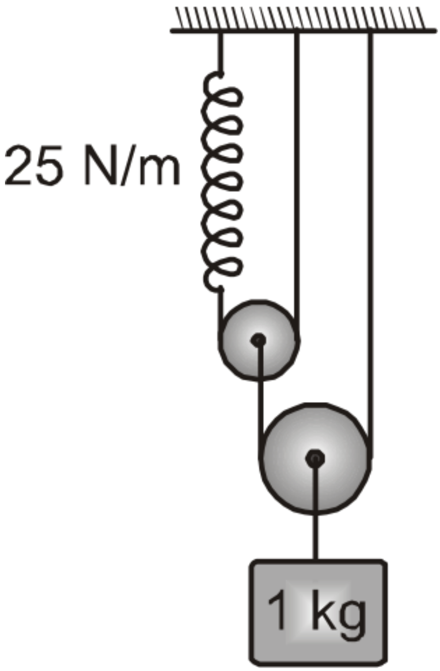
## Q-1 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS

Find the natural frequency of oscillation of the system as shown in figure. Pulleys are massless and frictionless. Spring and string are also massless. (Take $\pi^2 = 10$)



(A) $\frac{\pi}{2} Hz$

(B) $\sqrt{\pi} Hz$

(C) $\frac{10}{\sqrt{\pi}} Hz$

(D) $\pi Hz$

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Correct Option : D

**SOLUTION**

Let mass \'m\' falls down by x so spring extends by 4x ,

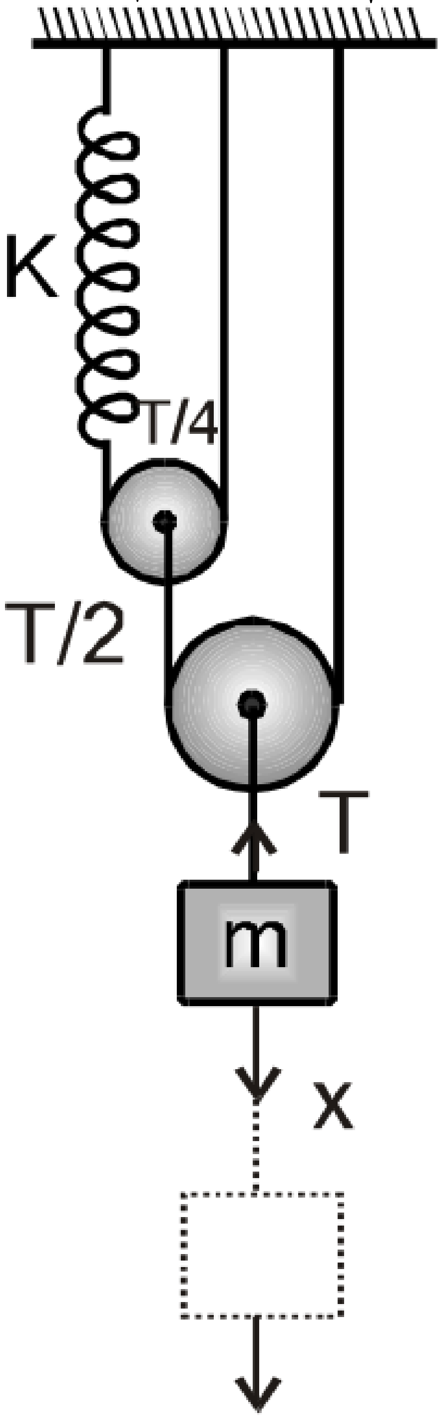
$\therefore \frac{T}{4} = k(4x)$

T=(16 k)x

Where T is the restoring force on mass m

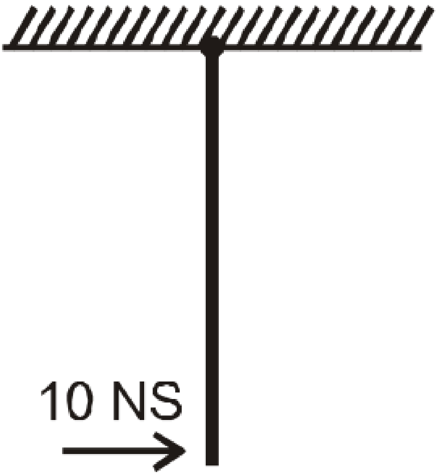
$\therefore F = \frac{1}{2\pi} \sqrt{\frac{16k}{m}}$

$$f=\frac{2}{\pi}\sqrt{\frac{k}{m}}=\frac{2}{\pi}\times\sqrt{\frac{25}{1}}=\pi Hz$$



**Q-2 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A thin uniform straight rod of mass 2 kg and length 1 m is free to rotate about its upper end. When at rest it receives an impulsive blow of 10 Ns at its lowest point, normal to its length as shown in figure. The kinetic energy of rod just after impact is




(A) 75 J

(B) 100 J

(C) 200 J

(D) 50 J

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Correct Option : A

## SOLUTION

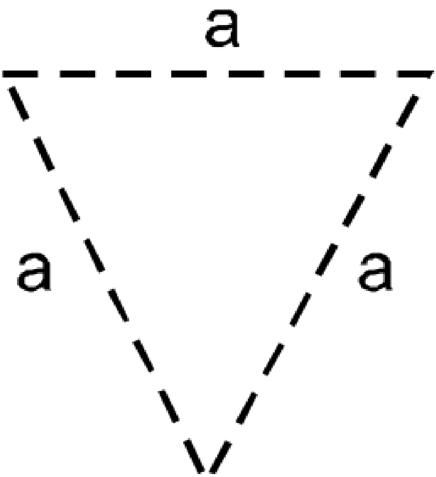
Apply C.O.A.M

$$10 \times 1 = \frac{ML^2}{3}\omega, \omega = 15rad. K. E. = \frac{1}{2}I\omega^2 = 75J$$



### Q-3 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS

All sides of an equilateral triangle are diameter of three identical uniform semi- circular rings each of mass m. Plane of each ring is perpendicular to the plane of paper. Then moment of inertia of this system of three semicircular rings about an axis through centroid of triangle and perpendicular to plane of paper is :




(A) $\dfrac{5ma^2}{24}$

(B) $\dfrac{5ma^2}{16}$

(C) $\dfrac{5ma^2}{8}$

(D) $\dfrac{5ma^2}{6}$

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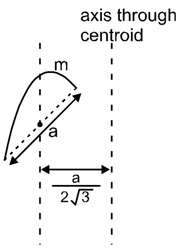
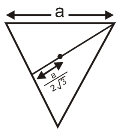
Correct Option : C

## SOLUTION



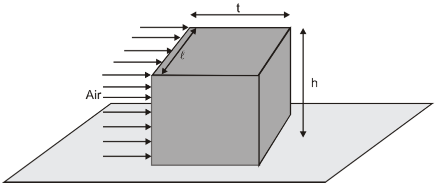

$$I' = I_{cm} + m\left(\frac{a}{2\sqrt{3}}\right)^2 = \frac{5ma^2}{24} = I_{cm} = \frac{m\left(\frac{a}{2}\right)^2}{2} = \frac{ma^2}{8}$$

$$I = 3I' = \frac{5ma^2}{8}$$



**Q-4 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A block of dimensions lxtxh and uniform density $\rho_w$ rests on a rough floor. Wind blowing with speed V and of density $\rho_a$ falls perpendicularly on one face of dimension lxh of the block as shown in figure. Assuming that air is stopped when it strikes the wall and there is sufficient friction on the ground so that the block does not slide, the minimum speed V so that the block topples is :




(A) $\left(\dfrac{\rho_w g}{\rho_a h}\right)^{1/2} t$

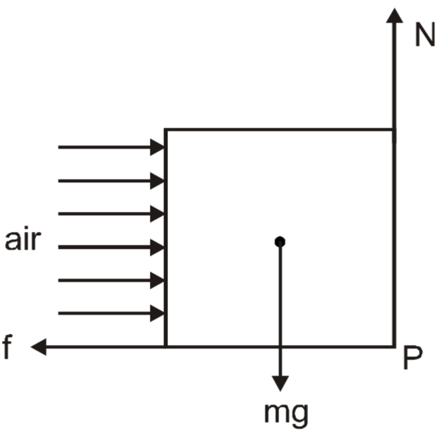
(B) $\left(\dfrac{\rho_a g}{\rho_w h}\right)^{1/2} t$

(C) $\left(\dfrac{g}{h}\right)^{1/2} g$

(D) None of these

Correct Option : A

**SOLUTION**



$$F = V\frac{dm}{dt} = \rho_a lhV.\,V = \rho_a lhV^2 \left\{ \therefore \frac{dm}{dt} = \rho_a lhV \right\}$$

Total torque of air about point P is $\rho_a lhV^2 \frac{h}{2}$

$$\tau_a = \frac{\rho_a lh^2V^2}{2}, \tau_w = Mg\frac{.1}{2} = \rho_w l.\,h.\,t.\,g\frac{t}{2}$$

for toppling $\tau_a > \tau_w \Rightarrow V > \left(\frac{\rho_\omega g}{\rho_A h}\right)^{1/2}.\,t$



**Q-5 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

An oscillation is superposition of three harmonic oscillations and decribed by the equation $x = A\sin 2\pi v_1$ where A changes with time according to $A = A_0(1 + \cos 2\pi v_2 t)$ with $A_0$ to be constant. The frequencies of pure harmonic oscillations forming this oscillation are

(A) $v_1, v_2, |v_1 - v_2|$

(B) $v_1, |v_1 - v_2|, v_1 + v_2$

(C) $v_1, v_2, |v_2 - v_1|$

(D) $v_1, v_2, v_1 + v_2$

Correct Option : B

**SOLUTION**

$x = A_0(1 + \cos 2\pi \upsilon_2 t). \sin 2\pi \upsilon_1 t$

$= A_0 \sin 2\pi \upsilon_1 t + \frac{A_0}{2}[(\sin 2\pi(\upsilon_1 + \upsilon_2)t + \sin 2\pi(\upsilon_1 - \upsilon_2)t]$

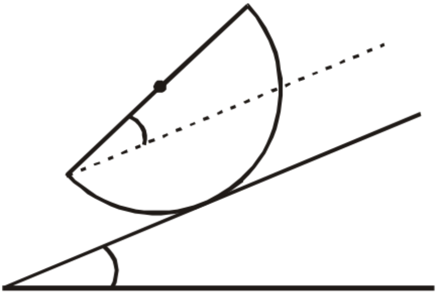
Hence frequency are

$\upsilon_1 |\upsilon_1 - \upsilon_2|. \upsilon_1 + \upsilon_2$



**Q-6 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform thin hemispherical shell is kept at rest and in equilibrium on an inclined plane of angle of inclination $\theta = 30$ as shown inf figure. If the surface of the inclined plane is sufficiently rough to prevent sliding then the angle $\alpha$ made by the plane of hemisphere with inclined plane is :



(A) Value of $\mu$ is needed

(B) $30^\circ$

(C) $45^\circ$

(D) $60^\circ$

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Correct Option : D

**SOLUTION**

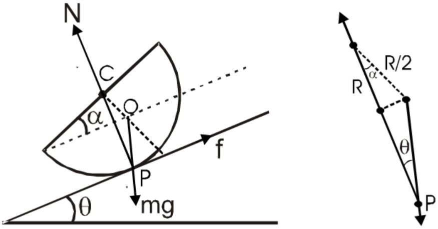
O is the centre of mass of the hollow hemisphere and is R/2 from C

$f = mg\sin\theta \ldots . (i)$

$N = mg\cos\theta \ldots . (2)$

$N \times \frac{R}{2}\sin\alpha = \left[R - \frac{R}{2}\cos\alpha\right] f \ldots . (3)$

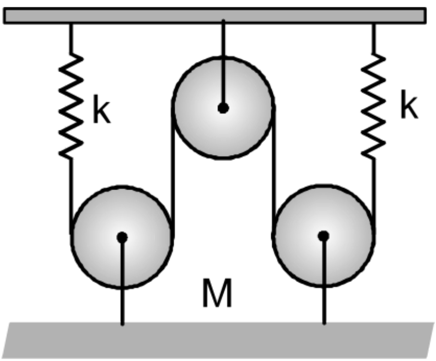
$$\therefore \tan\theta = \frac{\sin\alpha}{2-\cos\alpha} \Rightarrow \alpha = 30$$






**Q-7 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

The natural frequency of the system shown in figure is: {The pulleys are smooth and massless.}




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

(B) $\frac{2}{\pi}\sqrt{\frac{2k}{M}}$

(C) $\frac{1}{\pi}\sqrt{\frac{k}{M}}$

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

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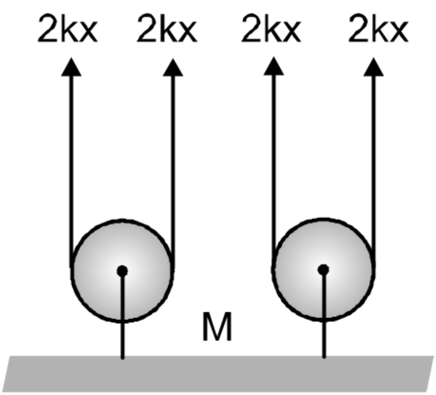
Correct Option : A

**SOLUTION**

If the mass M is dissipated by x from its mean position each spring further stretched by 2x




Net restoring force

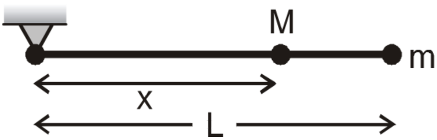
F=-8kx

M.a=-8kx

$$f=\frac{1}{2\pi}\sqrt{\left|\frac{a}{x}\right|}=\frac{1}{2\pi}\sqrt{\frac{8k}{M}}=\frac{1}{\pi}\sqrt{\frac{2k}{M}}$$

Q-8 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS

A massless stick of length L is hinged at one end and a mass m attached to its other end. The stick is free to rotate in vertical plane about a fixed horizontal axis passing through frictionless hinge. The stick is held in a horizontal position. At what distance x from the hinge should a second mass M = m be attached to the stick, so that stick falls as fast as possible when released from rest




(A) $\sqrt{2}L$

(B) $\sqrt{3}L$

(C) $\left(\sqrt{2}-1\right)L$

(D) $\left(\sqrt{3}-1\right)L$

Correct Option : C

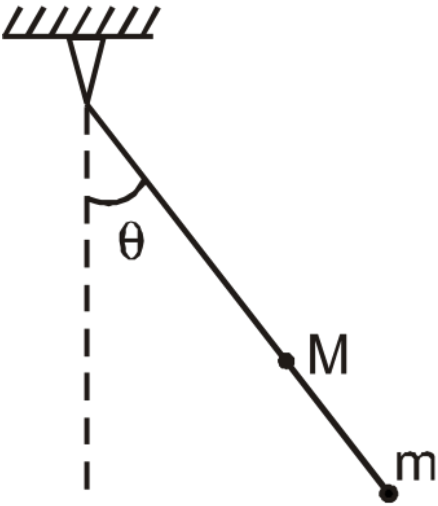
**SOLUTION**

Angular acceleration or rod

$$\alpha = \frac{m(x+L)g\sin\theta}{m(x^2+L^2)}$$

For rod to fall as fast as possible, $\frac{d\alpha}{dx} = 0$

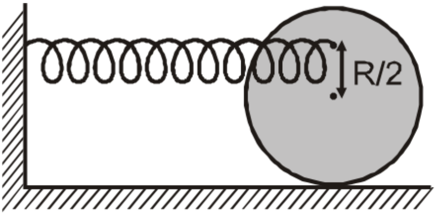
or $x = (\sqrt{2} - 1)L$






**Q-9 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform disc of mass m is attached to a spring of spring constant k as shown in figure and there is sufficient friction to prevent slipping of disc. Time period of small oscillations of disc is:




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

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

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

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

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Correct Option : B

**SOLUTION**

Let centre of disc is displaced by x from its equilibrium position (spring was in its natural length). Now calculate the torque about lowest point of disc.

$$k\frac{.3}{2}R.\ \frac{3x}{2} = \frac{3}{2}mR^2\frac{a}{R}$$

$$\frac{3kx}{2m} = a$$

So, $T = 2\pi\sqrt{\frac{2m}{3k}}$



**Q-10 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A particle is executing simple harmonic motion in a conservative force field. The total energy of simple harmonic motion is given by $E = ax^2 + bv^2$ where x is the displacement from mean position x = 0 and v is the velocity of the particle at x then choose the INCORRECT statements. {Potential energy at mean position is assumed to be zero}

(A) amplitude of S.H.M. is $\sqrt{\frac{E}{a}}$

(B) Maximum velocity of the particle during S.H.M. is $\sqrt{\frac{E}{b}}$

(C) Time period of motion is $2\pi\sqrt{\frac{b}{a}}$

(D) displacement of the particle is proportional to the velocity of the particle.

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Correct Option : D

**SOLUTION**

Amplitude is obtained for v=0

$$\therefore A=\sqrt{\frac{E}{a}}$$

maximum velocity is obtained for x=0

$$V_{\max }=\sqrt{\frac{E}{b}} V_{\max }=A \omega$$

$$\omega=\frac{\sqrt{\frac{E}{b}}}{\sqrt{\frac{E}{a}}}=\sqrt{\frac{a}{b}}$$

$$T=\frac{2 \pi}{\omega}=2 \pi \sqrt{\frac{b}{a}}$$

Alternative

$$E=\frac{1}{2} m v^{2}+\frac{1}{2} k x^{2}$$

$$b=\frac{m}{2}, a=\frac{k}{2}$$

$$\omega=\sqrt{\frac{k}{m}}=\sqrt{\frac{a}{b}}$$

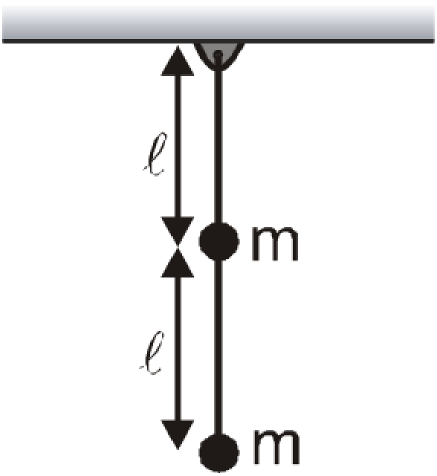
$$E=\frac{1}{2}mv_{\max}^2 \Rightarrow V_{\max}=\sqrt{\frac{E}{b}}$$

$$E=\frac{1}{2}lA^2A=\sqrt{\frac{E}{a}}$$



**Q-11 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

Two particle of mass m each are fixed to a massless rod of length 2l . The rod is hinged at one end about a smooth hinge and it performs oscillations of small angle in vertical plane. The length of the equivalent simple pendulum is:




(A) $\frac{3l}{2}$

(B) $\frac{10l}{3}$

(C) $\frac{5l}{3}$

(D) None of these

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Correct Option : C

## SOLUTION

$$T = 2\pi\sqrt{\frac{I}{mgl}}, I = ml^2 + m(2l)^2 = 5ml^2$$

$$= 2\pi\sqrt{\frac{5ml^2}{2m\frac{g\left(3l\right)}{2}}} = 2\pi\sqrt{\frac{5l}{3g}}$$

$$\therefore L_{eq} = \frac{5l}{3}$$



**Q-12 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

Two copper balls of radius r and 2r are released at rest in a long tube filled with liquid of uniform viscosity. After some time when both the spheres acquire critical velocity (terminal velocity) then ratio of viscous force on the balls is :

(A) $1:2$

(B) $1:4$

(C) $1:8$

(D) 1:18`

Correct Option : C

**SOLUTION**

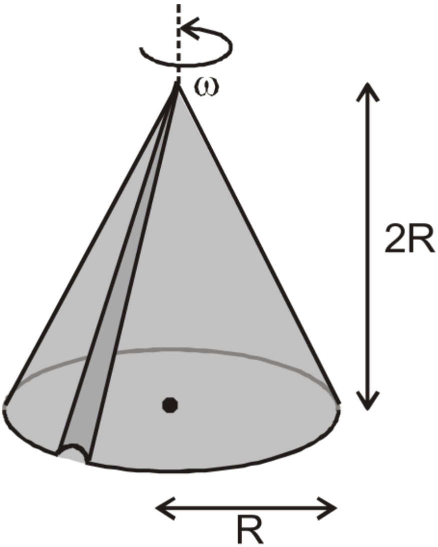
$$Mg - f_B = F_v$$

$$\Rightarrow \frac{4}{3}\pi r^3(\rho_m - \rho_l)g = F_v$$



**Q-13 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform solid cone of mass m, base radius R and height 2R, has a smooth groove along its slant height as shown in figure. The cone is rotating with angular speed $\omega$, about the axis of symmetry. If a particle of mass m is released from apex of cone, to slide along the groove, then angular speed of cone when particle reaches to the base of cone is




(A) $\frac{3\omega}{13}$

(B) $\frac{4\omega}{13}$

(C) $\frac{5\omega}{13}$

(D) $\frac{9\omega}{13}$

Correct Option : A

**SOLUTION**

Initially

$$I_1 = \frac{3}{10} mR^2 \& \omega_1 = \omega$$

Finally $I_2 = \dfrac{13}{10} mR^2 \& \omega_2 = \omega_{\text{new}}$

Using conservation of anular momentum

$$I_1\omega_1 = I_2\omega_2$$

$$\omega_2 = \omega_{\text{new}} = \frac{3\omega}{13}$$



**Q-14 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform metal rod (fixed at both ends) of $2mm^2$ cross-section is cooled from $40C$ to $20C$. The co- efficient of the linear expansion of the rod is $12 \times 10^{-6}$ per degree & its young modulus of elasticity is $10^{11} N/m^2$. The energy stored per unit volume of the rod is:

(A) $2880 J / m^3$

(B) $1500 J / m^3$

(C) $5760 J / m^3$

(D) $1440 J / m^3$

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Correct Option : A

**SOLUTION**

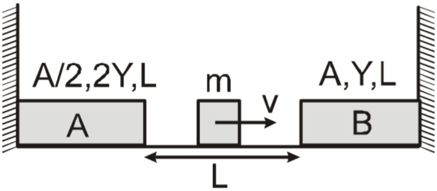
Energy Density =1/2 stress x strain =1/2Y $(\text{strain})^2 = 2880 J / m^3$



**Q-15 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

In the given figure, two elastic rods A & B are rigidly joined to end supports. A small block of mass m is moving with velocity v between the rods. All collisions are assumed to be elastic & the surface is given to be smooth. The time period of oscillations of small mass m will be:

(A = area of cross section, Y = youngs modulus, L = length of each rod)




(A) $\dfrac{2L}{v}+2\pi\sqrt{\dfrac{mL}{AY}}$

(B) $\dfrac{2L}{v}+2\pi\sqrt{\dfrac{2mL}{AY}}$

(C) $\dfrac{2L}{v}+\pi\sqrt{\dfrac{mL}{AY}}$

(D) $\dfrac{2L}{v}$

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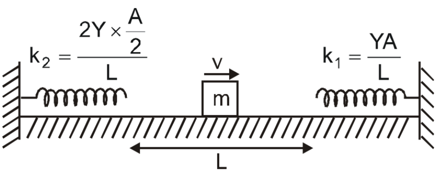
Correct Option : A

## SOLUTION

Rod behaves as spring constant $\dfrac{YA}{l}$

Equivalent system is



The time period of oscillations of block is

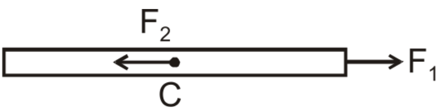
$$T = \frac{2L}{V} + \frac{1}{2}\left(2\pi\sqrt{\frac{mL}{YA}}\right) + \frac{1}{2}\left(2\pi\sqrt{\frac{mL}{2Y.A/2}}\right)$$

$$= \frac{2L}{V} + 2\pi\left(\frac{mL}{AY}\right)$$



**Q-16 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

Two forces $F_1$ and $F_2$ act on a thin uniform elastic rod placed in space. Force $F_1$ acts at right end of rod and $F_2$ acts exactly at centre of rod as shown (both forces act parallel to length of the rod).




$(i) F_1$ causes extension of rod while $F_2$ causes compression of rod.

(ii) $F_1$ causes extension of rod and $F_2$ also causes extension of rod.

(iii) $F_1$ causes extension of rod while $F_2$ does not change total length of rod.

The correct order of True/False in above statements is

(A) TFF

(B) FTF

(C) FFT

(D) FFF

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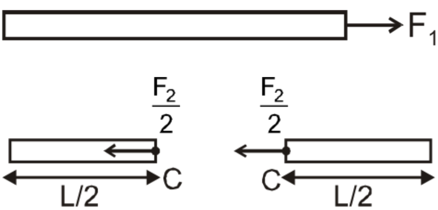
Correct Option : C

## SOLUTION

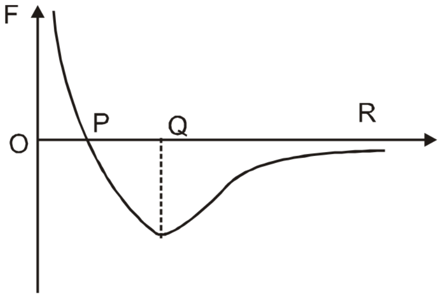
The force $F_1$ causes extension in rod. $F_2$ causes compression in left of rod and an equal extension in right half of rod. Hence $F_2$ does not effectively change length of the rod.






**Q-17 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

Figure shows roughly how the force F between two adjacent atoms in a solid varies with inter atomic separation r. Which of the following statements are correct ?




(A) OQ is the equilibrium separation.

(B) Hooke\'s law is obeyed near P.

(C) The potential energy of the atoms is the gradient of the graph at all points.

(D) The energy to separate the atoms completely is obtained from the magnitude of the area enclosed below the axis of r.

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Correct Option : BD

## SOLUTION

Since F-r curve is continuous, so $\left.\frac{dF}{dr}\right|_{-}(P^{+}) = \left.\frac{dF}{dr}\right|_{P^{-}} = \frac{dF}{dr}|_P = -\alpha$ and F (at P) =0 so

Hooke\'s law valid near point P.

Energy required to separate the atoms =$|\Delta U| = \left|-\int \vec{F} . \vec{dr}\right| =$ |Area enclosed between curve and r-axis|



**Q-18 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A particle constrained to move along x-axis given a velocity u along the positive x-axis. The acceleration \' a \' of the particle varies as a = -bx, where b is a positive constant and x is the x co-ordinate of the position of the particle . Then select the correct alternative(s): .

(A) The maximum displacement of the particle from the starting point is $\frac{u}{\sqrt{b}}$

(B) The particle will oscillate about the origin

(C) Velocity is maximum at the origin

(D) Given data is insufficient to determine the exact motion of the particle.

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Correct Option : ABC

**SOLUTION**

$$(A) \therefore \frac{dv}{dt} = -bx = v\frac{dv}{dx}$$

$$\int_u^0 vdv = \int_0^x -bxdx$$

$$\Rightarrow \frac{v^2}{2}\Big|_{-}(u)^0 = -b\frac{x^2}{2}\Big|_0^x$$

$$\Rightarrow -\frac{u^2}{2} = -\frac{bx^2}{2} \Rightarrow x = \frac{u}{\sqrt{b}}$$

$$B = F = m(-bx)$$

$$a = -bx = -\omega^2 x$$

(C) acceleration is always towards origin and acceleration is zero at origin which is the mean position of SHM

## Q-19 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS

A uniform ring having mass m, radius R, cross section area of the wire A and youngs modulus Y is rotating with an angular speed $\omega$($\omega$ is small) on a smooth horizontal surface. Which of the following options is correct :

(A) Tension in the wire is $\dfrac{mR\omega^2}{2\pi}$

(B) Change in length of the wire is $\dfrac{mR^2\omega^2}{2A.Y}$

(C) Change in radius of the ring is $\dfrac{mR^2\omega^2}{2\pi A.Y}$

(D) elastic potential energy stored is $\dfrac{1}{4\pi}\left(\dfrac{m^2\omega^4R^3}{A.Y}\right)$

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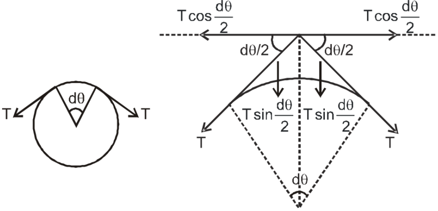
Correct Option : ACD

**SOLUTION**

Let T be the tension in the string




$$2T\frac{\sin(d\theta)}{2} = \frac{m}{2\pi R} \times R.\omega^2.Rd\theta$$

$$T = \frac{mR\omega^2}{2\pi}$$

$$Y = \frac{T/A}{\Delta l/l}$$

$$\frac{\Delta l}{l} = \frac{T}{Y.A} \Rightarrow \Delta l = \frac{T}{Y.a} \times l = \frac{m.R\omega^2}{2\pi} \times \frac{1}{Y.A} \times 2\pi R = \frac{m.}{Y}$$

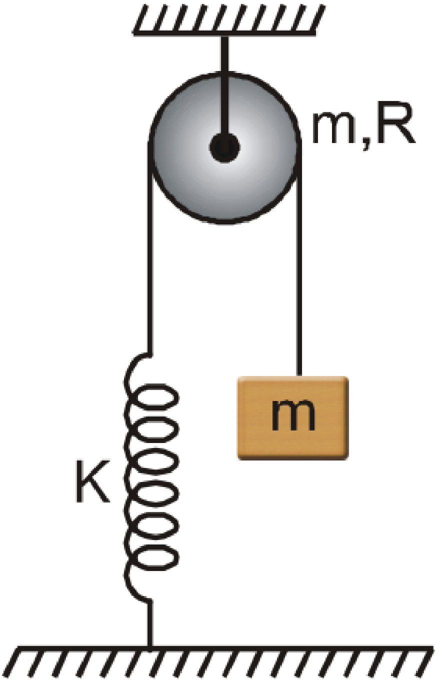
$$\frac{\Delta l}{l} = \frac{\Delta R}{R} = \frac{T}{Y.A} = \frac{m.R\omega^2}{2\pi A.Y} \Rightarrow \Delta R = \frac{mR^2\omega^2}{2\pi A.Y}$$

$$V = \frac{1}{2}K.X^2 = \frac{1}{2}\left(\frac{Y.A.}{l}\right) \times (\Delta l)^2 = \frac{1}{2}\frac{Y.A}{2\pi R} \times \left(\frac{m.R^2\omega^2}{Y.A}\right)^2$$



**Q-20 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform disc of mass m and radius R is free to rotate about its fixed horizontal axis without friction. There is sufficient friction between the inextensible light string and disc to prevent slipping of string over disc. At the shown instant extension in light spring is $\frac{3mg}{K}$, where m is mass of block, g is acceleration due to gravity and K is spring constant. Then select the correct alternative(s).




(A) Acceleration of block just after it is released is $\frac{4g}{3}$

(B) Tension in the string continuously increases till extension in the spring reaches maximum value.

(C) Acceleration of the block just after releases $\frac{3}{4}g$

(D) Angular acceleration of disc just after release is $\frac{4g}{3R}$

Correct Option : ABD

## SOLUTION

For disc, from torque equation

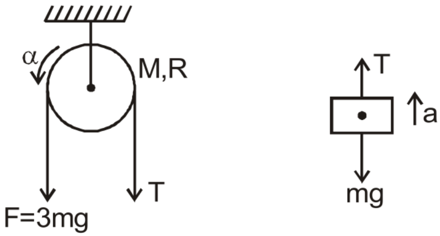
$$3mgR - TR = \frac{mR^2}{2}\alpha \ldots . (1)$$

By application of Newton\'s second law on block we get,

$$T - mg = ma \ldots . (2)$$

where $a = R\alpha \ldots (3)$

solving $a = \frac{4g}{3}$






**Q-21 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A solid glass hemisphere of density d and radius R lies (with curved surface of hemisphere below the flat surface) at the bottom of a tank filled with water of density $\rho$ such that the flat surface of hemisphere is H depth below the liquid surface. Weight of water + tank is $W_1$ and that of hemisphere is '$W_2$. W Then choose the incorrect options

(A) Force exerted by the liquid on the flat surface of hemisphere is independent of H and d but depends on R and $\rho$

(B) Force exerted by the liquid on the curved surface of hemisphere is independent of H and d but depends on R and $\rho$

(C) Force exerted by the liquid on the hemisphere is independent of H and d but depends on R and $\rho$

(D) Combined weight of water + tank + hemisphere with hemisphere inside water, taken by a weighing machine is equal to $W_1 + W_2$

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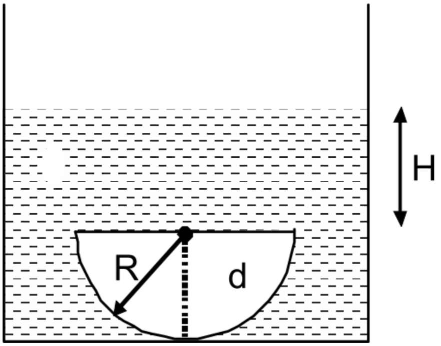
Correct Option : AB

**SOLUTION**




(a) Force on flat surface depends on H

(b) Pressure at the location of curved surface depends on H

(c) Net force on hemisphere by liquid $= \left(\frac{2}{3}\pi R^3\right)(\rho)g$



**Q-22 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A 20 gm particle is subjected to two simple harmonic motions

$x_1 = 2\sin 10t,$

$x_2 = 4\sin\left(10t + \frac{\pi}{3}\right)$. Where $x_1$ and $x_2$ are in meter & t is in sec.

(A) The displacement of the particle at t=0 will be $2\sqrt{3}m$

(B) Maximum speed of the particle will be $20\sqrt{7}m/s$.

(C) Magnitude of maximum acceleration of the particle will be $200\sqrt{7}m/s^2$

(D) Energy of the resultant simple harmonic motion will be 28 J

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Correct Option : ABCD

## SOLUTION

At t= 0

Displacement $x = x_1 + x_2 = 4\sin\left(\frac{\pi}{3}\right) = 2\sqrt{3}m.$

Resulting Amplitude

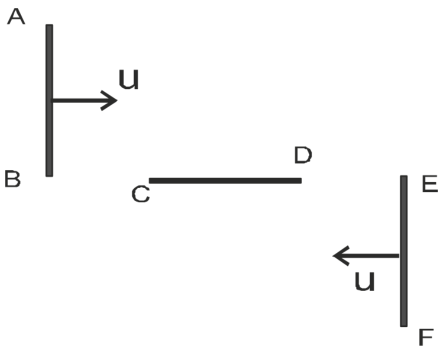
$A = \sqrt{2^2 + 4^2 + 2(2)(4)\cos\pi/3} = \sqrt{4+16+8} = \sqrt{28} = 2\sqrt{7}m$

Maximum speed $= A\omega = 20\sqrt{7}m/s$

Maximum acceleration $A\omega^2 = 200\sqrt{7}m/s^2$

Energy of the motion $= \frac{1}{2}m\omega^3 A^2 = 28J\,Ans.$

Three identical horizontal rods AB, CD and EF each of length 2m are on a smooth horizontal surface. Rod CD is at rest while the rods AB and EF are purely translating with equal and opposite velocities of magnitude 5 m/s.The ends B and E collide simultaneously with the ends C and D respectively, and the rods rigidly join just after the collisions.Find the angular speed of the system in rad/s just after the collision.




(A) 1

(B) 2

(C) 3

(D) 4

Correct Option : B

**SOLUTION**

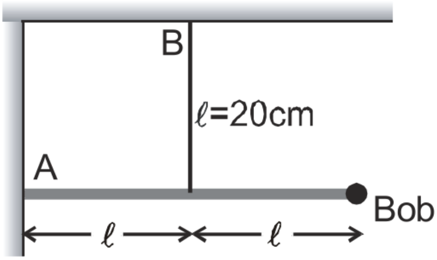
Applying conservation of the angular momentum of the system of three rods about midpoint of the rod CD

$$= m \times 5 \times 1 + m \times 5 \times 1 = \left[2\left(\frac{m2^2}{12} + m\left(\sqrt{2}\right)^2\right) + \frac{m2^2}{12}\right] \Rightarrow$$



**Q-24 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A weightless rigid rod with a small iron bob at the end is hinged at point A to the wall so that it can rotate in all directions. The rod is kept in the horizontal position by a vertical inextensible string of length 20 cm, fixed at its mid point. The bob is displaced slightly, perpendicular to the plane of the rod and string. Find period of small oscillations of the system in the form $\frac{\pi X}{10}$ sec. and fill value of X. $\left(g = 10m/s^2\right)$




(A) 1

(B) 2

(C) 3

(D) 4

Correct Option : D

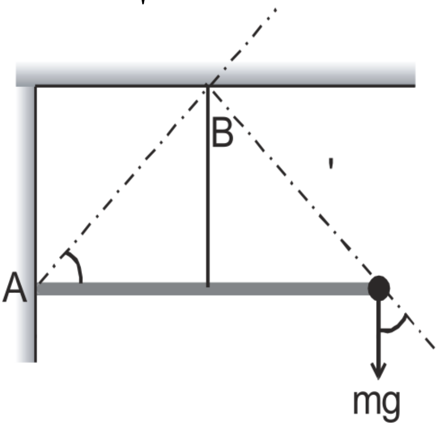
**SOLUTION**

The bob will execute SHM about a stationary axis passing through AB. If its effective length is l\' then $T = 2\pi\sqrt{\frac{l'}{g'}}$

$l' = l/\sin\theta = \sqrt{2}l$ (because $\theta = 45$)

$g' = g\cos\theta = g/\sqrt{2}$

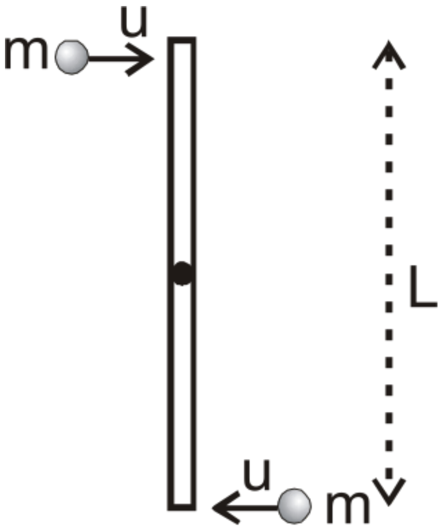
$$T = 2\pi\sqrt{\frac{2l}{g}} = 2\pi\sqrt{\frac{2 \times 0.2}{10}} = \frac{2\pi}{5}s$$






**Q-25 - JEE ADVANCED-PART TEST-16 (PHYSICS)-PHYSICS**

A uniform rod of mass 200 grams and length L = 1m is initially at rest in vertical position. The rod is hinged at centre such that it can rotate freely without friction about a fixed horizontal axis passing through its centre. Two particles of mass m = 100 grams each having horizontal velocity of equal magnitude u = 6 m/s strike the rod at top and bottom simultaneously as shown and stick to the rod. Find the angular speed (in rad/sec.) of rod when it becomes horizontal.




(A) 2

(B) 4

(C) 7

(D) 9

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Correct Option : D

**SOLUTION**

From conservation of angular momentum

$$mu\frac{L}{2}+mu\frac{L}{2}=\left[2m\frac{L^2}{12}+m\left(\frac{L}{2}\right)^2+\left(\frac{L}{2}\right)^2\right]\omega$$

$$muL = \left[\frac{mL^2}{6} + \frac{mL^2}{4} + \frac{mL^2}{4}\right]\omega = \frac{2mL^2}{3}\omega \text{ or}$$

$$\omega = \frac{3u}{2L} = \frac{3 \times 6}{2 \times 1} = 9rad/\sec$$