T = 2\pi\sqrt{\frac{I}{mgl}}$$

$$T = 2\pi\sqrt{\frac{\frac{ml^2}{12} + mx^2}{mgx}} = 2\pi\sqrt{\frac{l^2/12 + x^2}{gx}}$$

$$\boxed{T = 2\pi\sqrt{\frac{l^2 + 12x^2}{12gx}}}$$ or $$T = 2\pi\left(\frac{l^2}{12gx} + \frac{x}{g}\right)^{1/2}$$

for min (T); $\frac{dT}{dx} = 0$

$$\frac{dT}{dx} = 2\pi \times \frac{1}{2}\left[\frac{l^2}{12gx} + \frac{x}{g}\right]^{-1/2} \cdot \left[\frac{-l^2}{12gx^2} + \frac{1}{g}\right] = 0$$

$$\Rightarrow \frac{-l^2}{12gx^2} + \frac{1}{g} = 0 \Rightarrow \frac{l^2}{12x^2} = 1 \Rightarrow 12x^2 = l^2$$

$$\boxed{x = l/\sqrt{12}}$$

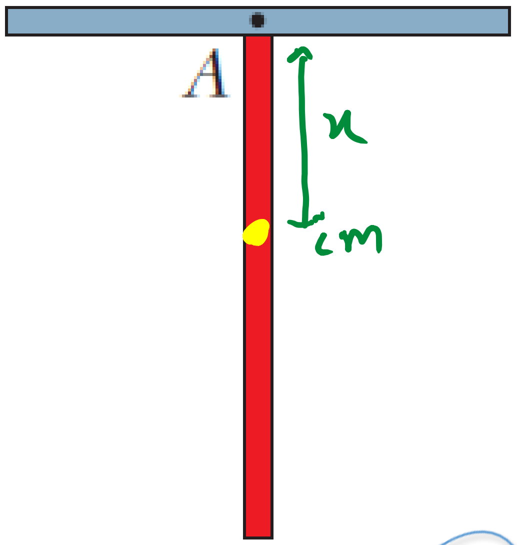
So, $$T_{min} = 2\pi\left(\frac{l^2}{12g\, l/\sqrt{12}} + \frac{l/\sqrt{12}}{g}\right)^{1/2} = 2\pi\left(\frac{l}{\sqrt{12}g} + \frac{l}{\sqrt{12}g}\right)^{1/2}$$

$$= 2\pi\left(2\frac{l}{\sqrt{12}g}\right)^{1/2} = 2\pi\left(\frac{2l}{2\sqrt{3}g}\right)^{1/2}$$

$$\boxed{T_{min} = 2\pi\sqrt{\frac{l}{\sqrt{3}g}}}$$ Ans

Ans. a

Solution: 13



$T = 2\pi\sqrt{\frac{I}{Mgx}}$

MoI of system about Point 'A'

$I_A = \frac{ml^2}{12} + \frac{ml^2}{3} = \frac{5ml^2}{12}$

$T = 2\pi\sqrt{\frac{5ml^2/12 \times 3}{(2m)g(l/4)}} = 2\pi\sqrt{\frac{5l}{6g}}$

$T = 2\pi\sqrt{\frac{5l}{6g}}$ Ans

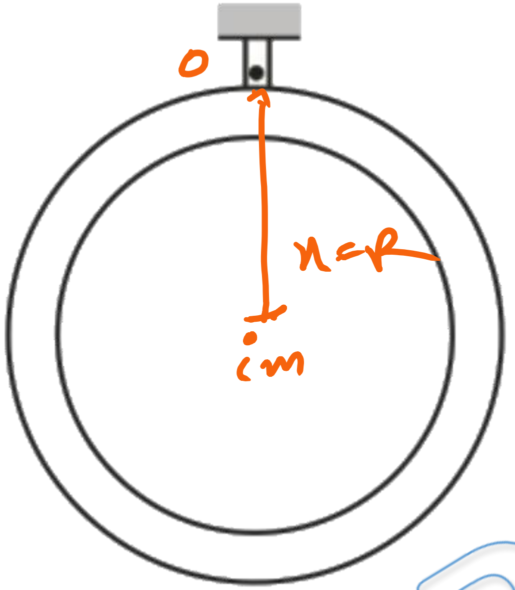
Distance of com of system from point 'A' $= x$

$x = \frac{m\left(\frac{l}{2}\right) + m(0)}{m+m}$

$x = \frac{l}{4}$

Ans. a

Solution: 14



MoI about point 'O'

$I_o = mR^2 + (mR^2)$

$I_o = 2mR^2$

$T = 2\pi\sqrt{\frac{I}{mgx}}$

$T = 2\pi\sqrt{\frac{2mR^2}{mg(R)}}$

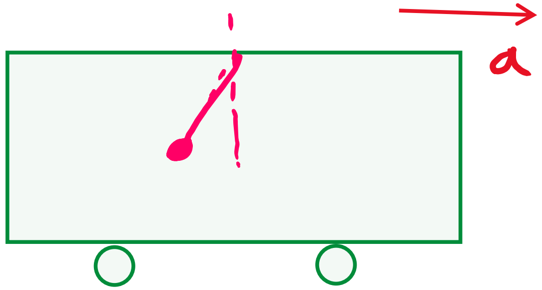
$T = 2\pi\sqrt{\frac{2R}{g}}$

$\frac{2\pi}{\omega} = 2\pi\sqrt{\frac{2R}{g}}$

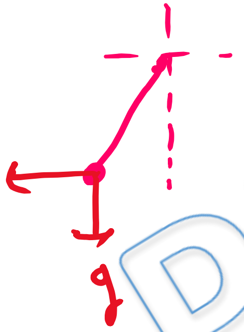
$\omega = \sqrt{\frac{g}{2R}}$ Ans

Ans. c

Solution: 15



w.r.t. train;



$g_{eff} = \sqrt{g^2 + a^2}$

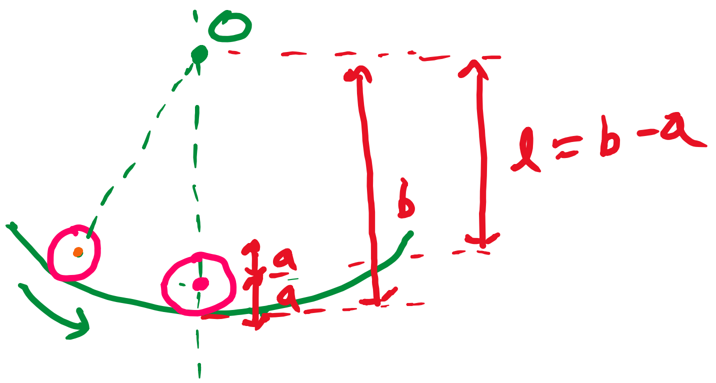
$T = 2\pi\sqrt{\frac{l}{g_{eff}}}$

$T = 2\pi\sqrt{\frac{l}{\sqrt{g^2+a^2}}}$

$\Rightarrow$ $\boxed{T = 2\pi\sqrt{\frac{l}{\sqrt{g^2+a^2}}}}$ Ans.

Ans. c

Solution: 16



$$T = 2\pi\sqrt{\frac{b-a}{g}}$$ Ans.

$$T = 2\pi\sqrt{\frac{I}{mgl}}$$

$$l = b - a$$

MoI about point 'O'

$$I = m(b-a)^2$$

$$T = 2\pi\sqrt{\frac{m(b-a)^2}{mg(b-a)}}$$

Ans. b

Solution: 17

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

$$T' = 2\pi\sqrt{\frac{l'}{(g/6)}}$$

for $T' = T$

$$2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{6l'}{g}}$$

$$\sqrt{6l'} = \sqrt{l}$$

$$l' = \frac{l}{6}$$

$l = 1m$

$$\boxed{l' = \frac{1}{6}m}$$ Ans.

Ans. a

Solution: 18

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

$\frac{\Delta T}{T}\% = \frac{1}{2}\frac{\Delta l}{l}\%$

$= \frac{1}{2} \times 2\%$

$\frac{\Delta T}{T}\% = 1\%$

$\Delta T = T \times 1\%$

$= T \times \frac{1}{100}$

$= \frac{(24 \times 60 \times 60)}{100}$

$\Delta T = 864 \text{ sec}$ Ans.

Ans. d

Solution19:

As pendulum is falling freely, means it does not oscillate at all.

Ans. c

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