Topics To Be Covered

1. - Kinematics
2. - NLM + friction
3. - Circular
4. - WPE
5. - COM
6. - Rotation
7. - SHM
8. - Gravitation
9. Elasticity
10. Thermal Exp.
    Calorimetry
    Heat transfer (Conduction + Radiation)
11. KTG & thermodynamics
12. Wave
13. Fluid mechanics

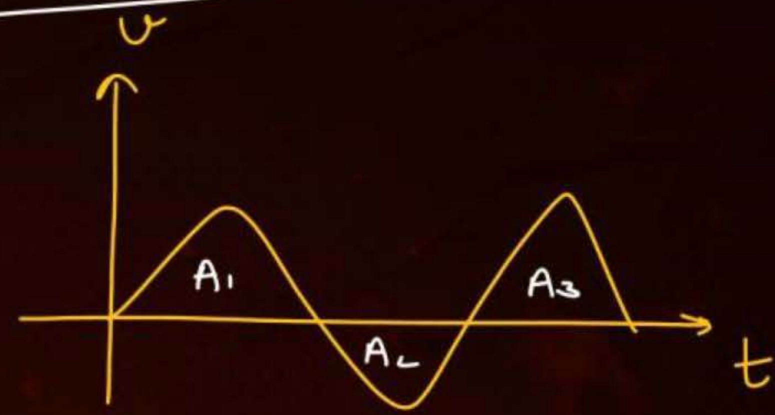
(Unit & Dim. & error)

Kinematics

* $\langle \vec{v} \rangle = \dfrac{\vec{d}}{t}$
* $\langle \vec{a} \rangle = \dfrac{\Delta \vec{v}}{\Delta t}$
* $a = v\dfrac{dv}{dx}$

$v_x = \dfrac{dx}{dt}$

$\vec{a} = \dfrac{d\vec{v}}{dt}$



Distance $= A_1 + A_2 + A_3$

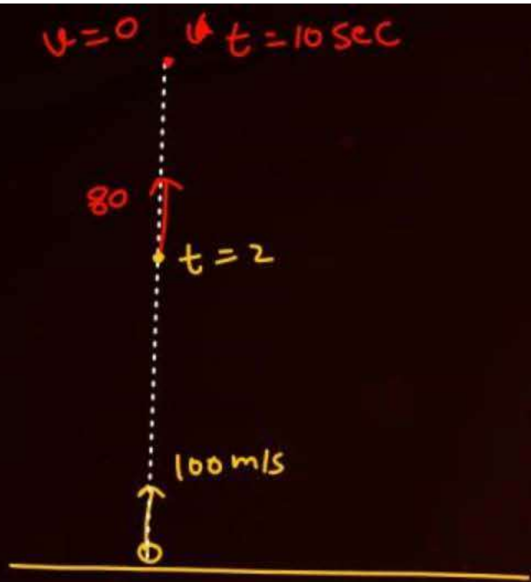
Displ. $= A_1 - A_2 + A_2$

Q $v = 3x^2$

find acc. at $x = 2$

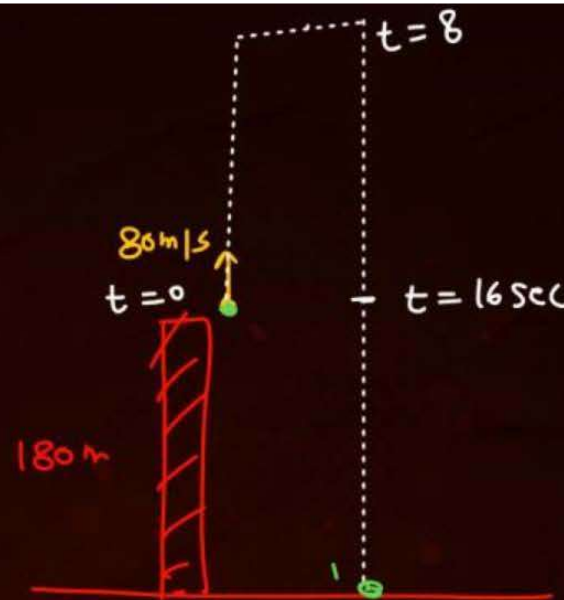
$6x = 6 \times 2 = 12$

$a = v\dfrac{dv}{dx} = 3x^2 \times 6x = 18x^3 = 144$



$$h = 100 \times 2 - \frac{1}{2} \times 10 \times 2^2$$
$$= 200 - 20 = 180$$

Q

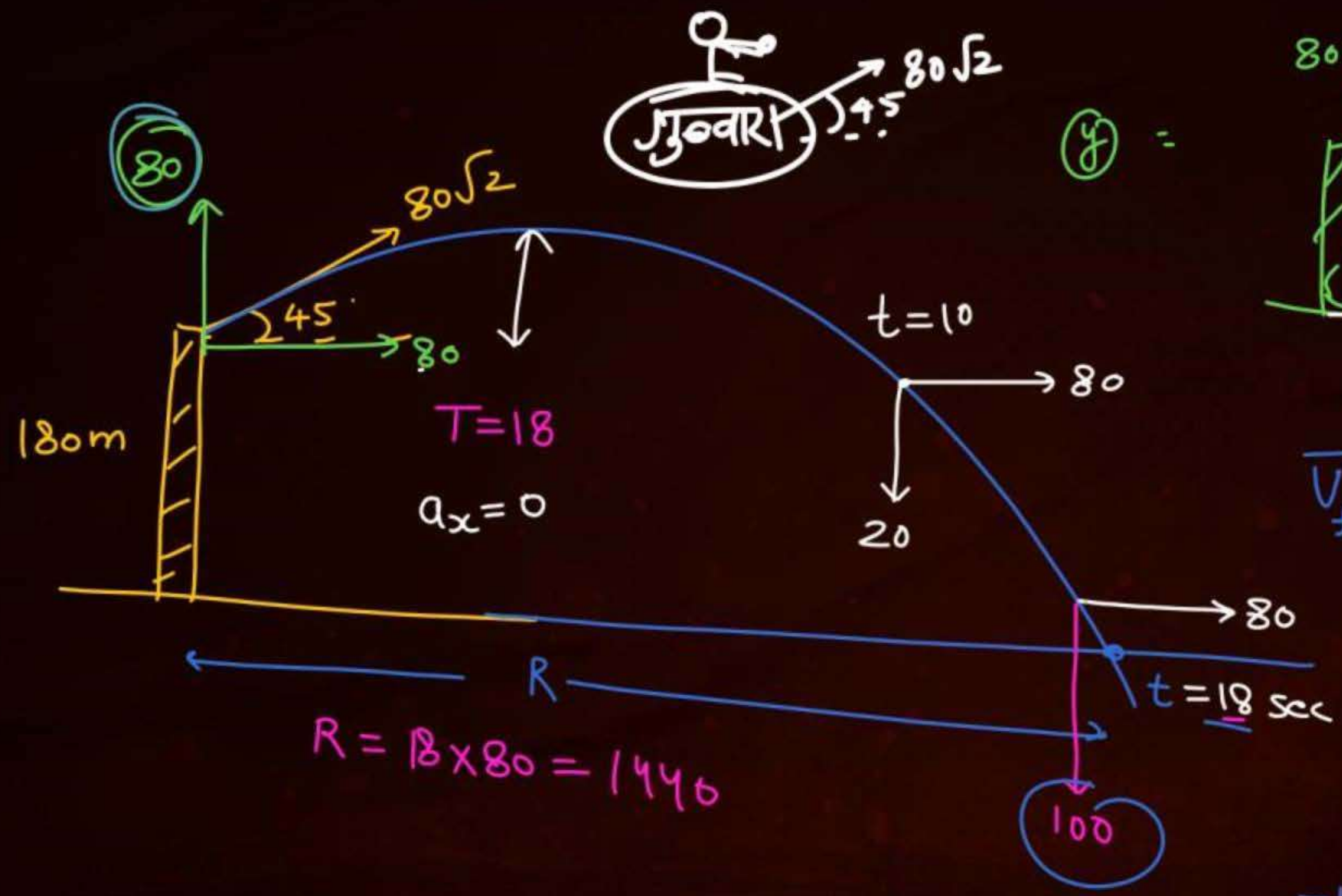


$\Rightarrow$

$$s = ut + \frac{1}{2}at^2$$

$$-180 = 80t + \frac{1}{2}(-10)t^2$$

$$t = 18\ \text{sec}$$

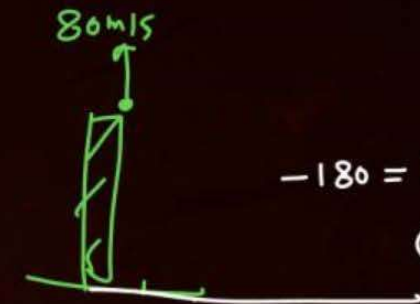


$T = 18$

$a_x = 0$

$R = 18 \times 80 = 1440$

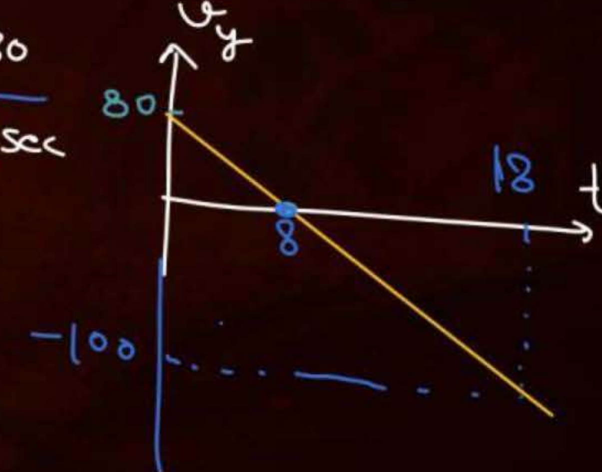
(y) :

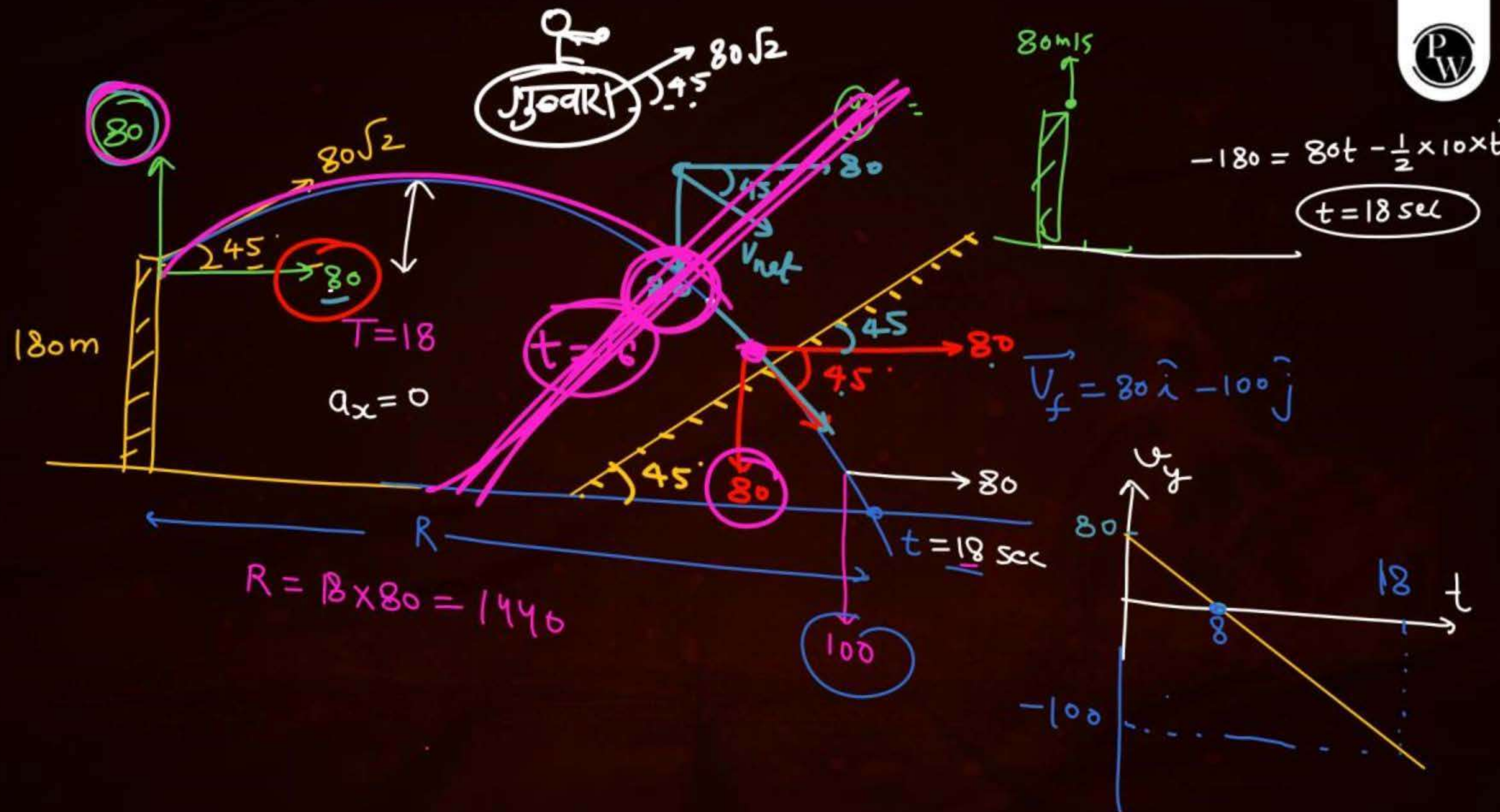


$-180 = 80t - \frac{1}{2} \times 10 \times t^2$

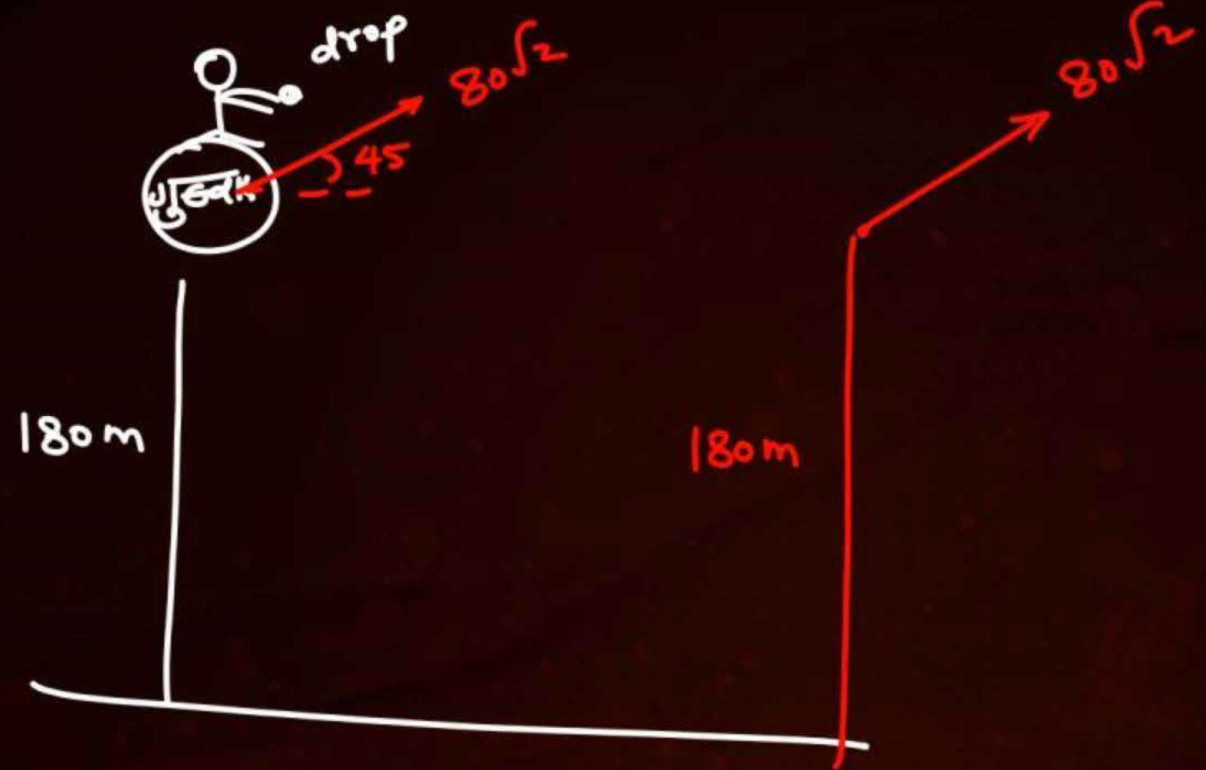
$t = 18\ sec$

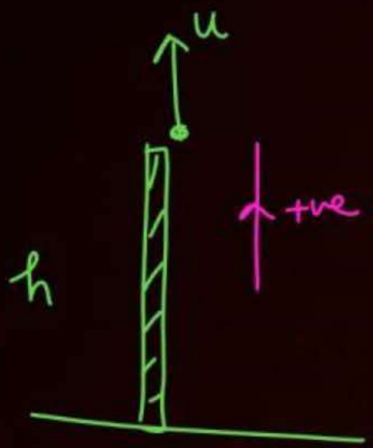
$\vec{V_f} = 80\hat{i} - 100\hat{j}$



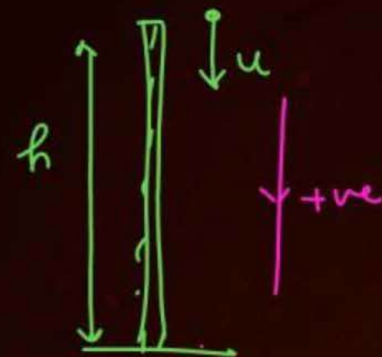


गुब्बारा
$80\sqrt{2}$
45°
80
$80\sqrt{2}$
45
80
180m
T=18
$a_x = 0$
80
45
V_{net}
45
80
45
$\vec{V_f} = 80\hat{i} - 100\hat{j}$
45
80
80
R
t = 18 sec
$R = 18 \times 80 = 1440$
100
80 m/s
$-180 = 80t - \frac{1}{2} \times 10 \times t^2$
t = 18 sec
v_y
80
18
t
8
-100

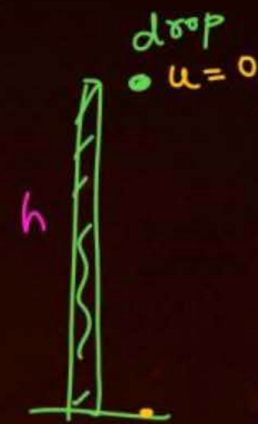

drop
80√2
45
180m
80√2
180m



$-h = ut - \frac{1}{2}gt^2$

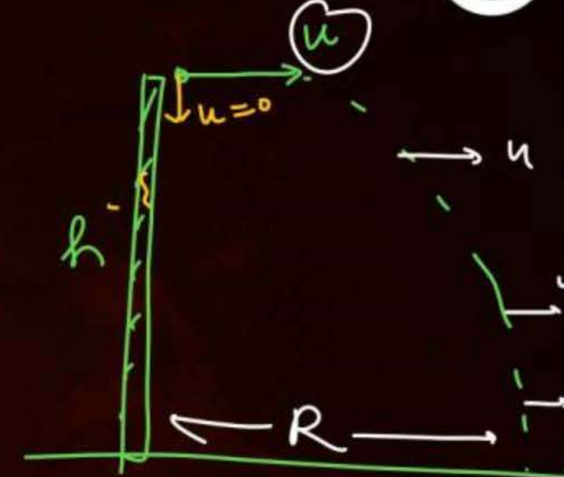


$+h = ut + \frac{1}{2}gt^2$



$h = 0 + \frac{1}{2}gt^2$

$\boxed{t = \sqrt{\frac{2h}{g}}}$



$h = 0 + \frac{1}{2}gt^2$

$t = \sqrt{\frac{2h}{g}}$

$R = ut$

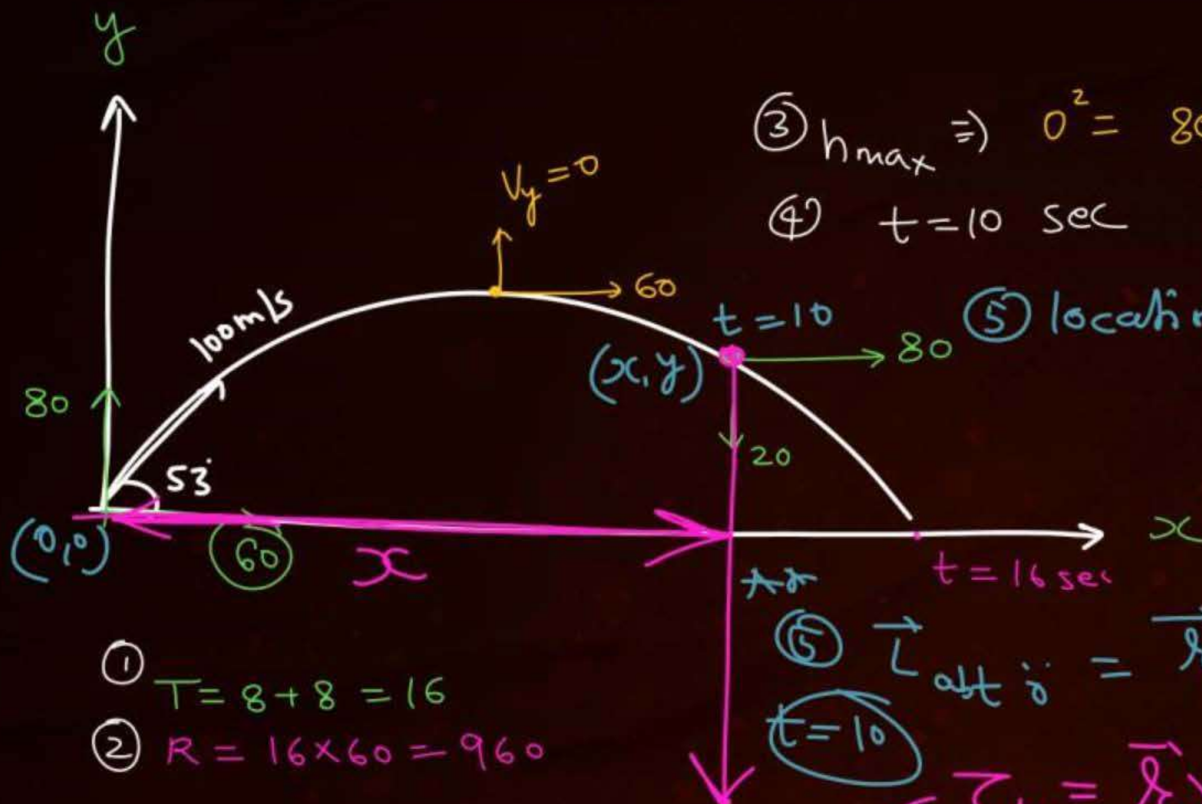
$$T = \frac{2u\sin\theta}{g} = \frac{2u_y}{a_y}$$

$$H_{max} = \frac{u^2\sin^2\theta}{2g} = \frac{u_y^2}{2a_y}$$

$$\text{Range} = u\cos\theta \cdot T = \frac{u^2\sin 2\theta}{g}$$

$$\hookrightarrow R = \frac{2u_x u_y}{a_y}$$

$20^\circ,\ 70^\circ$



③ $h_{max} \Rightarrow 0^2 = 80^2 - 2\times 10\times h_{max}$

④ $t = 10$ sec $\quad \vec{v} = 60\hat{i} - 20\hat{j}$

⑤ location at $t = 10$ sec, $x = 60\times 10 = 600$

$y = 80\times 10 - \frac{1}{2}\times 10\times 10^2$

① $T = 8 + 8 = 16$

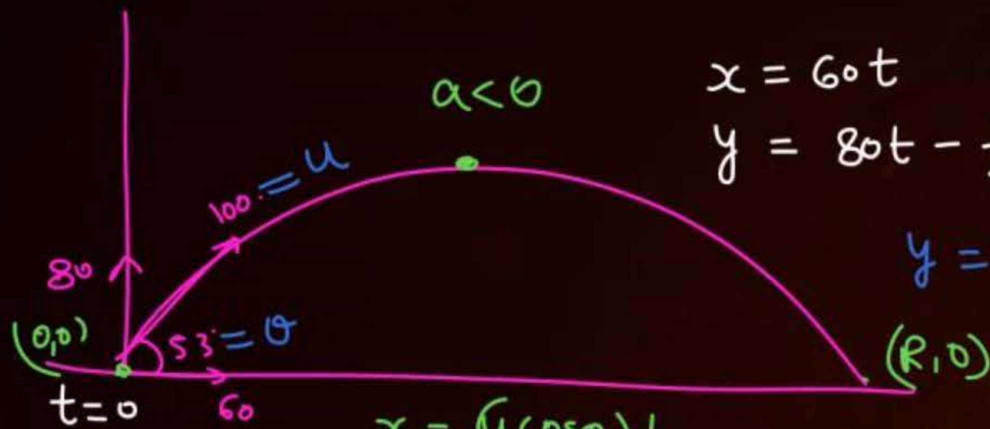
② $R = 16\times 60 = 960$

⑤ $\vec{L}_{at\ t=10} = \vec{r}\times m\vec{v} = (x\hat{i} + y\hat{j})\times m(80\hat{i} - 20\hat{j})$

$\tau_{mg} = \vec{r}\times\vec{F} = (x\hat{i} + y\hat{j})\times mg(-\hat{j})$

$= mg\, r_\perp = mgx$

$$y = 1\cdot x - \frac{x^2}{100} = x\left(1-\frac{x}{100}\right)$$



$$x = 60t$$

$$y = 80t - \frac{1}{2}\times 10\times t^2 = 80\cdot\frac{x}{60} - \frac{1}{2}\times g\times\left(\frac{x}{60}\right)^2$$

$$y = \frac{4x}{3} - \frac{1}{2}g\frac{x^2}{3600}$$

$$\boxed{\begin{aligned} y &= x\tan\theta - \frac{1}{2}g\frac{x^2}{u^2\cos^2\theta} \\ y &= x\tan\theta\left(1-\frac{x}{R}\right)\end{aligned}}$$

$$x = (u\cos\theta)t$$

$$y = u\sin\theta\, t - \frac{1}{2}gt^2 =$$

$$= \cancel{u}\sin\theta\frac{x}{\cancel{u}\cos\theta} - \frac{1}{2}\times g\times\frac{x^2}{u^2\cos^2\theta}$$

$$\boxed{y = x\tan\theta - \frac{1}{2}g\frac{x^2}{u^2\cos^2\theta}}$$

Kinematics

QUESTION

$\frac{1}{2k}\ln\left(g+kv^2\right)\Big|$

$g+kv^2=t$

$0+k2v\,dv=dt \qquad v\,dv=\frac{dt}{2k}$

A small ball of mass is thrown upward with velocity u from the ground. The ball experiences a resistive force mkv^2 where v is its speed. The maximum height attained by the ball is:

[JEE Main – 2020]

$F_{net}=\left(mg+mkv^2\right)$ नीचे

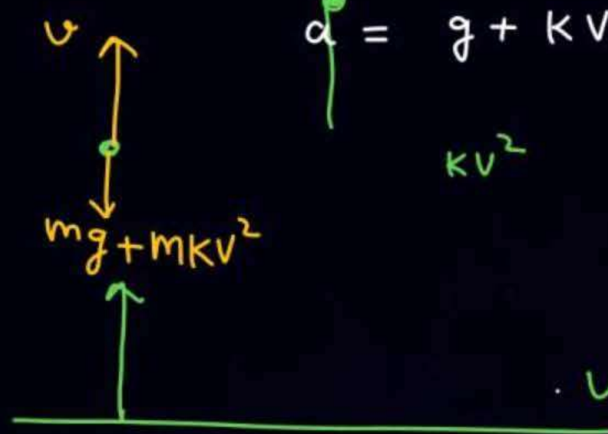
$a=g+kv^2=v\frac{dv}{dx}$

(1) $\cancel{\frac{1}{2k}\tan^{-1}\frac{ku^2}{g}}$

(2) $\frac{1}{2k}\ln\left(1+\frac{ku^2}{g}\right)$ ✓

(3) $\cancel{\frac{1}{k}\tan^{-1}\frac{ku^2}{2g}}$

(4) $\frac{1}{k}\ln\left(1+\frac{ku^2}{2g}\right)$



kv^2

$v\frac{dv}{dx}=g+kv^2$

$\int_u^0\frac{v\,dv}{g+kv^2}=\int_0^{h_{max}}dx$

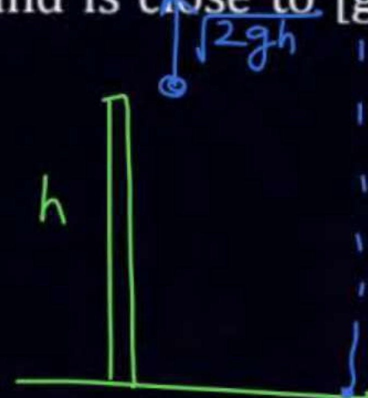
$\int\frac{dt}{2k\cdot t}=\int dx$

Ans : (2)

QUESTION

A helicopter raises from rest on the ground vertically upwards with a constant acceleration g. A food packet is dropped from the helicopter when it is a height h. The time taken by the packet to reach the ground is close to [g is the acceleration due to gravity]:

[JEE Main - 2020]



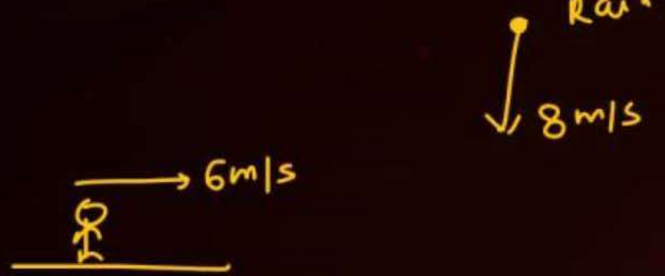
(1) $t = \sqrt{\frac{2h}{3g}}$

(2) $t = 1.8\sqrt{\frac{h}{g}}$

(3) $t = 3.4\sqrt{\left(\frac{h}{g}\right)}$

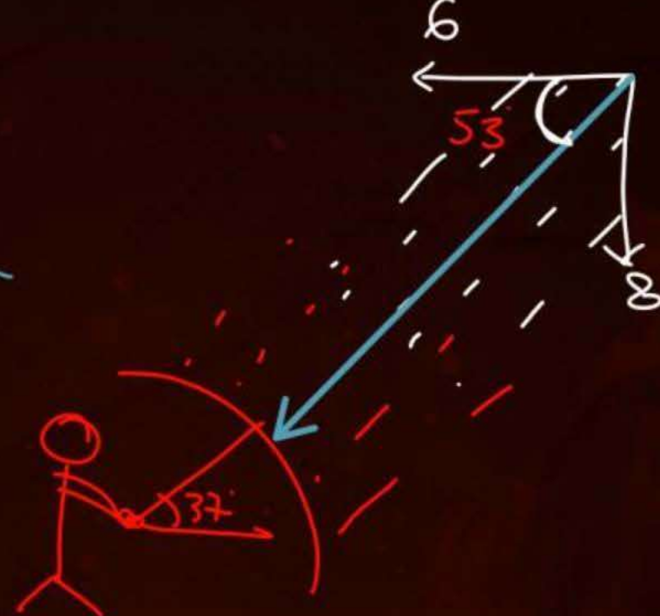
(4) $t = \frac{2}{3}\sqrt{\left(\frac{h}{g}\right)}$

Ans : (3)



$$\vec{v}_{rain/man} = \vec{v}_{rain} - \vec{v}_{man}$$

$$= -8\hat{j} - 6\hat{i}$$



QUESTION

When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to $(1 + \beta)v$, this angle changes to 45°. The value of β is close to: **[JEE Main - 2020]**

$\tan 60 = \frac{u}{v} = \sqrt{3}$ —— (1)

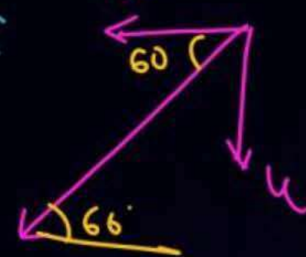
(1) 0.41

(2) 0.50

(3) 0.37

(4) 0.73

$v_{rain/man} = -u\hat{j} - v\hat{i}$



$\tan 45 = \frac{u}{(1+\beta)v}$

$1 = \frac{\sqrt{3}}{1+\beta}$

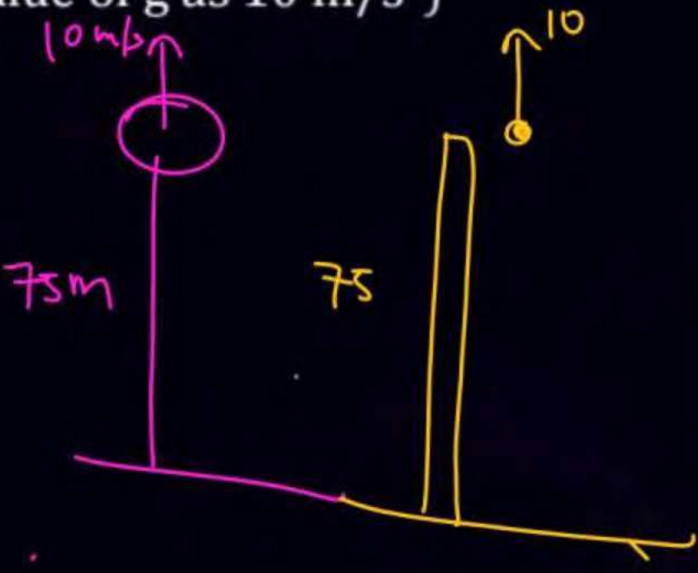
$1+\beta = \sqrt{3} = 1.73$

Ans : (4)

QUESTION

A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around: (takes the value of g as 10 m/s^2)

[JEE Main - 2021]



(1) 300 m

(2) 200 m

(3) 125 m

(4) 250 m

Ans : (3)

QUESTION

$$\frac{1}{2\sqrt{h}} + \frac{1}{2\sqrt{H-h}} \times (0-1) = 0$$

$$\frac{1}{\sqrt{h}} = \frac{1}{\sqrt{H-h}}$$

$$h = H-h$$

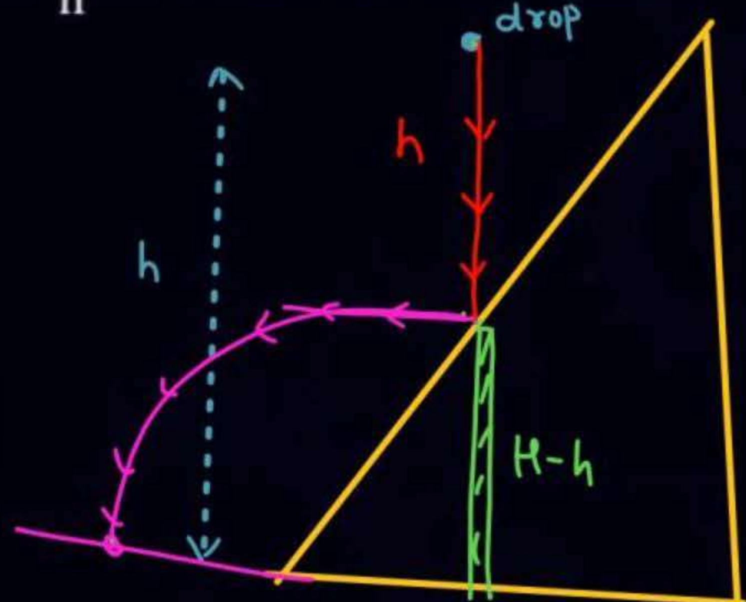
$$h = H/2$$

A body starts falling freely from height H hits an inclined plane in its path at height h. As a result of this perfectly elastic impact, the direction of the velocity of the body becomes horizontal. The value of $\frac{H}{h}$ for which the body will take the maximum time to reach the ground is ______.

[31 Jan 2024 - Shift 1]

$$\text{time}_{\text{max}} = \sqrt{\frac{2h}{g}} + \sqrt{\frac{2(H-h)}{g}}$$

$$\sqrt{\frac{2}{g}}\left[\sqrt{h} + \sqrt{H-h}\right]$$



$$\frac{H}{h} = 2$$

Ans. (2)

QUESTION

$v_1 = 8-6t$ $v_2 = -24t^2$

(1) A particle is moving along the x-axis with its coordinate with $x_{(t)}$ the time 't' given by $x_{(t)} = 10 + 8t - 3t^2$. Another (2) particle is moving the y-axis with its coordinate as a function of time given by $y_{(t)} = 5 - 8t^3$. At $t = 1$ s, the speed of the second particle as measured in the frame of the first particle is given as $\sqrt{v}$. Then v (in m/s) is ______.

[JEE Main - 2020]

$$\vec{v}_{2/1} = \vec{v}_2 - \vec{v}_1 = -24\hat{j} - 2\hat{i}$$

$$= -2\hat{i} - 24\hat{j}$$

$$|\vec{v}_{2/1}| = \sqrt{2^2 + (24)^2}$$

$t = 1$, $\vec{v}_1 = 2\hat{i}$

$v_2 = -24\hat{j}$

Ans : (580)

QUESTION

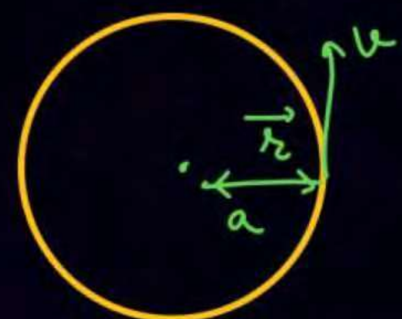
A particle moves such that its position vector $\boxed{\vec{r}_{(t)} = \cos\omega t\,\hat{i} + \sin\omega t\,\hat{j}}$ where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}_{(t)}$ and acceleration $\vec{a}_{(t)}$ of the particle: **[JEE Main - 2020]**

$v = -\omega \sin\omega t\,\hat{i} + \omega\cos\omega t\,\hat{j}$

$|v| = \omega \equiv \text{const}$

1. $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

2. $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$



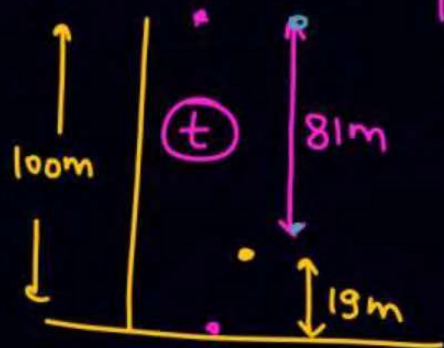
3. $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$

4. $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin

Ans : (1)

QUESTION

A ball is dropped from the top of a 100 m high tower on a planet. In the last $\frac{1}{2}$ s before hitting the ground, it covers a distance of 19 m. Acceleration due to gravity (in ms^{-2}) near the surface on that planet is _____. [JEE Main - 2020]



$$100 = 0 + \frac{1}{2} a t^2$$

$$81 = 0 + \frac{1}{2} a \left(t - \frac{1}{2}\right)^2$$

$$\frac{100}{81} = \frac{t^2}{\left(t - \frac{1}{2}\right)^2}$$

$$\frac{10}{9} = \frac{t}{t - \frac{1}{2}} \Rightarrow \checkmark$$

Ans : (8)

QUESTION

$F = -\alpha x^2$

$$0 + 0 + \int_0^x -\alpha x^2\,dx = 0 - \frac{1}{2} m v_0^2$$

$$\cancel{-}\,\alpha \frac{x^3}{3} = \cancel{+}\,\frac{1}{2} m v_0^2$$

A particle is projected with velocity v_0 along x-axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin i.e., $ma = -\alpha x^2$. The distance at which the particle stops:

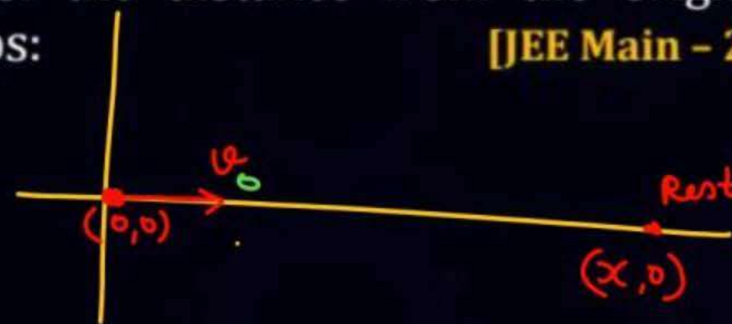
[JEE Main - 2021]

$$a = -\frac{\alpha}{m} x^2$$

$$v\frac{dv}{dx} = -\frac{\alpha}{m} x^2$$

$$\int_{v_0}^{0} v\,dv = -\frac{\alpha}{m}\int_0^x x^2\,dx$$

$$\cancel{-}\,\frac{v_0^2}{2} = \cancel{-}\,\frac{\alpha}{m}\cdot\frac{x^3}{3}$$



(1) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{2}}$

(2) $\left(\frac{2v_0}{3\alpha}\right)^{\frac{1}{3}}$

(3) $\left(\frac{2v_0^2}{3\alpha}\right)^{\frac{1}{2}}$

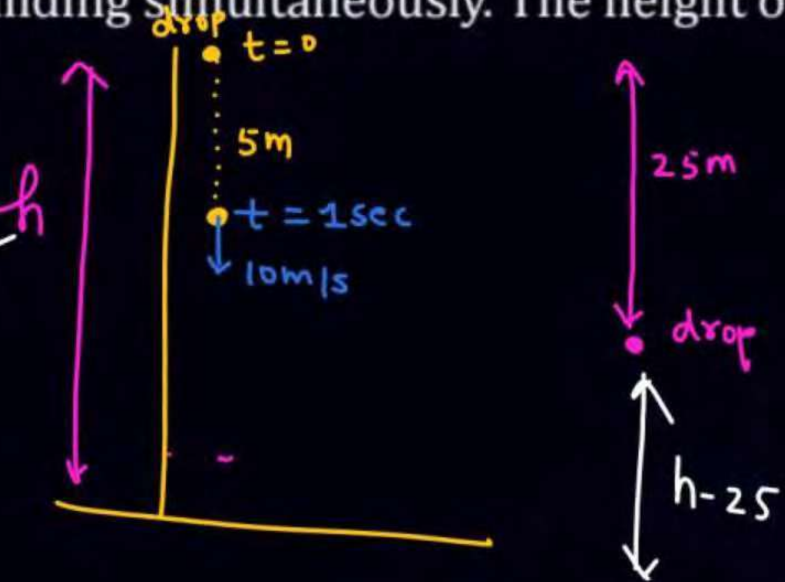
(4) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

Ans : (4)

QUESTION

A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is: **[JEE Main - 2021]**

1. 35 m
2. 45 m
3. 50 m
4. 25 m



$$h = 0 + \frac{1}{2} \times g \times t^2 = 5t^2$$

$$h - 25 = 0 + \frac{1}{2} g (t-1)^2$$

$$5t^2 - 25 = 5(t-1)^2$$

$$[t^2 - (t-1)^2] = 5$$

$$(2t-1) \times 1 = 5$$

$$t = 3 \text{ sec}$$

Ans : (2)

QUESTION

The trajectory of a projectile in a vertical plane is $y = \alpha x - \beta x^2$, where α and β are constants and x & y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection θ and the maximum height attained H are respectively given by :-

[JEE Main - 2021]

(1) $\tan^{-1}\alpha, \frac{\alpha^2}{4\beta}$

(2) $\tan^{-1}\beta, \frac{\alpha^2}{2\beta}$

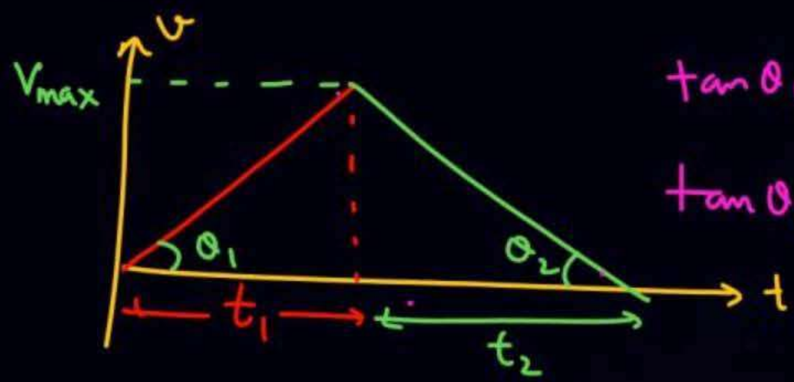
(3) $\tan^{-1}\alpha, \frac{4\alpha^2}{\beta}$

(4) $\tan^{-1}\left(\frac{\beta}{\alpha}\right), \frac{\alpha^2}{\beta}$

Ans : (1)

QUESTION

A scooter accelerates from rest for time t_1 at constant rate a_1 and then retards at constant rate a_2 for time t_2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be ______. [JEE Main - 2021]



$\tan\theta_1 = \frac{V_{max}}{t_1} = a_1$

$\tan\theta_2 = \frac{V_{max}}{t_2} = a_2$

(1) $\frac{a_1+a_2}{a_2}$

(2) $\frac{a_2}{a_1}$

(3) $\frac{a_1}{a_2}$

(4) $\frac{a_1+a_2}{a_1}$

Ans : (2)

QUESTION

A mosquito is moving with a velocity $\vec{v} - = 0.5t^2\hat{i} + 3t\hat{j} + 9\hat{k}$ m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2 s? **[JEE Main - 2021]**

(1) $\tan^{-1}\left(\frac{2}{3}\right)$ from x-axis

(2) $\tan^{-1}\left(\frac{2}{3}\right)$ from y-axis

(3) $\tan^{-1}\left(\frac{5}{2}\right)$ from y-axis

(4) $\tan^{-1}\left(\frac{5}{2}\right)$ from x-axis

Ans : (2)

QUESTION

A swimmer can swim with velocity of 12 km/h in still water. Water flowing in a river has velocity 6 km/h. The direction with respect to the direction of flow of river water he should swim in order to reach the point on the other bank just opposite to his starting point is ________°. (Round off to the Nearest Integer) (find the angle in degree)

[JEE Main - 2021]

$v \sin\theta = u$

$12 \sin\theta = 6$

$\sin\theta = \frac{1}{2}$

$\theta = 30°$

Ans : (12)

QUESTION

$$\alpha = 60 = \theta + 30 \qquad \theta = 30^\circ$$

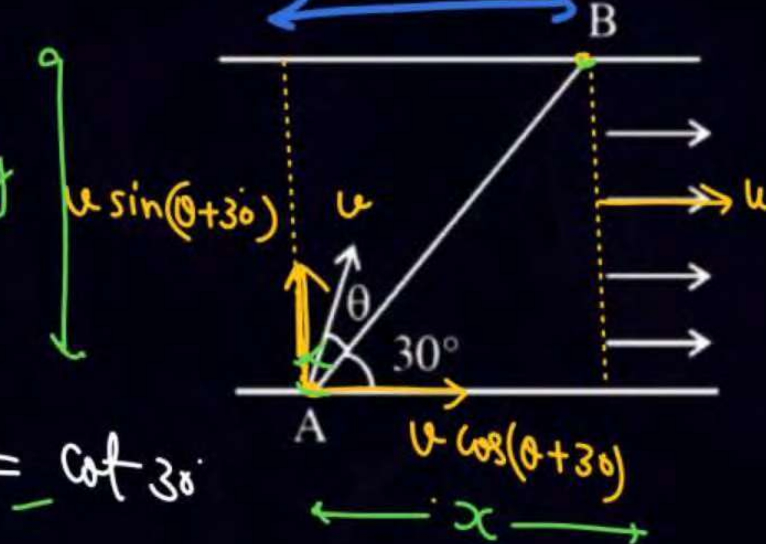
A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be ______°, so that the swimmer reaches point B.

[JEE Main - 2021]

$$\boxed{\begin{aligned} v + v\cos(\theta+30) &= \frac{x}{t} \\ v\sin(\theta+30) &= \frac{y}{t} \end{aligned}}$$

$$\frac{1+\cos(\theta+30)}{\sin(\theta+30)} = \frac{x}{y} = \frac{1}{\tan 30} = \sqrt{3}$$

$$\frac{1+\cos\alpha}{\sin\alpha} = \frac{1+2\cos^2\alpha/2-1}{2\sin\alpha/2\cos\alpha/2} = \cot\frac{\alpha}{2} = \cot 30^\circ$$

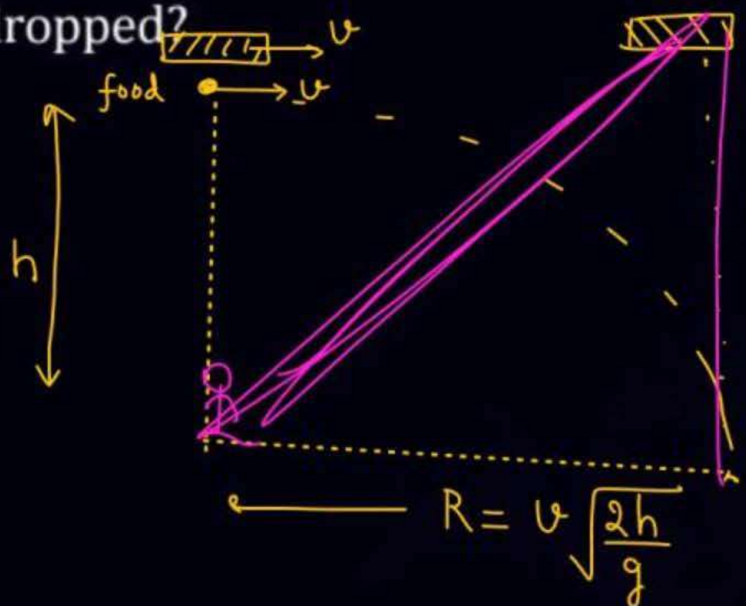


Ans : (30)

QUESTION

A helicopter is flying horizontally with a speed 'v' at an altitude 'h' has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped?

[JEE Main – 2021]



$\sqrt{h^2 + \left(v^2\frac{2h}{g}\right)}$

(1) $\sqrt{\frac{2ghv^2+1}{h^2}}$

(2) $\sqrt{2ghv^2 + h^2}$

(3) $\sqrt{\frac{2v^2h}{g} + h^2}$

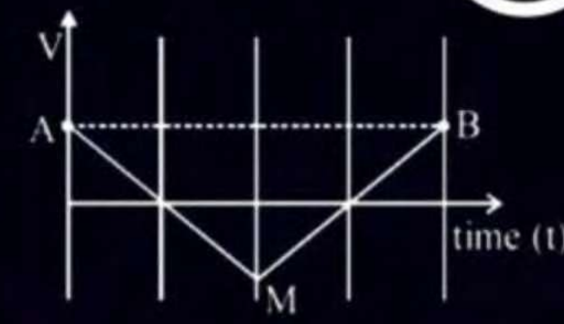
(4) $\sqrt{\frac{2gh}{v^2} + h^2}$

Ans : (3)

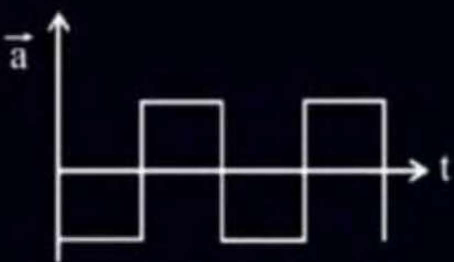
QUESTION

If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?

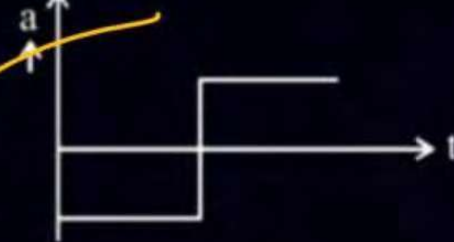
[JEE Main - 2021]



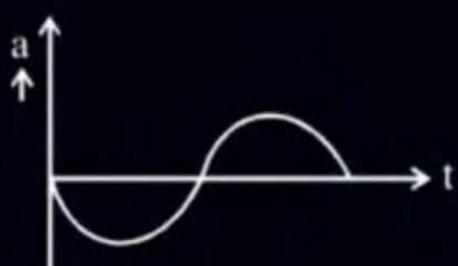
(1)



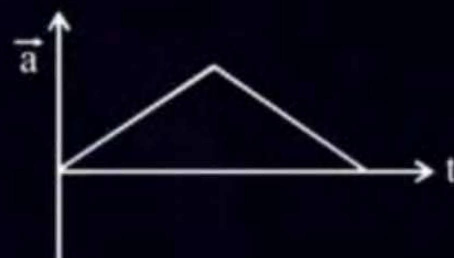
(2)



(3)



(4)



Ans : (2)

QUESTION

The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is $x = 0$ at $t = 0$; then its displacement after time $(t = 1)$ is: [JEE Main - 2021]

(1) $v_0 + g + F$

(2) $v_0 + \frac{g}{2} + \frac{F}{3}$

(3) $v_0 + \frac{g}{2} + F$

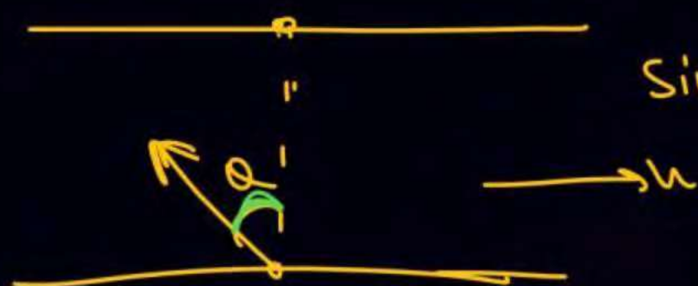
(4) $v_0 + 2g + 3F$

Ans : (2)

QUESTION

30°

A person is swimming with a speed of 10 m/s at an angle of 120° with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is 'x' m/s. The value of 'x' to the nearest integer is ______. [JEE Main - 2021]



$$\sin\theta = \frac{v_{\text{छोटा}}}{v_{\text{बड़ा}}}$$

Ans : (5)

QUESTION

If the velocity of a body related to displacement x is given by $v = \sqrt{5000 + 24x}$ m/s, then the acceleration of the body is m/s^2.

[JEE Main - 2021]

$$v^2 = 5000 + 24x$$

$$2\,v\frac{dv}{dx} = 24$$

Ans : (12)

QUESTION

A ball spun with angular acceleration $\alpha = 6t^2 - 2t$ where t is in second and α is in rads^{-2} and angular position of 4 rad. The most appropriate for the angular position of the ball is:

[JEE Main - 2022]

(1) $\frac{3}{2}t^4 - t^2 + 10t$

(2) $\frac{t^4}{2} - \frac{t^3}{3} + 10t + 4$

(3) $\frac{2t^4}{36} - \frac{t^3}{6} + 10t + 12$

(4) $2t^4 - \frac{t^3}{2} + 5t + 4$

Ans : (2)

QUESTION

A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?

[JEE Main - 2022]

(1) 25 m

(2) 50 m

(3) 100 m

(4) 200 m

$$R = \frac{u^2 \sin 2\theta}{g} \qquad R_{max} = \frac{u^2}{g} = 100$$

$$h_{max} = \frac{u^2}{2g}$$

Ans : (2)

QUESTION

A ball is projected from the ground with a speed 15 ms^{-1} at an angle θ with horizontal so that its range and maximum height are equal, then '$\tan\theta$' will be equal to ______.

[JEE Main - 2022]

$$\frac{u^2 \sin 2\theta}{g} = \frac{u^2 \sin^2\theta}{2g}$$

(1) 1/4

(2) 1/2

(3) 2

(4) 4

Ans : (4)

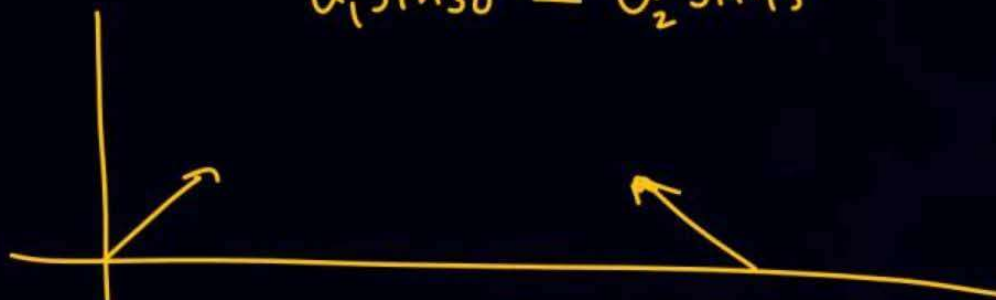
QUESTION

v_1 v_2

Two projective thrown at 30° and 45° with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is ______.

[JEE Main - 2022]

$v_1 \sin 30 = v_2 \sin 45$



(1) $1 : \sqrt{2}$

(2) $2 : 1$

(3) $\sqrt{2} : 1$

(4) $1 : 2$

Ans : (3)

QUESTION

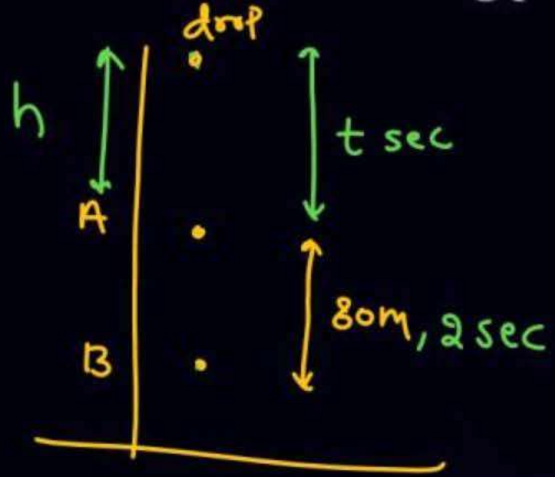
A particle is moving in one dimension (along x-axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $x = -3t^3 + 18t^2 + 16t$, where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is _____ m/s. **[01 Feb. 2024 - Shift 1]**

Ans. (52)

QUESTION

A body falling under gravity covers two points A and B separated by 80 m in 2 s. The distance of upper point A from the starting point is ______ m (use g = 10 ms^{-2})

[27 Jan. 2024 - Shift 2]



$$h = 0 + \frac{1}{2} g t^2$$

$$h + 80 = 0 + \frac{1}{2} g (t+2)^2$$

$$80 = \frac{1}{2} g \left[(2t+2) \cdot 2 \right]$$

Ans. (45)

QUESTION

A particle is moving in a straight line. The variation of position 'x' as a function of time 't' is given as $x = (t^3 - 6t^2 + 20t + 15)$ m. The velocity of the body when its acceleration becomes zero is:

[29 Jan. 2024 - Shift 2]

(1) 4 m/s

(2) 8 m/s

(3) 10 m/s

(4) 6 m/s

Ans. (2)

QUESTION

A particle initially at rest starts moving from reference point. x = 0 along x-axis, with velocity v that varies as $v = 4\sqrt{\text{xm}}/\text{s}$. The acceleration of the particle is ______ ms^{-2}.

[01 Feb. 2024 - Shift 2]

$v^2 = 16x$

Ans. (8)

QUESTION

$(x\hat{i}+y\hat{j})$

A particle starts from origin at t = 0 with a velocity $5\hat{\imath}$ m/s and moves in x – y plane under action of a force which produces a constant acceleration of $(3\hat{\imath}+2\hat{\jmath})$ m/s^2. If the x-coordinate of the particle at that instant is 84 m then the speed of the particle at this time is $\sqrt{\alpha}$m/s. The value of α is ______.

[27 Jan. 2024 - Shift 1]

$\vec{u}_i = 5\hat{i}$

$\vec{a} = 3\hat{i}+2\hat{j}$

$F = m(3\hat{i}+2\hat{j})$

$3\cancel{m}x + 2\cancel{m}y = \frac{1}{2}\cancel{m}v_f^2 - \frac{1}{2}\cancel{m}5^2$

$84 = 5t + \frac{1}{2}\times 3\times t^2$

$v_x = 5+3t$

$v_y = 0+2t$

Ans $\sqrt{V_x^2+V_y^2}$

Ans. (673)

QUESTION

A bullet is fired into a fixed target looses one third of its velocity after travelling 4 cm. It penetrates further D × 10^{-3} m before coming to rest. The value of D is:

[27 Jan. 2024 - Shift 2]

$$\left(\frac{2v}{3}\right)^2 = v^2 - 2 \times a \times 4$$
$$0^2 = v^2 - 2 \times a \times x$$

1. 2
2. 5
3. 3
4. 32

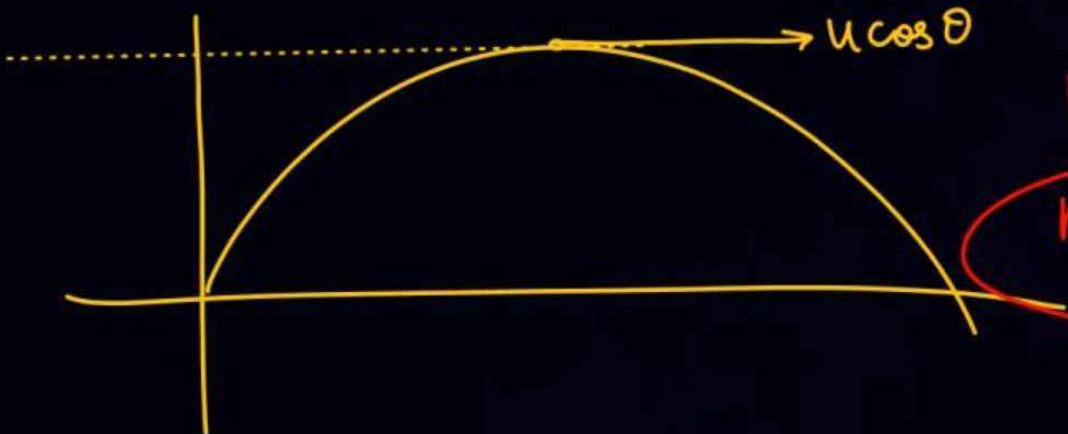
Ans $x - 4$

Check

Ans. (4)

QUESTION

A particle of mass m projected with a velocity 'u' making an angle of 30° with the horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height h is: [30 Jan. 2024 - Shift 1]



$m v r_{\perp}$

$m(u\cos\theta)\, h_{max}$

(1) $\frac{\sqrt{3}}{16}\frac{mu^3}{g}$

(2) $\frac{\sqrt{3}}{2}\frac{mu^2}{g}$

(3) $\frac{mu^3}{\sqrt{2}g}$

(4) Zero

Ans. (1)

3. A driver travelling at speed 36 kmh^{-1} sees the light turn red at the intersection. If his reaction time is 0.6s, and then the car can deaccelerate at $4ms^{-2}$. Find the stopping distance of the car.

36 km/hr चाल से गतिशील एक चालक देखता है कि चौराहे की बत्ती लाल हो गयी है। यदि उसका प्रतिक्रिया काल 0.6 s है तथा कार का सम्भव अवमंदन 4 m/s^2 है तो कार के रूकने की दूरी ज्ञात कीजिये।

Ans. 18.5 m

$36 \times \frac{5}{18} = 10 m/s$

$10 \times .6 = \underline{6m}$

$v^2 = u^2 + 2as$

$0 = 10^2 - 2 \times 4 \times x_2$

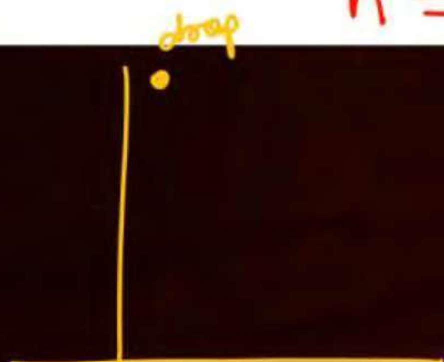
$x_2 = \frac{100}{8} = \frac{25}{2} = \underline{12.5}$

10. A stone is dropped from the top of a tall cliff, and 1s later a second stone is thrown vertically downward with a velocity of $20\ ms^{-1}$. How far below the top of the cliff will the second stone overtake the first?
एक पत्थर को किसी ऊँची पहाड़ी के शीर्ष पर से नीचे गिराया जाता है। इसके 1s पश्चात् एक दूसरे पत्थर को ऊर्ध्वाधर नीचे की ओर $20\ ms^{-1}$ वेग से फैंका जाता है। यह दूसरा पत्थर पहाड़ी के शिखर से कितनी दूर नीचे प्रथम पत्थर से आगे निकल जाएगा ?

$$h = 0 + \frac{1}{2} \times g \times t^2$$

Ans. $\frac{45}{4}$ m

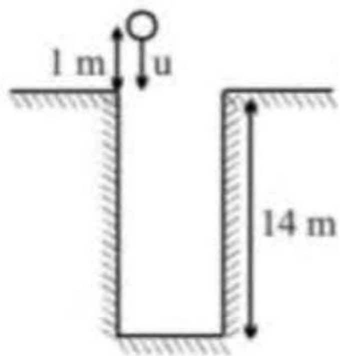
$$h = 20(t-1) + \frac{1}{2} \times g \times (t-1)^2$$



13. A boy throws a ball with speed u in a well of depth 14 m as shown. On bounce with bottom of the well the speed of the ball gets halved. What should be the minimum value of u (in m/s) such that the ball may be able to reach his hand again? It is given that his hands are at 1 m height from top of the well while throwing and catching.

m

एक लड़का किसी गेंद को u चाल से चित्रानुसार 14 m गहरे कुँए में फेंकता है। कुँए के तल से टकराने पर गेंद की चाल आधी हो जाती है। u (m/s में) का न्यूनतम मान क्या होना चाहिये ताकि गेंद पुन: उसके हाथों तक पहुँच सके ? गेंद को फेंकते तथा पकड़ते समय लड़के के हाथ कुँए के शीर्ष से 1 m की ऊँचाई पर होते है।

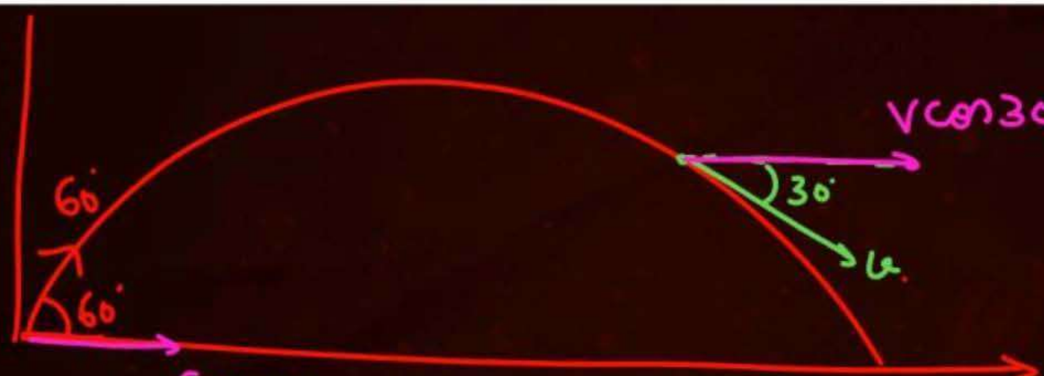


Ans. 30

6. A particle is thrown with a speed 60 ms^{-1} at an angle 60° to the horizontal. When the particle makes an angle 30° with the horizontal in downward direction, it's speed at that instant is v. What is the value of v^2 in SI units ? $v^2 = ?$

एक कण को क्षैतिज से 60° कोण बनाते हुये 60 ms^{-1} की चाल से फैंका जाता है। जब कण क्षैतिज के साथ नीचे की ओर 30° कोण बनाता है तो उस क्षण पर इसकी चाल v है। v^2 का मान क्या है ?

Ans. 1200



$60 \times \cos 60° = V \cos 30°$

11. A particle is projected in the x-y plane with y-axis along vertical. Two second after projection the velocity of the particle makes an angle 45° with the X-axis. Four second after projection, it moves horizontally. Find the velocity of projection.

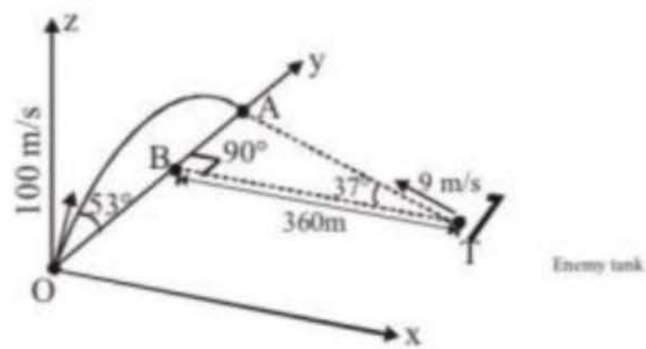
lay

एक कण को x-y तल में प्रक्षेपित किया जाता है। इस तल में y-अक्ष ऊर्ध्वाधर के अनुदिश है। प्रक्षेपण के 2 s पश्चात् कण का वेग X-अक्ष के साथ 45° कोण बनाता है। प्रक्षेपण के 4 s पश्चात् यह क्षैतिजत: गति करता है। प्रक्षेपण का वेग ज्ञात कीजिए।

Ans. $20\sqrt{5}$ m/s

16. A tank is initially at a perpendicular distance BT = 360 m from the plane of firing as shown. The enemy tank is moving with a speed of 9 m/s in direction TA as shown in figure. A gun can fire shell in y-z plane only with a speed 100 m/s at an angle of 53° such that the shell lands at points A. If tank started at t=0 then time interval (in sec) after which shell is to be fired to hit the tank is

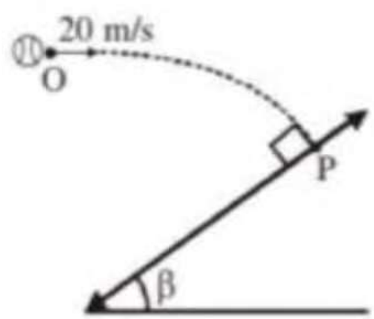
प्रदर्शित चित्र में एक टैंक प्रारम्भ में गोली दागने के प्रक्षेपण तल से BT = 360 m की लम्बवत् दूरी पर है। एक शत्रु का टैंक TA दिशा में 9 m/s की चाल से गतिशील है। एक बन्दूक y-z तल में लगी हुई है। यह 53° कोण पर 100 m/s की चाल से इस प्रकार गोली दागती है कि गोली केवल बिन्दु A पर ही टकराती है। यदि टैंक t = 0 समय पर गति करना प्रारम्भ कर दे तो वह समयान्तराल (सेकण्ड में) क्या होना चाहिये ताकि जिसके पश्चात् गोली दागने पर यह गोली टैंक से जा टकराये ?



Ans. 34

19. A ball is thrown horizontally from a point O with speed 20 m/s as shown. Ball strikes the incline plane along the normal to it after two seconds. Find value of x, if $\beta = \pi/x$ (where β is the angle of incline in degree).

एक गेंद को चित्रानुसार बिन्दु O से क्षैतिज रूप से 20 m/s की चाल से फेंका जाता है। यह गेंद दो सेकण्ड पश्चात् नत-तल पर इसके अभिलम्ब के अनुदिश टकराती है। यदि $\beta = \pi/x$ हो (जहां β आनत कोण डिग्री में है) तो x का मान ज्ञात कीजिए।



Ans. 4

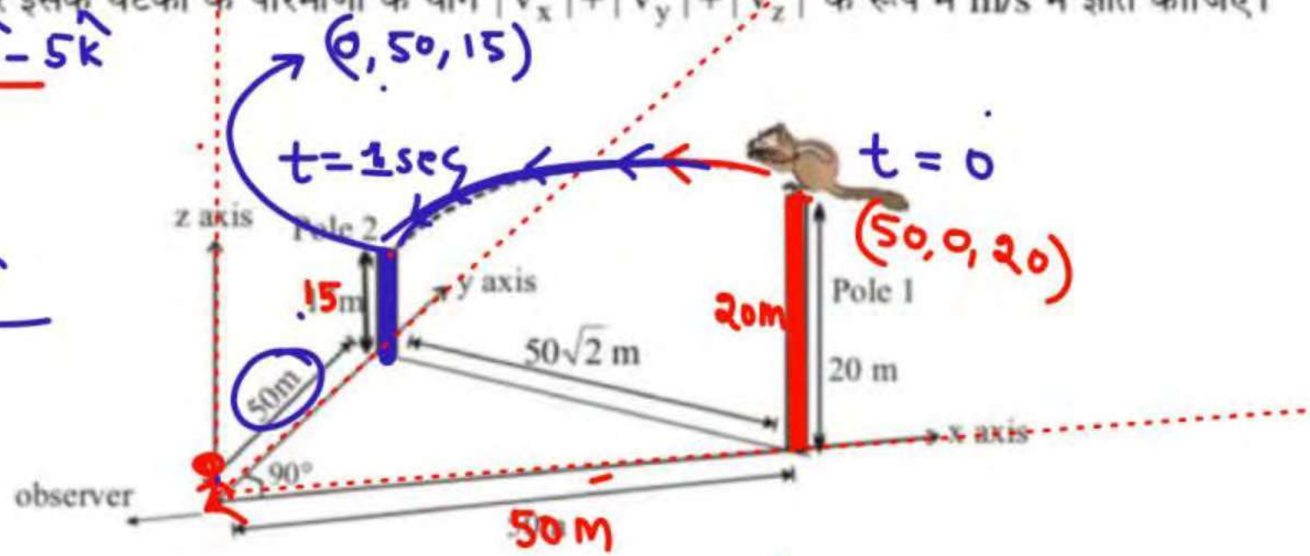
5. A small squirrel jumps from pole 1 to pole 2 in horizontal direction. Squirrels is observed by a very small observer at origin. What is average velocity vector of squirrel ? If average velocity vector is expressed as $v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$, express your answer as sum of magnitudes of its components $|v_x|+|v_y|+|v_z|$ in unit m/s. $\langle\vec{v}\rangle = v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$

एक छोटी गिलहरी खम्भे 1 से खम्भे 2 तक क्षैतिज दिशा में कूदती है। इस गिलहरी को मूल बिन्दु पर खडा एक बहुत छोटा प्रेक्षक देखता है। गिलहरी का औसत वेग सदिश क्या होगा ? यदि औसत वेग सदिश को $v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$ द्वारा दर्शाया जाए तो अपना उत्तर इसके घटकों के परिमाणों के योग $|v_x|+|v_y|+|v_z|$ के रूप में m/s में ज्ञात कीजिए।

$t = 1$

$\langle\vec{v}\rangle = \dfrac{-50\hat{i}+50\hat{j}-5\hat{k}}{1}$

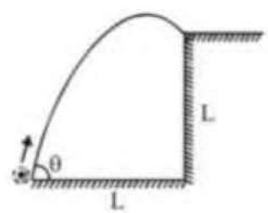
$50+50+5 = 105$



Ans. 0105

27. A ball is thrown at an angle θ up to the top of a cliff of height L, from a point at a distance L from the base, as shown in figure. Assuming that one of the following quantities is the initial speed required to make the ball hit right at the edge of the cliff, which one is it :-

एक गेंद को किसी L ऊँचाई वाली पहाड़ी के शीर्ष की ओर पहाड़ी के आधार से L दूरी पर स्थित बिन्दु से θ कोण पर फेंका जाता है। यह गेंद पहाड़ी की चोटी के किनारे से टकराये, इसके लिये गेंद की प्रारम्भिक चाल होगी (चित्र देखें) :-

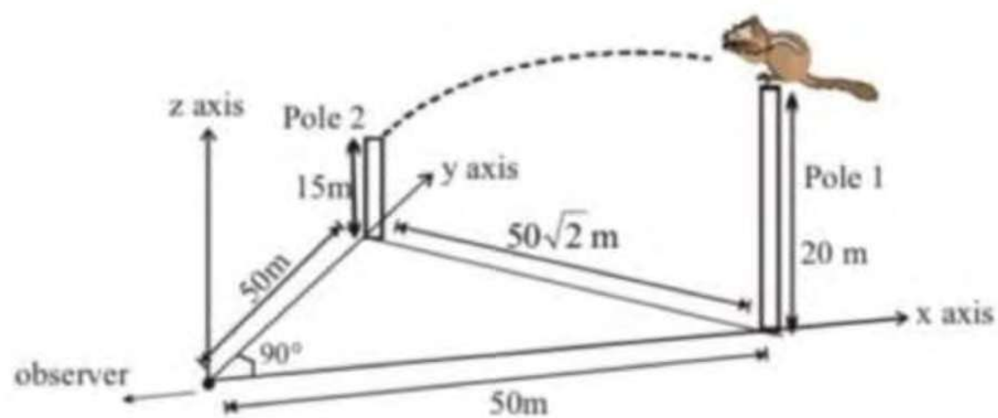


(A) $\sqrt{\frac{gL}{2(\tan\theta-1)}}$ (B) $\frac{1}{\cos\theta}\sqrt{\frac{gL}{2(\tan\theta-1)}}$ (C) $\frac{1}{\cos\theta}\sqrt{\frac{gL}{2(\tan\theta+1)}}$ (D) $\sqrt{\frac{gL\tan\theta}{2(\tan\theta+1)}}$

Ans. (B)

5. A small squirrel jumps from pole 1 to pole 2 in horizontal direction. Squirrels is observed by a very small observer at origin. What is average velocity vector of squirrel ? If average velocity vector is expressed as $v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$, express your answer as sum of magnitudes of its components $|v_x|+|v_y|+|v_z|$ in unit m/s.

एक छोटी गिलहरी खम्भे 1 से खम्भे 2 तक क्षैतिज दिशा में कूदती है। इस गिलहरी को मूल बिन्दु पर खडा एक बहुत छोटा प्रेक्षक देखता है। गिलहरी का औसत वेग सदिश क्या होगा ? यदि औसत वेग सदिश को $v_x\hat{i}+v_y\hat{j}+v_z\hat{k}$ द्वारा दर्शाया जाए तो अपना उत्तर इसके घटकों के परिमाणों के योग $|v_x|+|v_y|+|v_z|$ के रूप में m/s में ज्ञात कीजिए।



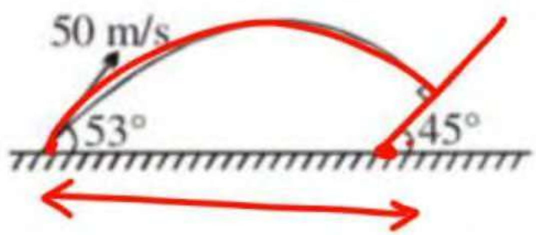
Ans. 0105

18. A projectile is thrown with velocity of 50 m/s towards an inclined plane from ground such that it strikes the inclined plane perpendicularly. The angle of projection of the projectile is 53° with the horizontal and the inclined plane is inclined at an angle of 45° to the horizontal.

(i) Find the time of flight.

(ii) Find the distance between the point of projection and the foot of inclined plane.

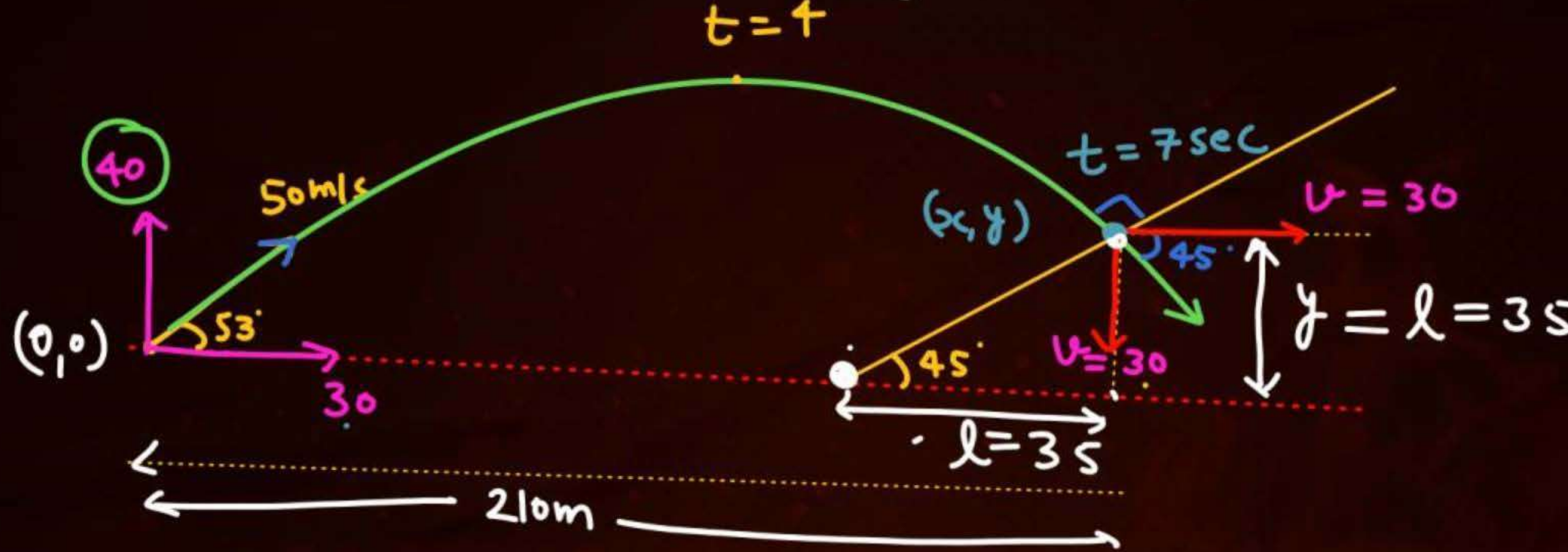
एक प्रक्षेप्य को धरातल से नत-तल की तरफ 50 m/s के वेग से इस प्रकार फैंका जाता है कि यह लम्बवत् रूप से नत-तल से टकराता है। प्रक्षेप्य का प्रक्षेपण कोण क्षैतिज से 53° है तथा नत-तल क्षैतिज से 45° कोण पर झुका है। ज्ञात कीजिए (i) उड्डयनकाल (ii) प्रक्षेपण बिन्दु तथा नत-तल के पाद के मध्य दूरी



Ans. (i) 7 s, (ii) 175 m

$$x = 30 \times 7 = 210$$

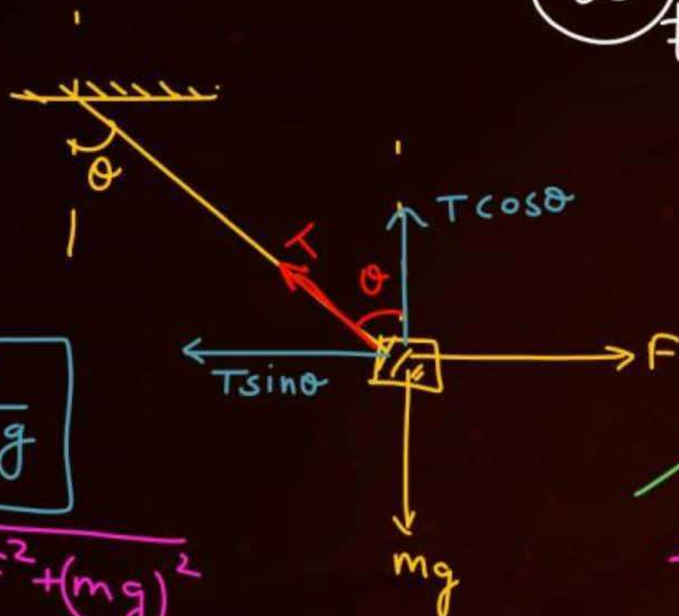
$$y = 40 \times 7 - \frac{1}{2} \times 10 \times 7^2 = 35$$



NLM & friction, Circular motion

5 वार

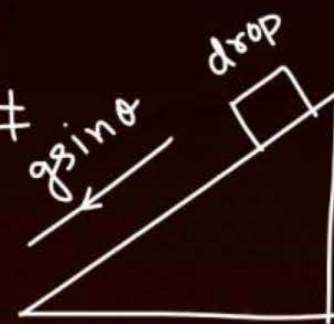
1

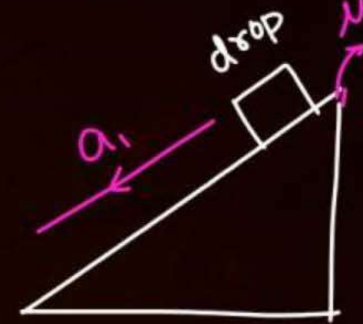


$$\boxed{\tan\theta = \frac{F}{mg}}$$

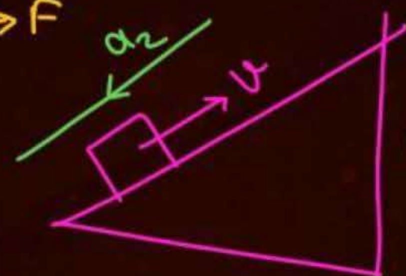
$$T = \sqrt{F^2 + (mg)^2}$$

2 #

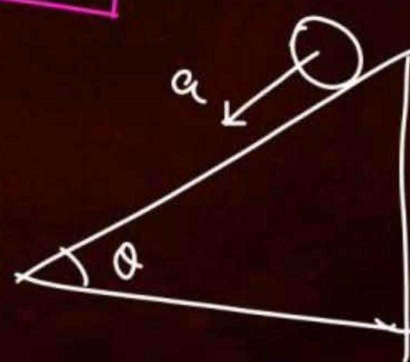




$$a_1 = g\sin\theta - \mu g\cos\theta$$

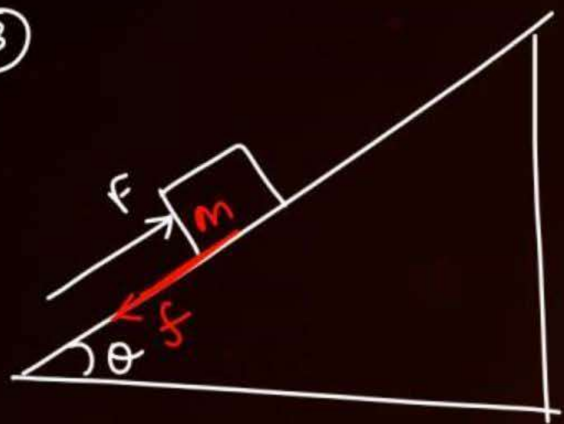


$$a_2 = g\sin\theta + \mu g\cos\theta$$



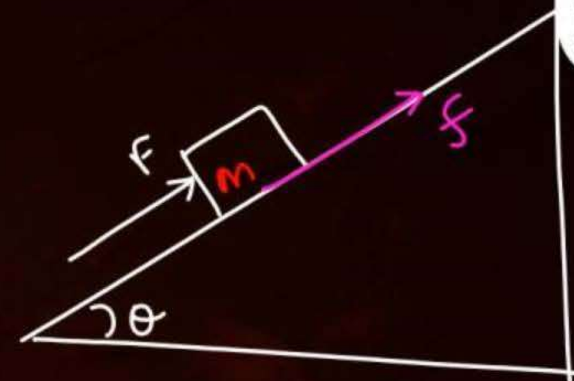
$$a = \frac{g\sin\theta}{1 + I/mR^2}$$

③



Fmin to slide up = $mg\sin\theta + \mu_s mg\cos\theta$

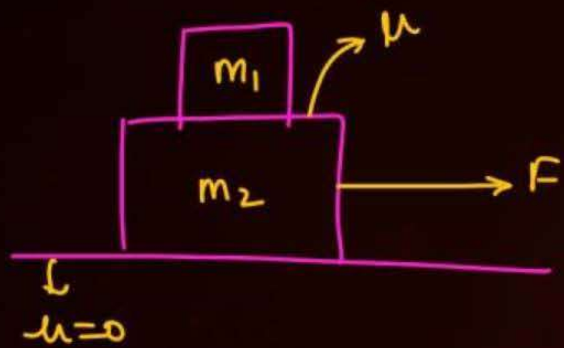
④



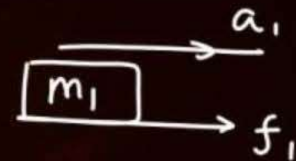
Fmin to prevent the Sliding of block down

$= mg\sin\theta - \mu mg\cos\theta$

(5)



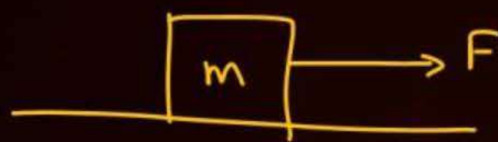
$$\left(a_{\text{ऊपर वाला}}\right)_{max} = \frac{\mu_s \cancel{m_1} g}{\cancel{m}} = \mu_s g$$



$$F = (m_1 + m_2)\, a_c$$

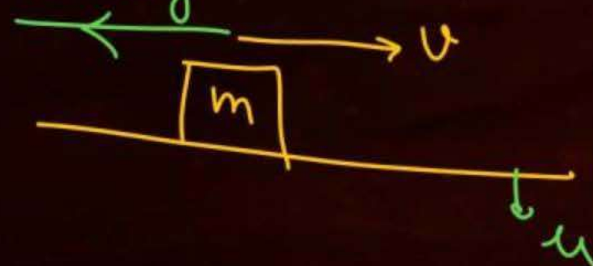
F_{max} so that both block move together w/o slipping $= (\mu_s g)(m_1 + m_2)$

(6)

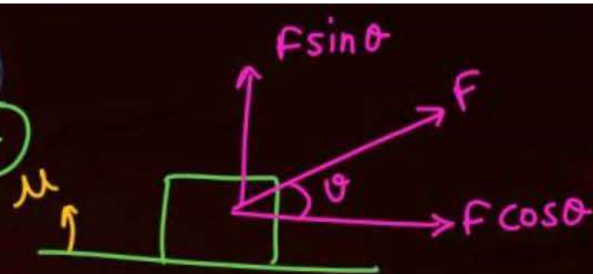


$(F_{min})_{\text{to slide the block}} = \mu mg$

(7) $a = \mu g$



(7)



find the min force required to move the block $= \dfrac{\mu mg}{\sqrt{1+\mu^2}}$

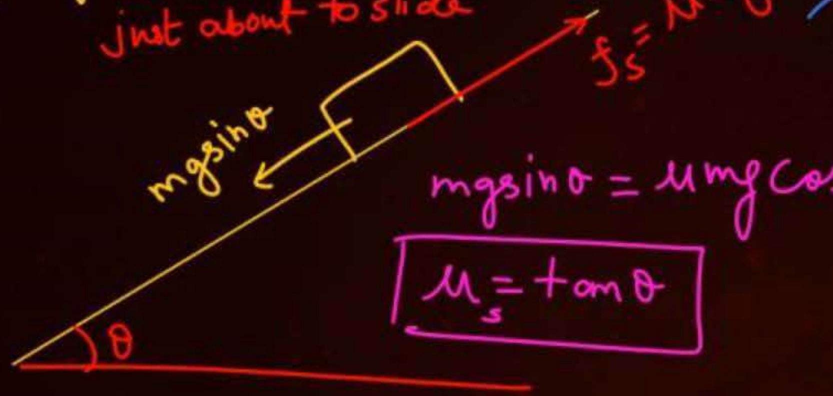
$$F\cos\theta = (f_s)_{max} = \mu(mg - F\sin\theta)$$

$$F(\cos\theta + \mu\sin\theta) = \mu mg$$

कम $\quad F = \dfrac{\mu mg}{\underbrace{\boxed{\cos\theta + \mu\sin\theta}}_{max}}$

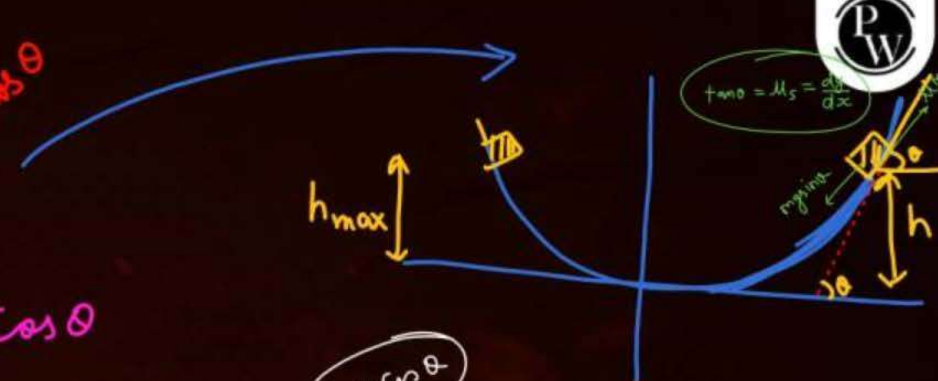
(8) Angle of repose/sliding.

just about to slide

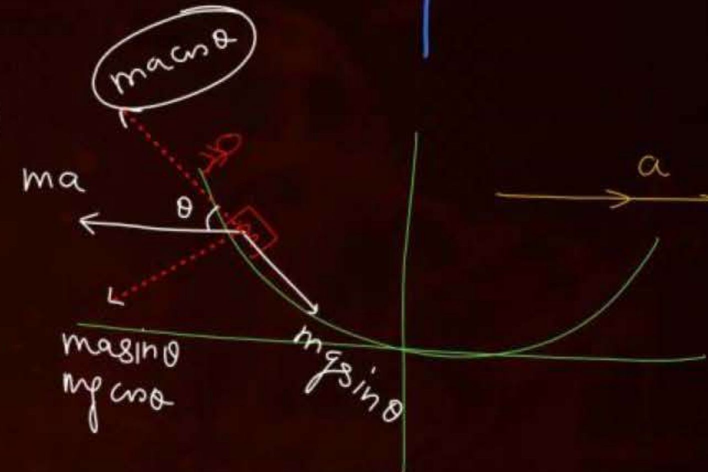


$$mg\sin\theta = \mu mg\cos\theta$$

$$\boxed{\mu_s = \tan\theta}$$



(9)



(10) Circular motion.

$\frac{d}{dt}(\text{speed}) = a_t$

$a_c = \frac{v^2}{R} = R\omega^2$

$a_{net} = \sqrt{a_t^2 + a_c^2}$

$\frac{d}{dt}(\text{Velocity}) = \vec{a}_{net}$

Q $v = 4t^2$ (speed)

$(R = 2m)$

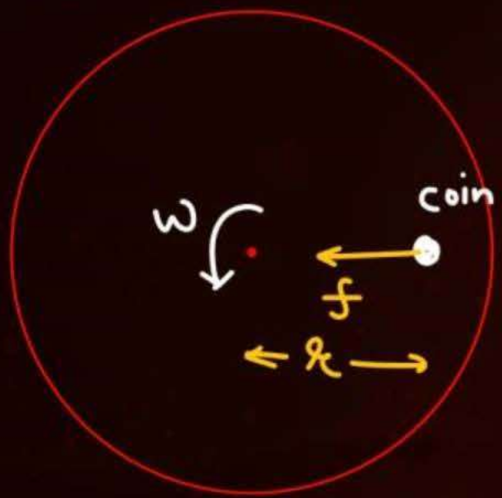
find acc. at $t = 3$ sec.

$a_t = \frac{dv}{dt} = 8t = 24$

$a_c = \frac{v^2}{R} = \frac{(4t^2)^2}{R} = \frac{(36)^2}{2}$

$a_{net} = \sqrt{a_c^2 + a_t^2}$

(11)



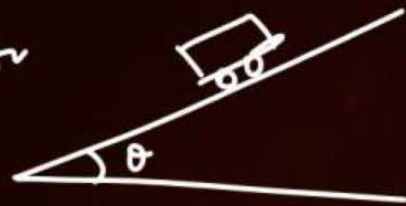
$$f_s = m r \omega^2$$

$$(f_s)_{max} = \mu_s mg$$

(12) Banking of road.

(1) without friction

$$\tan\theta = \frac{v^2}{Rg}$$



(2) friction $\bar{c}$

$$v_{max} = \sqrt{Rg\tan(\theta+\phi)}$$

$$V_{min} = \sqrt{Rg\tan(\theta-\phi)}$$

$$\tan\phi = \mu_s$$

*

(3) Level horizontal road.

$$\mu mg = \frac{m v_{max}^2}{R}$$

$$v_{max} = \sqrt{\mu g R}$$

*

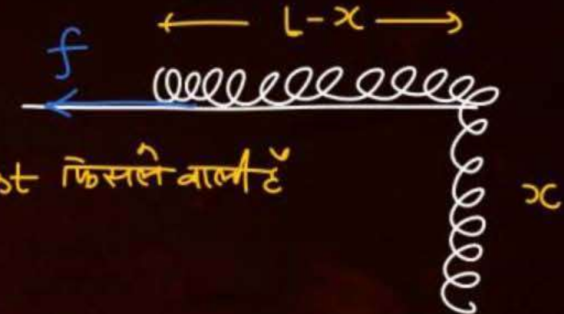
13

$NL = l_0$

$$kx = \frac{mv^2}{r} = mr\omega^2$$

$$kx = \frac{mv^2}{(l_0+x)} = m(l_0+x)\omega^2$$

14

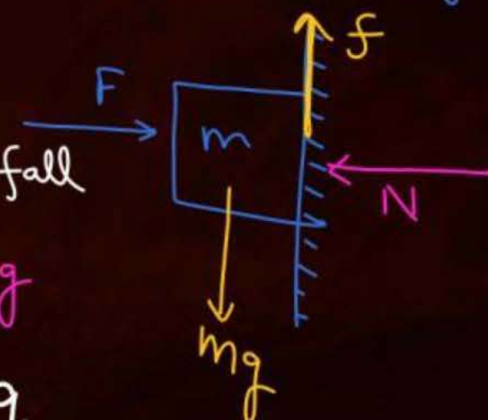


just फिसलने वाली है

$$\lambda x m g = \mu \lambda (L-x) g$$

15

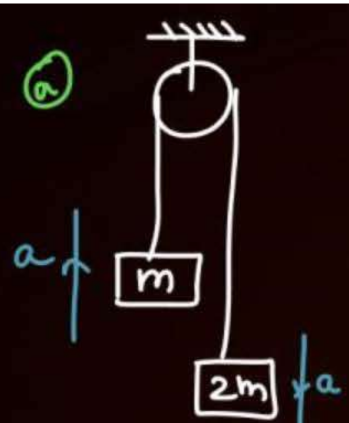
F_{min} so that block doesnot fall



$$(f_s)_{max} > mg$$

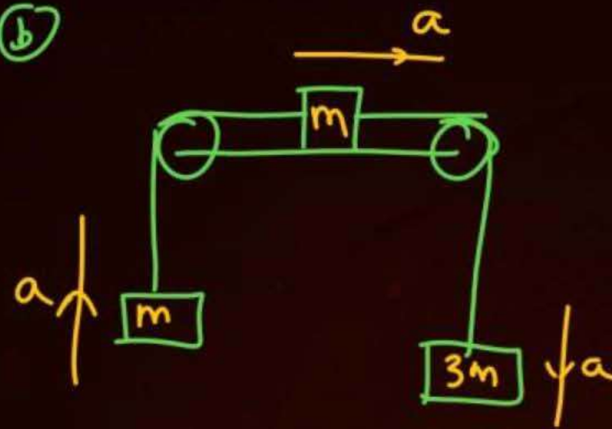
$$\mu F \geq mg$$

(16) (a)



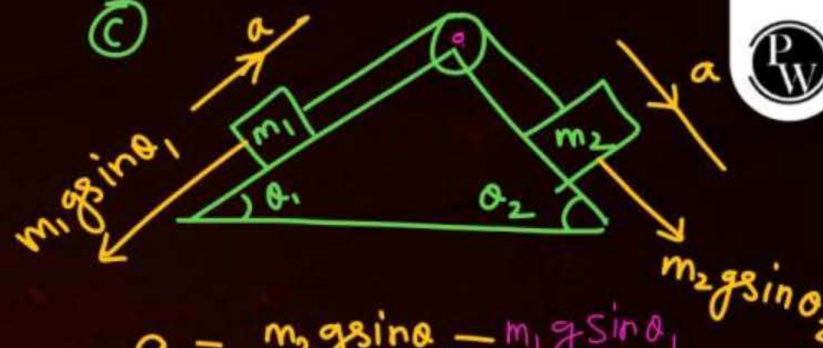
$$a = \frac{2mg - mg}{m + 2m}$$

(b)



$$a = \frac{3mg - mg}{m + m + 3m}$$

(c)



$$a = \frac{m_2 g\sin\theta_2 - m_1 g\sin\theta_1}{m_1 + m_2 + \frac{I}{R^2}}$$

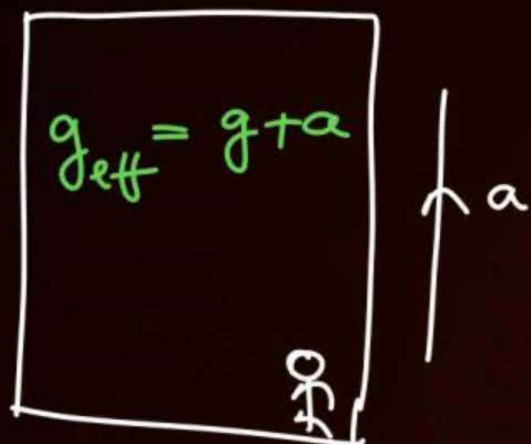
Rotation

$$a = \frac{2mg - mg}{m + 2m + \frac{I}{R^2}}$$

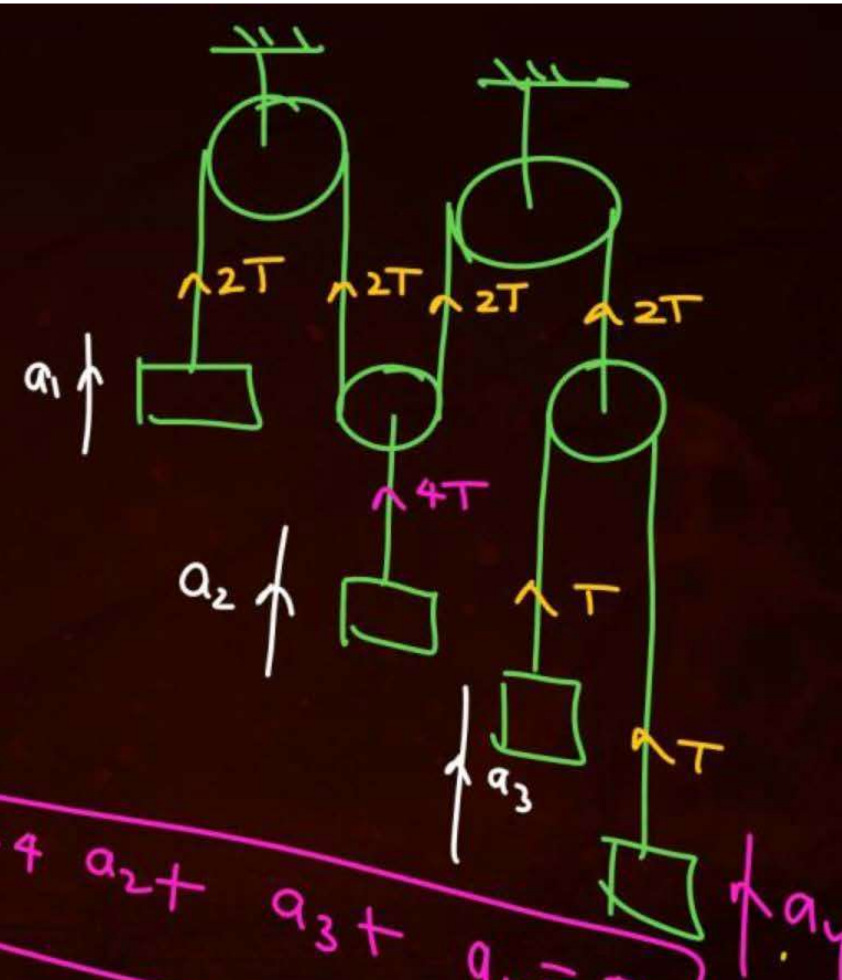
pulley

(17) $\vec{F}_{psedo} = -m_{block}\,\vec{a}_{fr}$

(17)



(18)



$$\boxed{2a_1 + 4a_2 + a_3 + a_4 = 0}$$

(19) $ROC = \dfrac{v^2}{a_N}$

* (20)

$$T = 2\pi\sqrt{\frac{m}{K}}$$

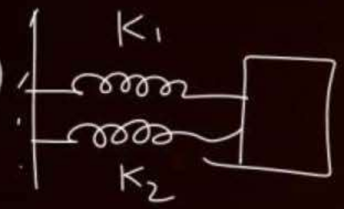
$$KL = K_1 \frac{L}{3} = K_2 \cdot \frac{2L}{3}$$

$$K_1 = 3K$$

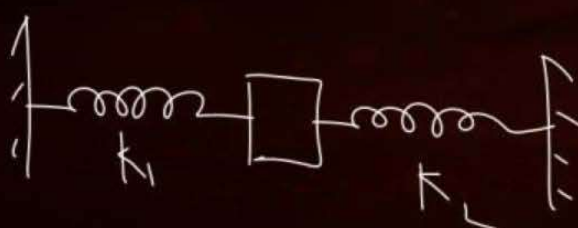
$$K_2 = \frac{3K}{2}$$

SHM

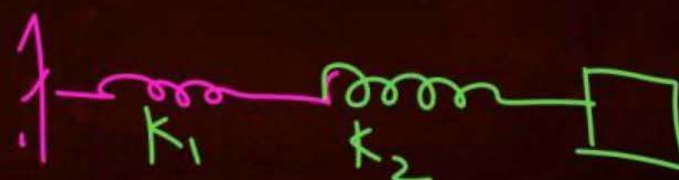
(21)



$$K_{eq} = K_1 + K_2$$



$\Rightarrow$



$$K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$

$$\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2}$$

QUESTION

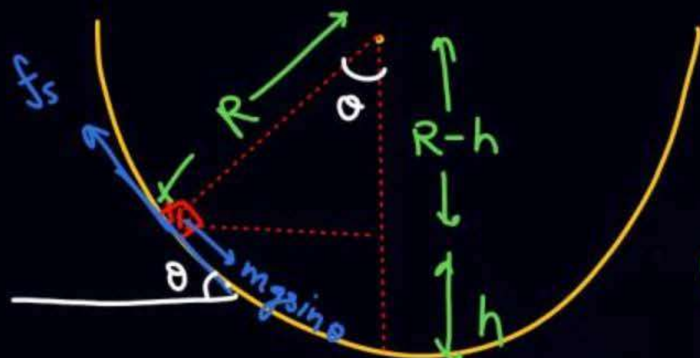
An insect is at the bottom of a hemispherical ditch of radius 1 m. It crawls up the ditch but starts slipping after it is at height h from the bottom. If the coefficient of friction between the ground and the insect is 0.75, then h is: ($g = 10\ ms^{-2}$). [JEE Main - 2020]

(1) 0.80 m

(2) 0.60 m

(3) 0.45 m

(4) 0.20 m



$$mg\sin\theta = \mu_s mg\cos\theta$$

$$\tan\theta = \mu_s = \frac{3}{4}$$

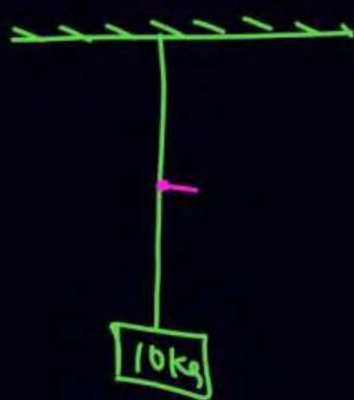
$$\theta = 37^\circ$$

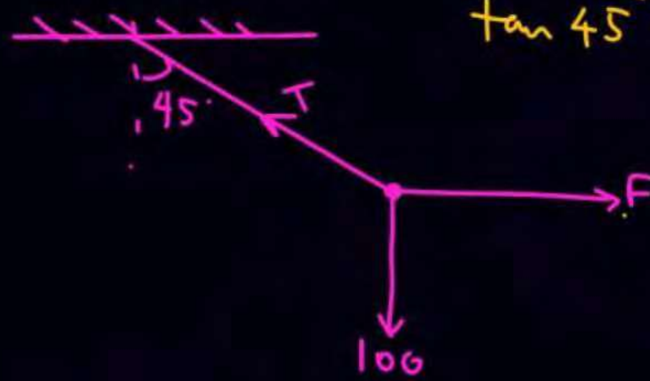
$$\cos\theta = \frac{R-h}{R} = \frac{4}{5} = \frac{1-h}{1}$$

Ans : (4)

QUESTION

A mass of 10 kg is suspended by a rope of length 4 m, from the ceiling. A force F is applied horizontally at the mid-point of the rope such that the top half of the rope makes an angle of 45° with the vertical. Then F equals:
(Take $g = 10\ ms^{-2}$ and the rope to be massless). [JEE Main - 2020]





$$\tan 45^\circ = \frac{F}{mg}$$

(1) 100 N

(2) 90 N

(3) 75 N

(4) 70 N

Ans : (1)

QUESTION

$mg(3x\sin\theta) + 0 + 0 - \mu mg\cos\theta \cdot x = 0^2 - 0^2$

Rest

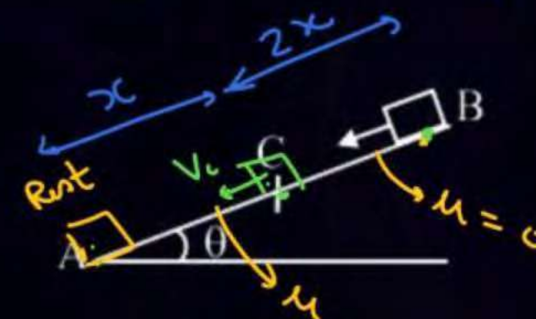
A small block starts slipping down from a point B on an inclined plane AB, which is making an angle θ with the horizontal section, BC is smooth and the remaining section CA is rough with a coefficient of friction μ. It is found that the block comes to rest as it reaches the bottom (point A) of the inclined plane. If BC = 2AC, the coefficient of friction is given by μ = k tanθ. The value of k is ______.

[JEE Main - 2020]

$v_c^2 = 0^2 + 2 \times g\sin\theta \times (2x)$

$0^2 = v_c^2 - 2(\mu g\cos\theta - g\sin\theta) \times x$

$0^2 = v_c^2 + 2(g\sin\theta - \mu g\cos\theta)\, x$



Ans : (3)

QUESTION

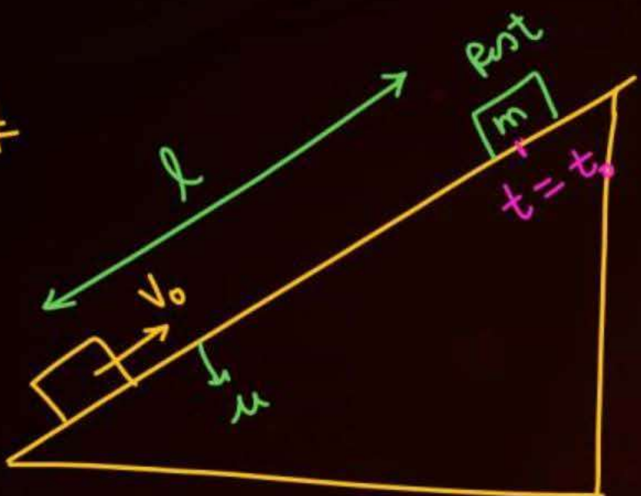
HW

A block starts moving up an inclined plane of inclination $30°$ with an initial velocity of v_0. It comes back to its initial position with velocity $\frac{v_0}{2}$. The value of the coefficient of kinetic friction between the block and the inclined plane is close to $\frac{I}{1000}$. The nearest integer to I is ______.

[JEE Main - 2020]

Ans : (346)

#



$0^2 = v_0^2 - 2 a_{\text{जाते}} \cdot l$

$0 = v_0 - a_{\text{जाते}} t_{\text{जाते}}$

$a_{\text{जाते}} = g\sin\theta + \mu g\cos\theta$

$a_{\text{आते}} = g\sin\theta - \mu g\cos\theta$

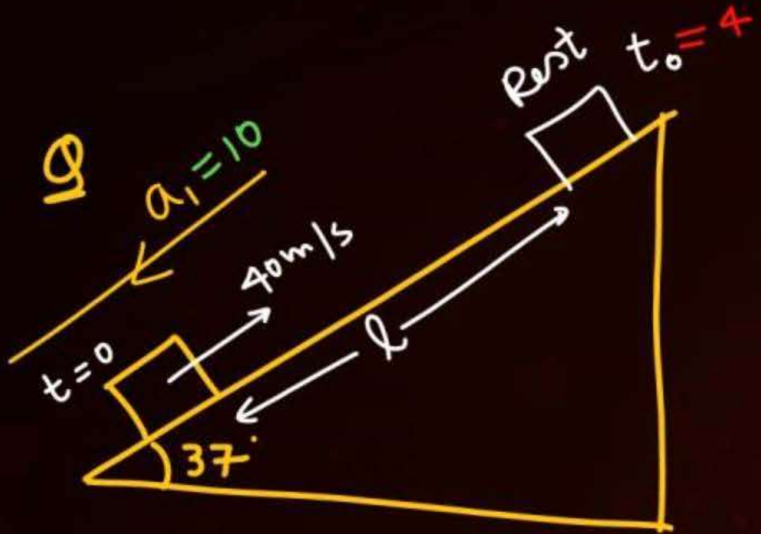
वापस आते वक्त

$$l = 0 + \frac{1}{2} a_{\text{आते}} t_{\text{आते}}^2$$

प (1) $l = ?$

(2) $\dfrac{t_{\text{जाते}}}{t_{\text{आते}}} = \checkmark$

Q



$\mu = .5$

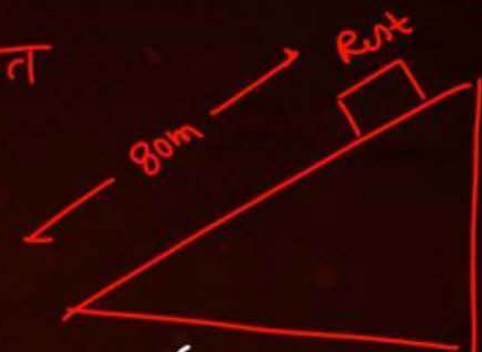
$a_1 = g\sin\theta + \mu g\cos\theta$

$= 6 + 8 \times .5 = 10$

① $l = ?$

$0^2 = (40)^2 - 2 \times 10 \times l$, $l = 80$

② आते वक्त



$80 = 0 + \frac{1}{2}(g\sin\theta - \mu g\cos\theta)\, t^2_{\text{आते}}$

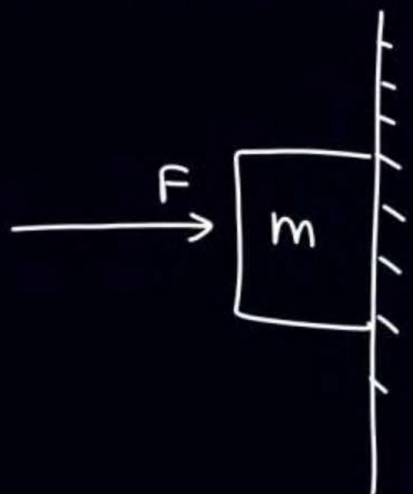
$160 = \left(6 - \frac{1}{2} \times 8\right) t^2_{\text{आते}}$

$t_{\text{आते}} = \sqrt{80}$

QUESTION

The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall will be ______ N. [$g = 10\ ms^{-2}$].

[JEE Main - 2021]



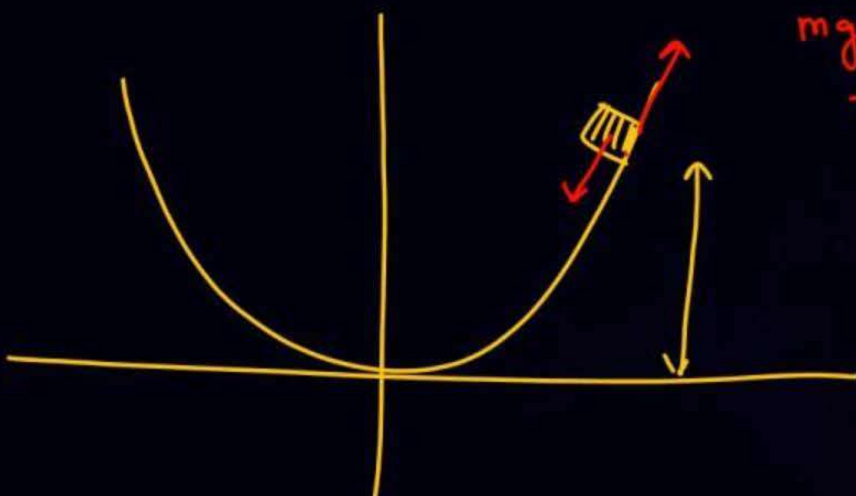
$$mg = \mu_s F$$

$$5 = .2 \times F$$

Ans : (25)

QUESTION

An inclined plane is bent in such a way that the vertical cross-section is given by $y = \frac{x^2}{4}$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction $\mu = 0.5$, the maximum height in cm at which a stationary block will not slip downward is ______ cm. [JEE Main - 2021]



$mg\sin\theta = \mu_s mg\cos\theta$

$\tan\theta = \mu_s = \frac{1}{2} = \frac{dy}{dx} = \frac{2x}{4}$

$x = 1, \; y = \frac{1}{4} m = 25 \text{ cm}$

Ans : (25)

QUESTION

A block of mass m slides along a floor while a force of magnitude F is applied to it at angle θ as shown in figure. The coefficient of kinetic friction is μ_k. Then, the block's acceleration 'a' is given by: (g is acceleration due to gravity) **[JEE Main - 2021]**

$$a = \frac{F\cos\theta - f}{m}$$

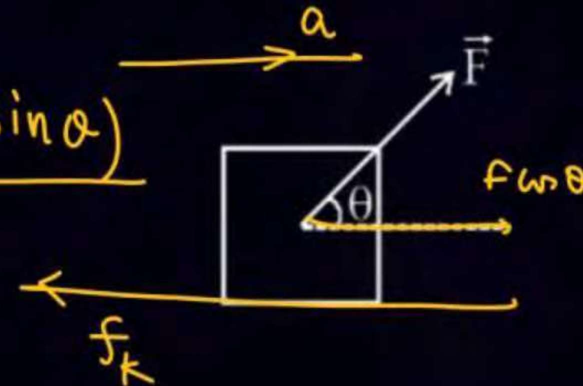
(1) $-\cancel{\frac{F}{m}\cos}\theta - \mu_k\left(g - \frac{F}{m}\sin\theta\right)$

(2) $\frac{F}{m}\cos\theta - \mu_k\left(g - \frac{F}{m}\sin\theta\right)$ ✓

(3) $\frac{F}{m}\cos\theta - \mu_k\left(g + \frac{F}{m}\sin\theta\right)$

(4) $\frac{F}{m}\cos\theta + \mu_k\left(g - \frac{F}{m}\sin\theta\right)$

$$a = \frac{F\cos\theta - \mu(mg - F\sin\theta)}{m}$$



Ans : (2)

QUESTION

A person standing on a spring balance inside a stationary lift measures 60 kg. The weight of that person if the lift descends with uniform downward acceleration of 1.8 m/s^2 will be ______ N. [g = 10 m/s^2]. **[JEE Main - 2021]**

$$g_{eff} = g - a = 10 - 1.8 = 8.2$$

$$N = mg_{eff} = 60 \times 8.2$$

$$= 492$$

Ans : (492)

QUESTION

$$kx = ma$$

$$F + kx = ma_B$$

$$\frac{F + ma}{m} = a_B$$

Two masses A and B, each of mass M are fixed together by a massless spring. A force acts on the mass B as shown in figure. If the mass A starts moving away from mass B with acceleration 'a', then the acceleration of mass B will be: [JEE Main - 2021]

$$(F_{net})_{ext} = F(-\hat{i}) = m\vec{a}_B + ma\,\hat{i}$$

$$\vec{a}_B = \frac{(-ma - F)}{m}\hat{i} = \left(\frac{F + ma}{m}\right)(-\hat{i})$$

(1) $\frac{Ma - F}{M}$

(2) $\frac{MF}{F + Ma}$

(3) $\frac{F + Ma}{M}$

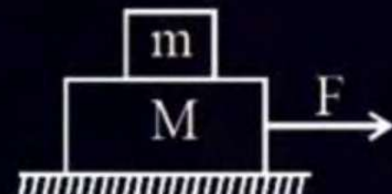
(4) $\frac{F - Ma}{M}$

QUESTION

Two blocks (m = 0.5 kg and M = 4.5 kg) are arranged on a horizontal frictionless table as shown in figure. The coefficient of static friction between the two blocks is $\frac{3}{7}$. Then the maximum horizontal force that can be applied on the larger block so that the blocks move together is ______ N.

(Round off to the Nearest Integer) [Take g as 9.8 ms^{-2}]. **[JEE Main - 2021]**

$$F_{net} = 5 \times \frac{3}{7} \times 9.8$$



Ans : (21)

QUESTION

A boy pushes a box of mass 2 kg with a force $F = (20\hat{\imath} + 10\hat{\jmath})$ N on a frictionless surface. If the box was initially at rest, then ______ m is displacement along the x-axis after 10 s.

[JEE Main - 2021]

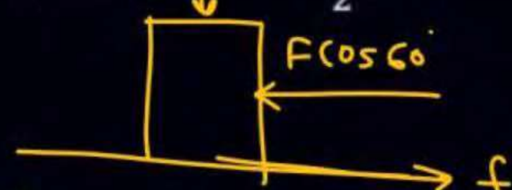
$$x = 0 + \frac{1}{2} \times 10 \times 10^2$$

Ans : (500)

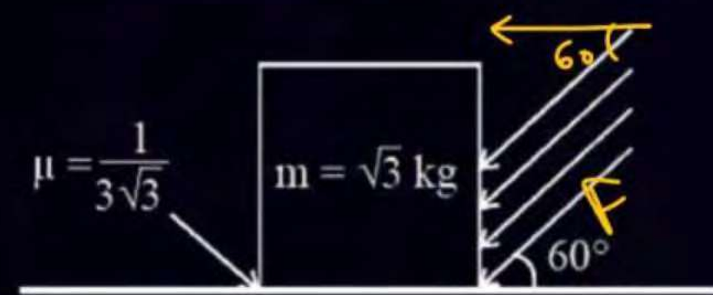
QUESTION

As shown in the figure, a block of mass $\sqrt{3}$ kg is kept on a horizontal rough surface of coefficient of friction The critical force to be applied on the vertical surface as shown at an angle $60°$ with horizontal such that it does not move, will be $3x$. The value of x will be. [$g = 10\ \mathrm{m/s^2}$; $\sin 60° = \frac{\sqrt{3}}{2}$; $\cos 60° = \frac{1}{2}$].

[JEE Main – 2021]



$$F\cos 60^\circ = \mu\left(mg + F\sin 60^\circ\right)$$



Ans : (3)

QUESTION

A body of mass 2 kg moves under a force of $(2\hat{i} + 3\hat{j} + 5\hat{k})$N. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is ______. (Round off to the Nearest Integer)

[JEE Main - 2021]

$y = 0 + \frac{1}{2} \times \frac{3}{2} \times 4^2$

$y = 12$

$8 = 0 + \frac{1}{2} \times 1 \times t^2$

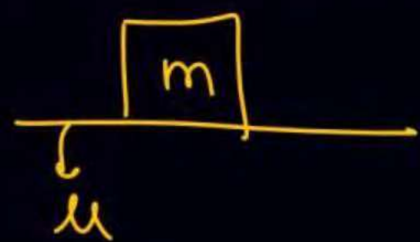
$t = 4\,\text{sec}$

Ans : (12)

QUESTION

A body of mass 1 kg rests on a horizontal floor with which it has a coefficient of static friction $\frac{1}{\sqrt{3}}$. It is desired to make the body move by applying the minimum possible force F N. The value of F will be ______.

(Round off to the Nearest Integer) [Take $g = 10\ ms^{-2}$]. **[JEE Main - 2021]**



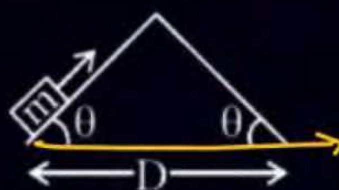
$$F = \frac{\mu mg}{\sqrt{1+\mu^2}} = \frac{1}{\sqrt{3}} \times \frac{10}{\sqrt{1+\frac{1}{3}}} = 5$$

Ans : (5)

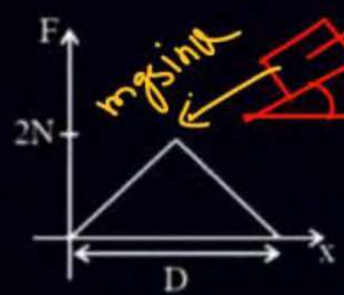
QUESTION

An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile. The correct applied force vs distance graph will be:

[JEE Main - 2021]

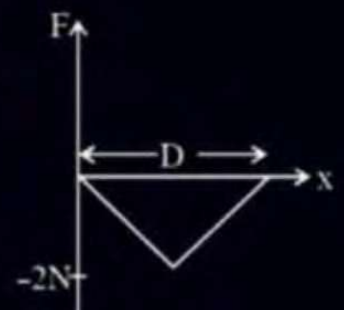


(1)

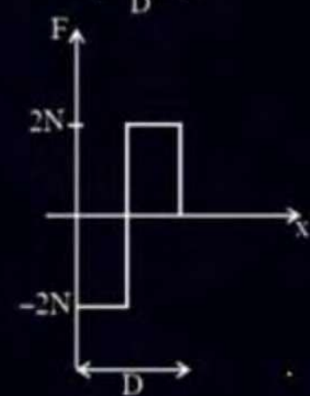


(2)

(3)



(4)

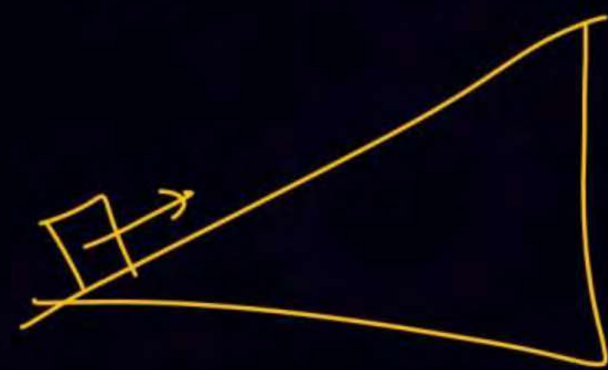


Ans : (2)

QUESTION

A body of mass 'm' is launched up on a rough inclined plane making an angle of $30°$ with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of x is ______. [JEE Main - 2021]

$$t_{\text{जाने वाला}} = \frac{1}{2} t_{\text{आने}}$$



Ans : (3)

QUESTION

$$J = \int_0^{2T} F.dt = mV_f - 0$$

A particle of mass M originally at rest is subjected to a force whose direction is constant but magnitude varies with time according to the relation $F = F_0\left[1 - \left(\frac{t-T}{T}\right)^2\right]$ Where F_0 and T are constants. The force acts only for the time interval 2T. The velocity v of the particle after time 2 T is:

[JEE Main - 2021]

$$a = \frac{F_0}{m}\left[1 - \left(\frac{t-T}{T}\right)^2\right] = \frac{dv}{dt}$$

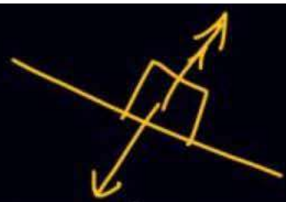
$$\int_0^{v} dv = \int_0^{2T} \frac{F_0}{m}\left[1 - \left(\frac{t-T}{T}\right)^2\right] dt$$

1. $2F_0T/M$
2. $F_0T/2M$
3. $4F_0T/3M$
4. $F_0T/3M$

Ans : (3)

JA

QUESTION



$m a_2 \sin 30 + N = mg\cos\theta$

$4a_2 + N = 40\sqrt{3}$

A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is: Given m = 8 kg, M = 16 kg. Assume all the surfaces shown in the figure to be frictionless.

[JEE Main – 2021]

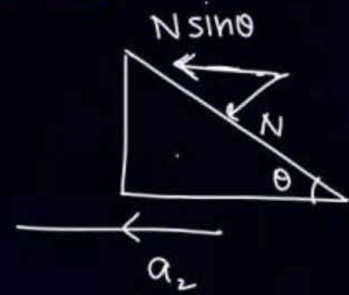
$\cancel{m} a_2 \cos\theta + \cancel{m} g\sin\theta = \cancel{m} a_1$

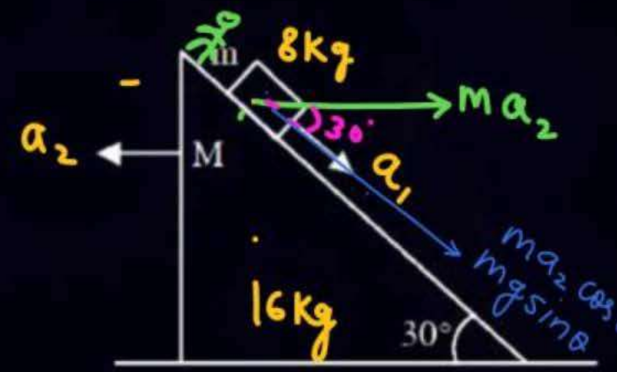
$\boxed{a_1 = a_2\cos\theta + g\sin\theta}$

$N\sin\theta = 16 \times a_2$

$N\,\frac{1}{2} = 16 a_2$

$\boxed{N = 32 a_2}$





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

(2) $\frac{6}{5}$g

(3) $\frac{3}{5}$g

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

Ans : (4)

QUESTION

When a body slides down from rest along a smooth inclined plane making an angle of $30°$ with the horizontal, it takes time T. When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1. The coefficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where x = ______. **[JEE Main - 2021]**

$$l = 0 + \frac{1}{2} \cdot g\sin\theta \, T^2$$

$$l = 0 + \frac{1}{2} \times (g\sin\theta - \mu g\cos\theta)(\alpha T)^2$$

Ans : (3)

QUESTION

For a free body diagram shown in the figure, the four forces are applied in the 'x' and 'y' directions. What additional force must be applied and at what angle with positive x-axis so that the net acceleration of body is zero?

[JEE Main - 2022]

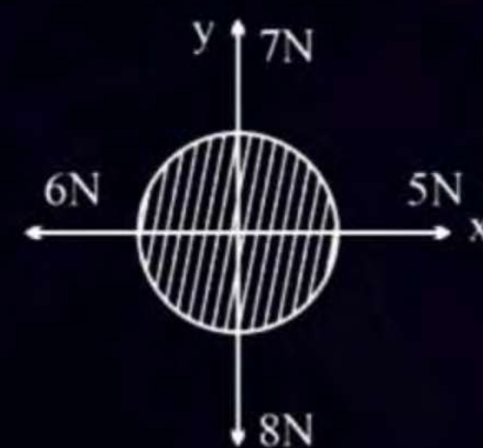
(1) $\sqrt{2}$ N, 45°

$\vec{F} + (-1\hat{i} - 1\hat{j}) = 0$

(2) $\sqrt{2}$ N, 135°

(3) $\frac{2}{\sqrt{3}}$ N, 30°

(4) 2 N, 45°



Ans : (1)

QUESTION

$a = \mu g$

A bag is gently dropped on a conveyor belt moving at a speed of 2 m/s. The coefficient of friction between the conveyor belt and bag is 0.4 Initially, the bag slips on the belt before is stops due to friction. The distance travelled by the bag on the belt during slipping motion is: [Take g = 10 m/s^{-2}].

[JEE Main - 2022]

$2^2 = 0 + 2a \times s$

$4 = 2 \times 4 \times s$

(1) 2 m

(2) 0.5 m

(3) 3.2 m

(4) 0.8 ms

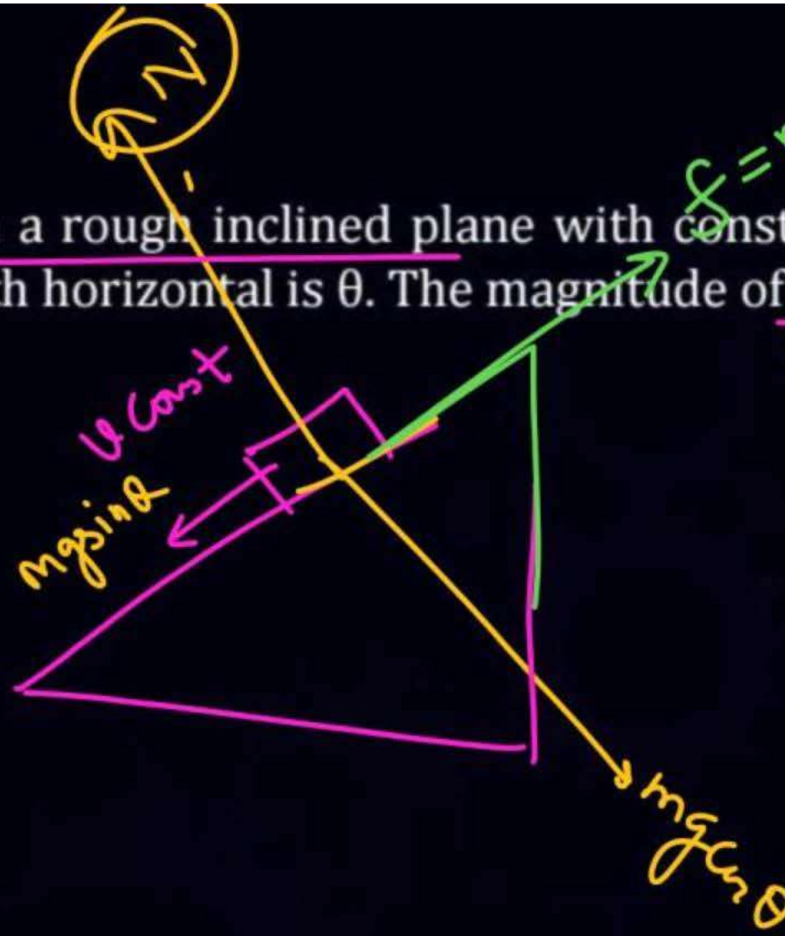
Ans : (2)

QUESTION

A block of mass M slides down on a rough inclined plane with constant velocity. The angle made by the incline plane with horizontal is θ. The magnitude of the contact force will be:

[JEE Main - 2022]

$\sqrt{N^2 + f^2}$



(1) Mg

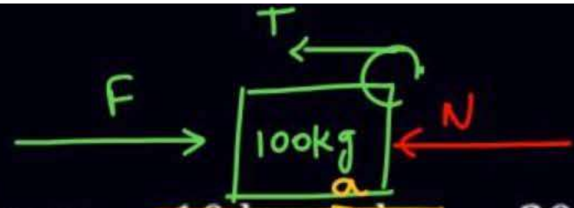
(2) $\cancel{Mg\cos\theta}$

(3) $\sqrt{Mg\sin\theta + Mg\cos\theta}$

(4) $Mg\sin\theta\sqrt{1+\mu}$

Ans : (1)

QUESTION



$F - T - N = 100 \times a$

$F - 240 - 520 = 100 \times 26$

Three masses M = 100 kg, m_1 = 10 kg and m_2 = 20 kg are arranged in a system as shown in figure. All the surface are frictionless and strings are inextensible and weightless. The pulleys are also weightless and frictionless. A force F is applied on the system so that the mass m_2 moves upward with an acceleration of 2 ms^{-2}. The value of F is:
(Take g = 10 ms^{-2}).

[JEE Main - 2022]

$T - 200 = 20 \times 2$

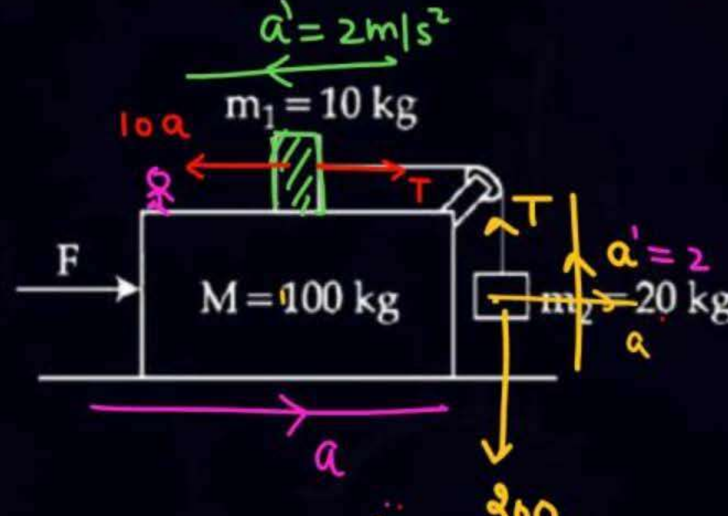
$\boxed{T = 240}$

$10a - T = 10 \times 2$

$10a = 240 + 20 = 260$

$\boxed{a = 26}$

$2600 + 760 = 3360$



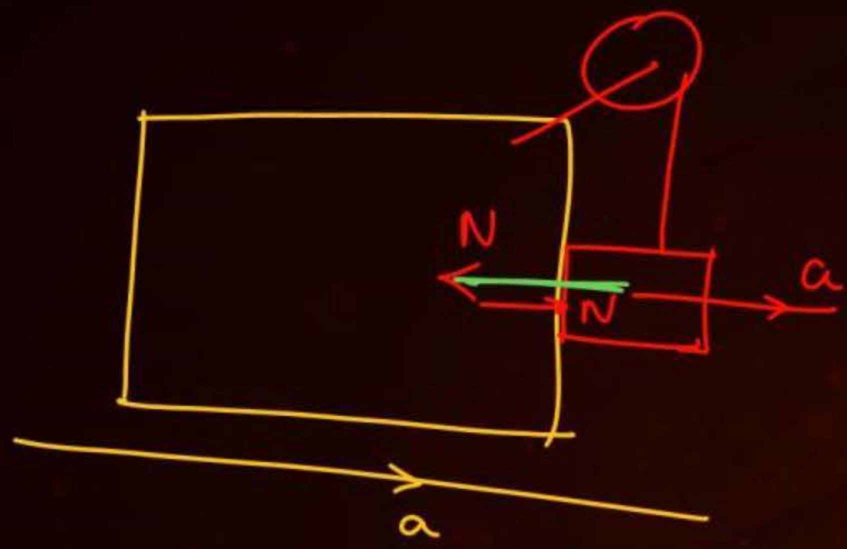
(1) 3360 N

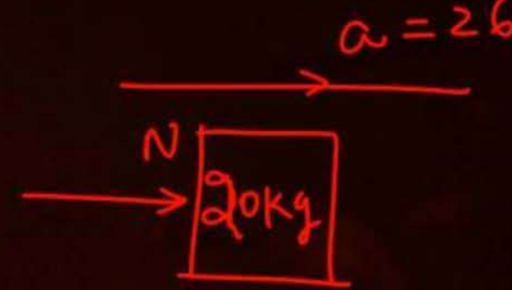
(2) 3380 N

(3) 3120 N

(4) 3240 N

Ans : (1)





$$N = 20 \times a = 20 \times 26$$
$$= \cancel{260}$$
$$520$$

QUESTION

$T - 500 = 50 \times 5$

$T = 750$

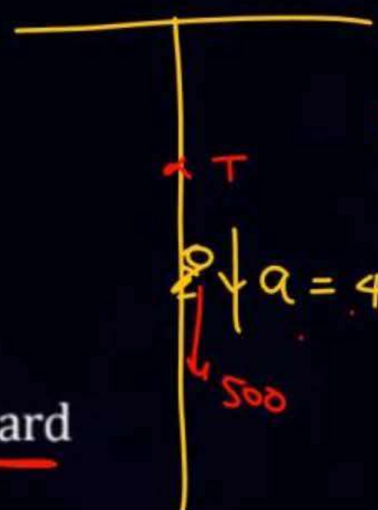
A monkey of mass 50 kg climbs on a rope which can withstand the tension (T) of 350 N. If monkey initially climbs down with an acceleration of $4\ m/s^2$ and then climbs up with an acceleration of $5\ m/s^2$. Choose the correct option ($g = 10\ m/s^2$) **[JEE Main – 2022]**

(1) T = 700 N while climbing upward

(2) T = 350 N while going downward

(3) Rope will break while climbing upward

(4) Rope will break while going downward

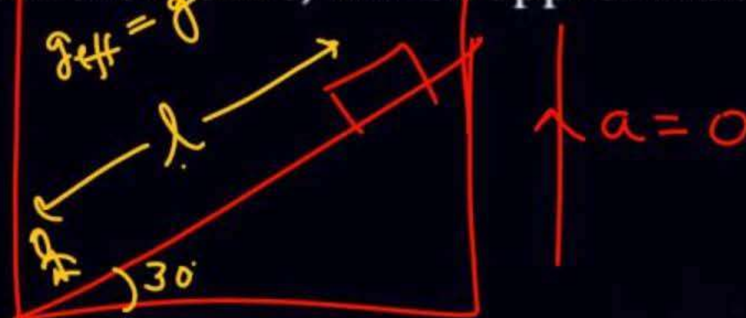


$500 - T = 50 \times 4$

Ans : (3)

QUESTION

A block 'A' takes 2 s to slide down a frictionless incline of 30° and length 'l', kept inside a lift going up with uniform velocity 'v'. If the incline is changed to 45°, the time taken by the block, to slide down the incline, will be approximately: **[JEE Main - 2022]**



1. 2.66 s
2. 0.83 s
3. 1.68 s
4. 0.70 s

$$l = 0 + \frac{1}{2} \times g \sin 30^\circ \times 2^2$$

$$l = 0 + \frac{1}{2} \times g \sin 45^\circ \times t^2$$

Ans : (3)

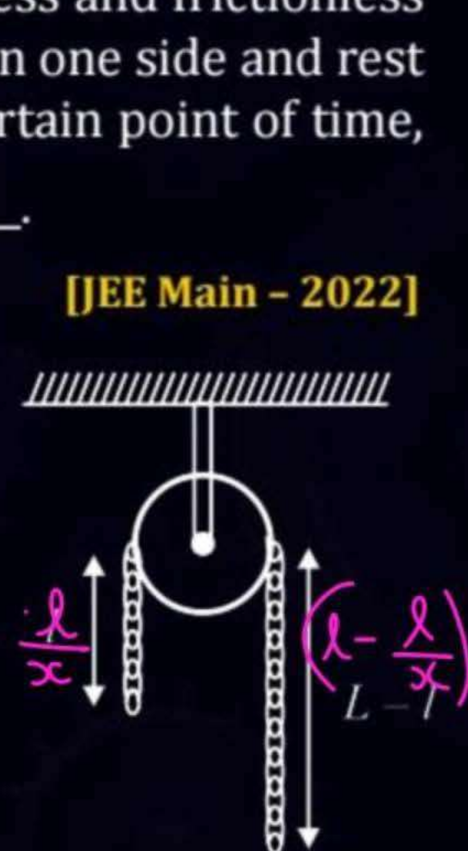
QUESTION

A uniform metal chain of mass m and length 'L' passes over a massless and frictionless pulley. It is released from rest with a part of its length 'l' is hanging on one side and rest of its length '$L - l$' is hanging on the other side of the pulley. At a certain point of time, when $l = \frac{L}{x}$, the acceleration of the chain is $\frac{g}{2}$. The value of x is ______.

[JEE Main - 2022]

$$a = \frac{\cancel{g}}{2} = \frac{\left(\cancel{l} - \frac{\cancel{l}}{x}\right)\cancel{\lambda}\cancel{g} - \frac{l}{x}\cancel{\lambda}\cancel{g}}{\cancel{l}\cancel{\lambda}}$$

$$\frac{1}{2} = \left(1 - \frac{1}{x}\right) + \left(-\frac{1}{x}\right)$$



(1) 6

(2) 2

(3) 1.5

(4) 4

Ans : (4)

QUESTION

A uniform chain of 6 m length is placed on a table such that a part of its length is hanging over the edge of the table. The system is at rest. The co-efficient of static friction between the chain and the surface of the table is 0.5 , the maximum length of the chain hanging from the table is _____ m.

[JEE Main - 2022]

$$\lambda x g = \frac{1}{2}\times(l-x)\lambda g$$

Ans : (2)

QUESTION

$a =$ ✓

A force on object of mass 100 g is $(10\hat{i} + 5\hat{j})$N. The position of that object at $t = 2$ s is $(a\hat{i} + b\hat{j})$m after starting from rest. The value of $\frac{a}{b}$ will be ______. **[JEE Main – 2022]**

Ans : (2)

QUESTION

A disc with a flat small bottom beaker placed on it at a distance R from its centre is revolving about an axis passing through the centre and perpendicular to its plane with an angular velocity ω. The coefficient of static of the disc is μ. The beaker will revolve with disc if:

[JEE Main - 2022]

1. $R \le \frac{\mu g}{2\omega^2}$
2. $R \le \frac{\mu g}{\omega^2}$
3. $R \ge \frac{\mu g}{2\omega^2}$
4. $R \ge \frac{\mu g}{\omega^2}$

$f = mr\omega^2 < (f_s)_{max}$

$mr\omega^2 < \mu mg$

Ans : (2)

QUESTION

A curved in a level road has a radius 75 m. The maximum speed of a car turning this curved road can be 30 m/s without skidding. If radius of curved road is changed to 48 m and the coefficient of friction between the tyres and the road remains same, then maximum allowed speed would be _____ m/s. [JEE Main - 2022]

$$V_{max} = \sqrt{\mu R g}$$

$$30 = \sqrt{\mu \times 75 g}$$

$$v = \sqrt{\mu g R}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{R_1}{R_2}} = \sqrt{}$$

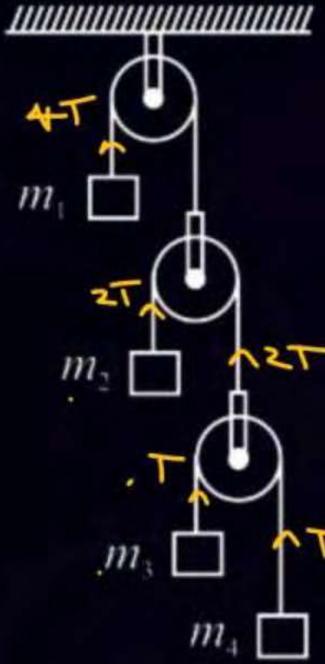
$$\frac{30}{v_2} = \sqrt{\frac{75}{48}}$$

Ans : (24)

QUESTION

In the arrangement shown in figure a_1, a_2, a_3 and a_4 are the acceleration of masses m_1, m_2, m_3 and m_4 respectively. Which of the following relation is true for this arrangement?

[JEE Main - 2022]



(1) $4a_1 + 2a_2 + a_3 + a_4 = 0$

(2) $a_1 + 4a_2 + 3a_3 + a_4 = 0$

(3) $a_1 + 4a_2 + 3a_3 + 2a_4 = 0$

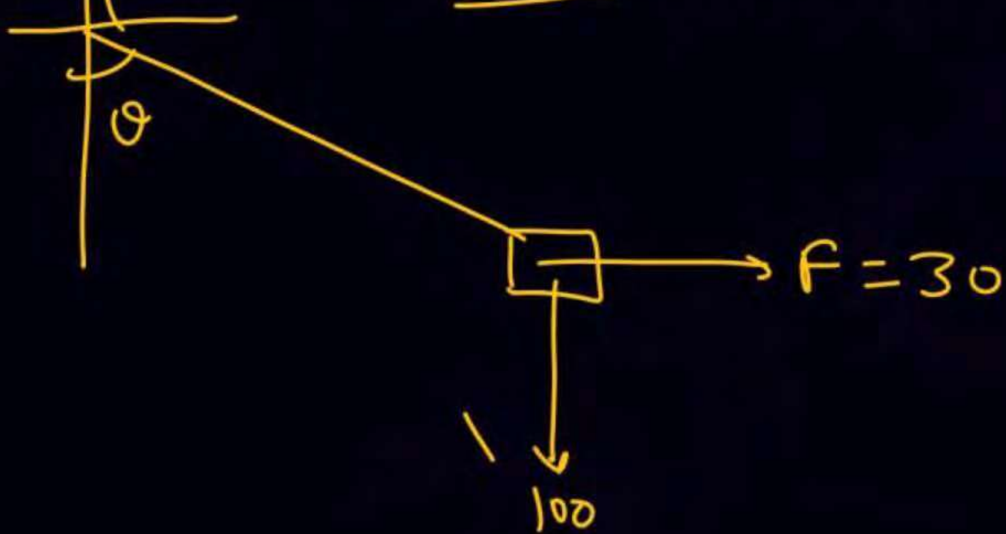
(4) $2a_1 + 2a_2 + 3a_3 + a_4 = 0$

Ans : (1)

QUESTION

A mass of 10 kg is suspended vertically by a rope of length 5 m from the roof. A force of 30 N is applied at the middle point of rope in horizontal direction. The angle made by upper half of the rope with vertical is $\theta = \tan^{-1}(x \times 10^{-1})$. The value of x is ______. (Given $g = 10\ m/s^2$).

[JEE Main - 2022]



Ans : (3)

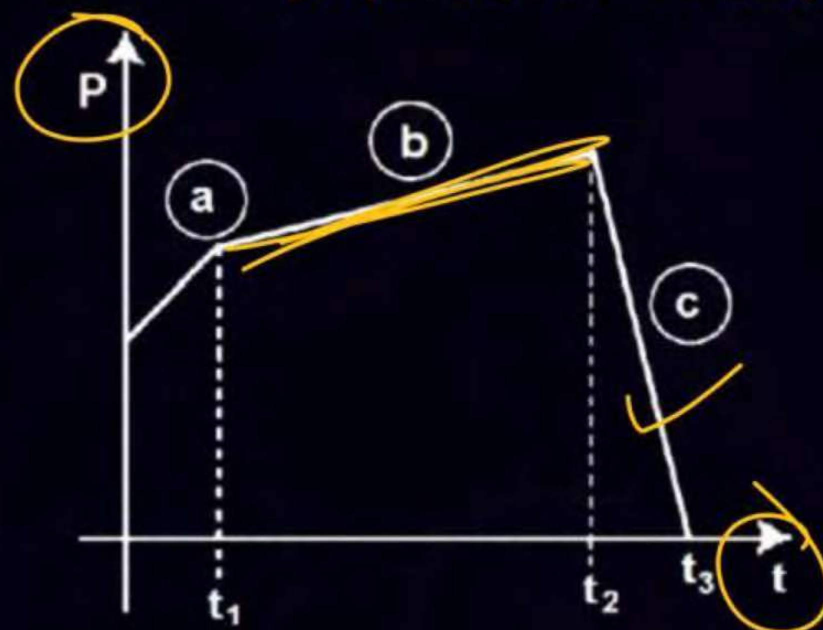
QUESTION

The figure represents the momentum time (p–t) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively?

If $(t_3 - t_2) < t_1$.

[30 January 2023 - Shift 1]

$$F = \frac{dp}{dt}$$



1. c and a
2. b and c
3. c and b
4. a and b

Ans : (3)

QUESTION

A cricket player catches a ball of mass 120 g moving with 25 m/s speed. If the catching process is completed in 0.1 s then the magnitude of force exerted by the ball on the hand of player will be (in SI unit):

[01 Feb. 2024 - Shift 2]

(1) 24

(2) 12

(3) 25

(4) 30

$$\langle F \rangle = \frac{0 - mv}{\Delta t}$$

Ans : (4)

QUESTION

Given below are two statements:

Statement (I): The limiting force of static friction depends on the area of contact and independent of materials.

Statement (II): The limiting force of kinetic friction is independent of the area of contact and depends on materials.

In the light of the above statements, choose the most appropriate answer from the options given below: **[27 Jan. 2024 - Shift 2]**

1. Statement I is correct but Statement II is incorrect
2. Statement I is incorrect but Statement II is correct
3. Both Statement I and Statement II are incorrect
4. Both Statement I and Statement II are correct

Ans : (2)

QUESTION

A stone of mass 900 g is tied to a string and moved in a $\boxed{\text{vertical circle}}$ of radius 1 m making 10 rpm. The tension in the string, when the stone is at the lowest point is (if $\pi^2 = 9.8$ and $g = 9.8\ \text{m/s}^2$).

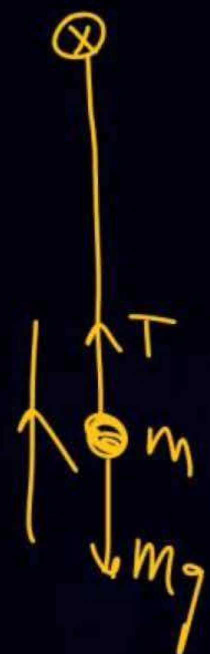
[29 Jan. 2024 - Shift 2]

(1) 97 N

(2) 9.8 N

(3) 8.82 N

(4) 17.8 N



$$T - mg = \frac{mv^2}{R} = mR\omega^2$$

Ans : (2)

QUESTION

$a = \frac{T-10}{2}$

All surfaces shown in figure are assumed to be frictionless and the pulleys and the string are light. The acceleration of the block of mass 2 kg is: [30 Jan. 2024 - Shift 1]

$Ta_1 + 2Ta_2 = 0$

$a_1 + 2a_2 = 0$

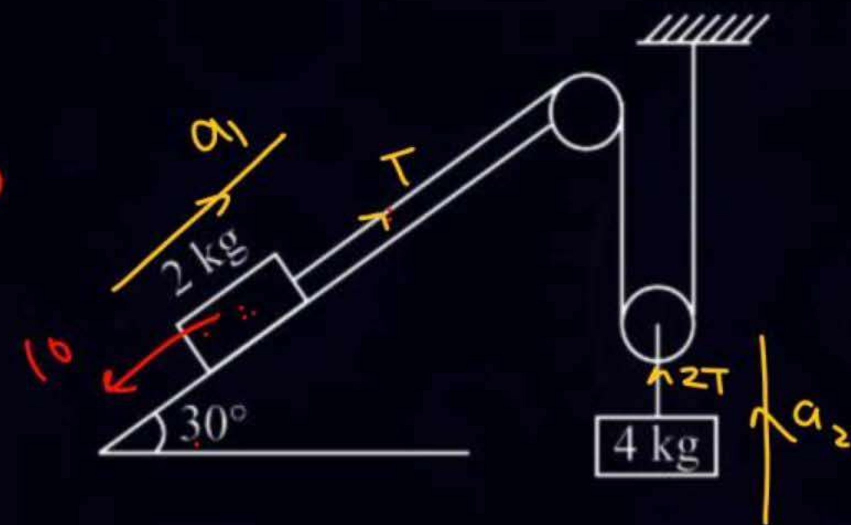
$\left(\frac{T-10}{2}\right) + 2\times\left(\frac{2T-40}{4}\right) = 0$

(1) g

(2) g/3

(3) g/2

(4) g/4



Ans : (2)

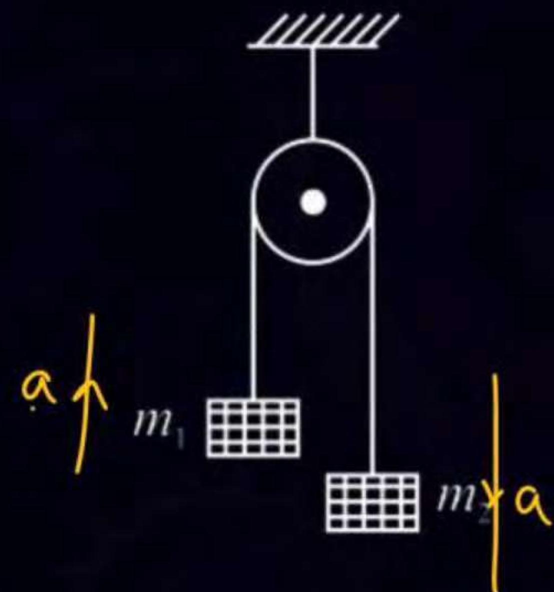
QUESTION

A light string passing over a smooth light fixed pulley connects two blocks of masses m_1 and m_2. If the acceleration of the system is g/8, then the ratio of masses is:

$a = g/8$

[31 Jan. 2024 - Shift 2]

1. 9/7
2. 8/1
3. 4/3
4. 5/3



Ans : (1)

QUESTION

A particle of mass m is fixed to one end of a light spring having force constant k and unstretched length l. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is:

[JEE Main - 2020]

(1) $\dfrac{ml\omega^2}{k+m\omega^2}$

(2) $\dfrac{ml\omega^2}{k-m\omega^2}$

(3) $\dfrac{ml\omega^2}{k-m\omega}$

(4) $\dfrac{ml\omega^2}{k+m\omega}$

$$kx = m(l+x)\omega^2$$

$$x(k-m\omega^2) = ml\omega^2$$

Ans : (2)

QUESTION

$\Delta l / l_i = \frac{x}{l}$

$k >> m\omega^2$

A spring mass system (mass m, spring constant k and natural length l) rest in equilibrium on a horizontal disc. The free end of the spring is fixed at the centre of the disc. If the disc together with spring mass system, rotates about it's axis with an angular velocity ω, ($k >> m\omega^2$) the relative change in the length of the spring is best given by the option:

[JEE Main - 2020]

$$x = \frac{m l \omega^2}{k - m\omega^2} \approx \frac{m l \omega^2}{k}$$

$$\frac{x}{l} = \frac{m\omega^2}{k}$$

(1) $\frac{2m\omega^2}{k}$

(2) $\frac{m\omega^2}{3k}$

(3) $\sqrt{\frac{3}{2}}\left(\frac{m\omega^2}{k}\right)$

(4) $\frac{m\omega^2}{k}$

Ans : (4)

QUESTION

A bead of mass m stays at point P(a, b) on a wire bent in the shape of a parabola $y = 4Cx^2$ and rotating with angular speed ω (see figure). The value of ω is (neglect friction):

[JEE Main - 2020]

$\frac{dy}{dx} = 8Cx$

$\cancel{m}g\sin\theta = \cancel{m}a\omega^2\cos\theta$

$g\tan\theta = a\omega^2$

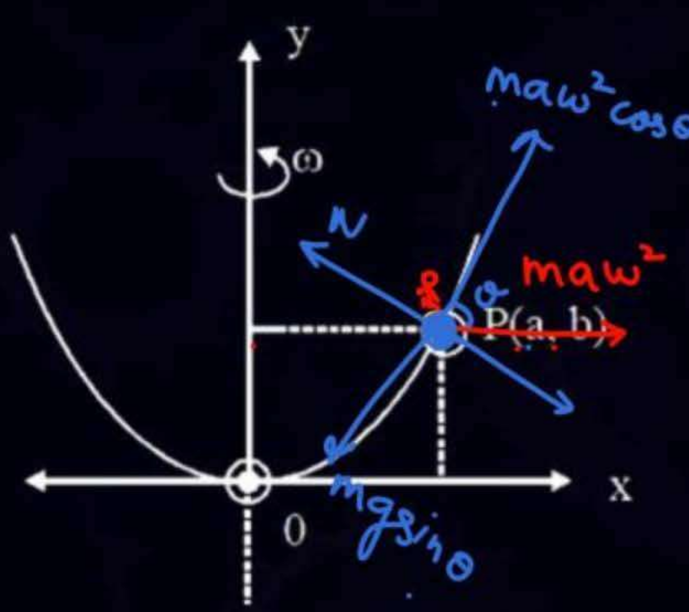
$g \cdot 8C\cancel{a} = \cancel{a}\omega^2$

(1) $\sqrt{\frac{2gC}{ab}}$

(2) $2\sqrt{2gC}$

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

(4) $2\sqrt{gC}$



Ans : (2)

QUESTION

JA

A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F which is inversely proportional to R^3. Its time period of revolution will be given by: [JEE Main - 2021]

(1) $T \propto R^2$

(2) $T \propto R^{3/2}$

(3) $T \propto R^{5/2}$

(4) $T \propto R^{4/3}$

$$F = \frac{K}{R^3} = mR\omega^2$$

$$\omega^2 = \frac{K}{mR^4}$$

$$\omega \propto \frac{1}{R^2}$$

$$\omega = \frac{2\pi}{T} \propto \frac{1}{R^2}$$

Ans : (1)

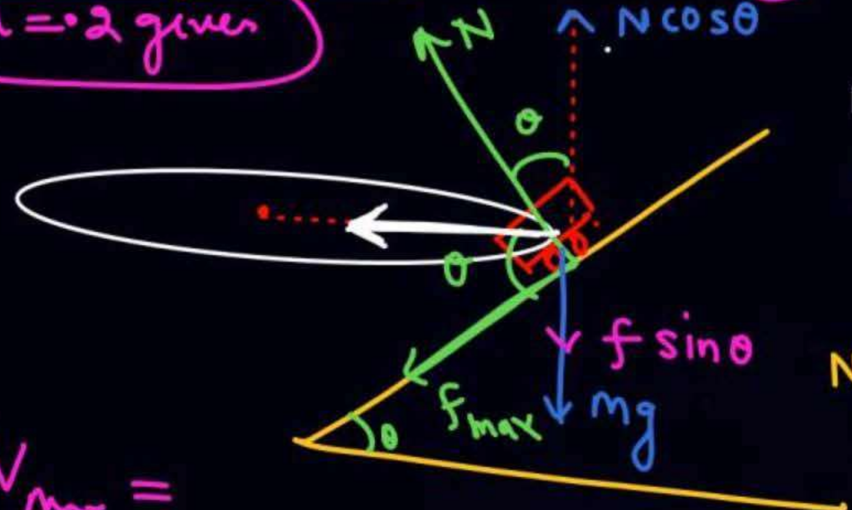
QUESTION R

$V_{max} = \sqrt{Rg\tan(\theta+\phi)} \equiv ?$

The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is $N = ?$ $\times 10^3$ kg m/s²

$\mu = .2$ given

[JEE Main - 2021]



$V_{max} =$

(1) 10.2

(2) 7.2

(3) 12.4

(4) 6.96

$N\cos\theta = f\sin\theta + mg$

$N\sin\theta + f\cos\theta = \frac{mv^2}{R}$

$f = \mu N$

$N\cos\theta - \mu N\sin\theta = mg$

$N = \frac{mg}{\cos\theta - \mu\sin\theta} = \frac{8000}{\frac{\sqrt{3}}{2} - .2\times\frac{1}{2}}$

Ans : (1)

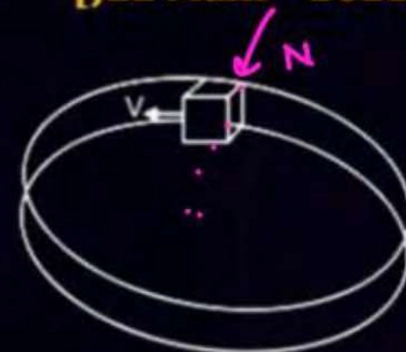
QUESTION

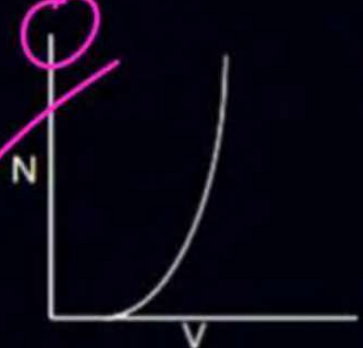
A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (V)?

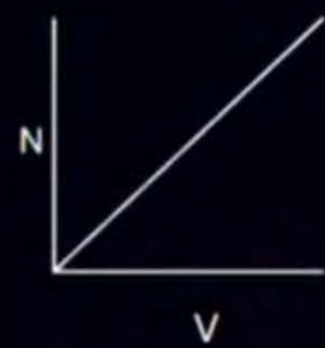
[JEE Main - 2022]

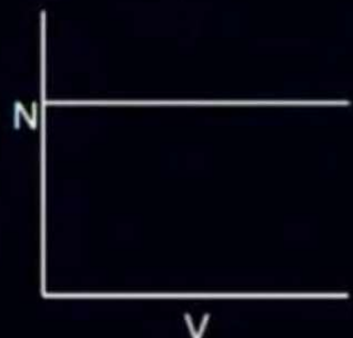
$N = \frac{mv^2}{R}$

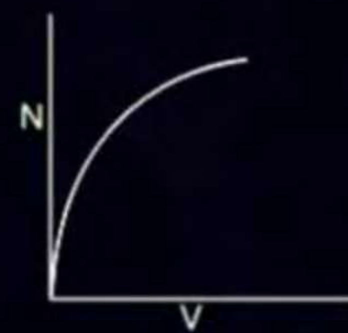
$y = kx^2$



(1)


(2)


(3)


(4)


Ans : (1)

QUESTION

$P = \vec{F} \cdot \vec{v}$

A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration (a) is verying with time t as $a = k^2rt^2$, where k is constant. The power delivered to the particle by the force acting on it is given as: **[JEE Main - 2022]**

$F = m(-a_c\hat{i} + a_t\hat{j})$

(1) zero

(2) $mk^2r^2t^2$

(3) mk^2r^2t

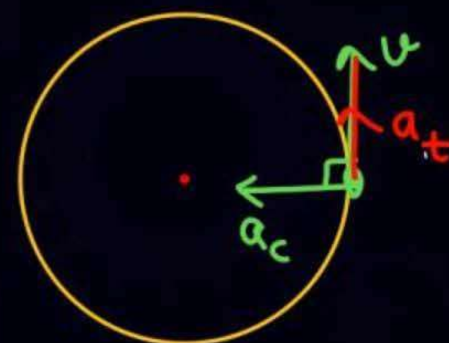
(4) mk^2rt

$k^2rt^2 = \frac{v^2}{r}$

$v^2 = k^2r^2t^2$

$v = kr t$

$a_t = kr$



$P = mkr \cdot v$

$= mk^2r^2 \cdot t$

Ans : (3)

QUESTION

60 $v = \frac{2\pi R}{T}$

A clock has a continuously moving second's hand of 0.1 m length. The average acceleration of the tip of the hand (in units of ms^{-2}) is of the order of: [JEE Main - 2020]

half $= \langle a \rangle = \frac{2v}{T/2} = \frac{4v}{T} = \frac{4 \times R}{T} \frac{2\pi}{T}$

1. 10^{-3}
2. 10^{-2}
3. 10^{-4}
4. 10^{-1}

Ans : (1)

QUESTION

$$2460\frac{\pi}{30} = 90\frac{\pi}{30} + \alpha\, 26$$

The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is (Assuming the acceleration to be uniform). **[JEE Main - 2021]**

ω_i ω_f

$$\omega_f^2 = \omega_i^2 + 2\alpha\theta$$

$$1\ \text{rpm} = \frac{\pi}{30}\ (\text{rad/sec})$$

$$\frac{\theta}{2\pi}$$

Ans : (728)

QUESTION

A particle of mass m is suspended from a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be:

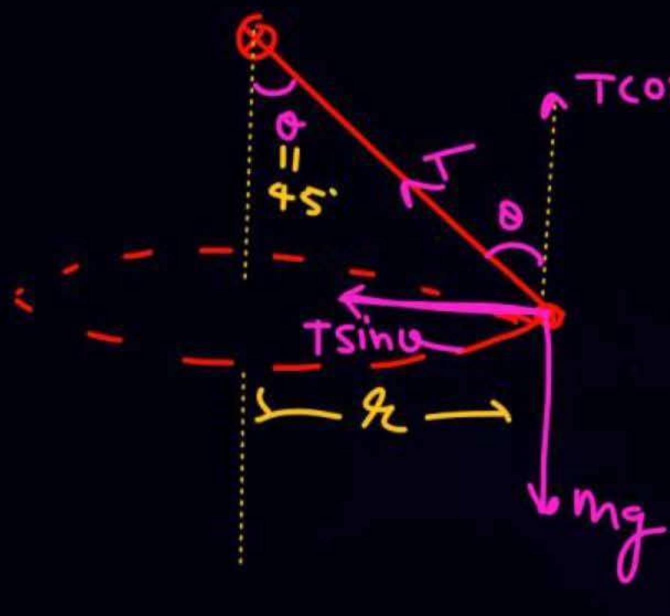
[JEE Main - 2021]

(1) $\sqrt{rg}$

(2) $\sqrt{2rg}$

(3) $2\sqrt{rg}$

(4) $\sqrt{\frac{rg}{2}}$



$T\cos\theta = mg$

$T\sin\theta = \frac{mv^2}{r} = mr\omega^2$

$\tan\theta = \frac{v^2}{rg}$

$v = \sqrt{rg}$

Ans : (1)

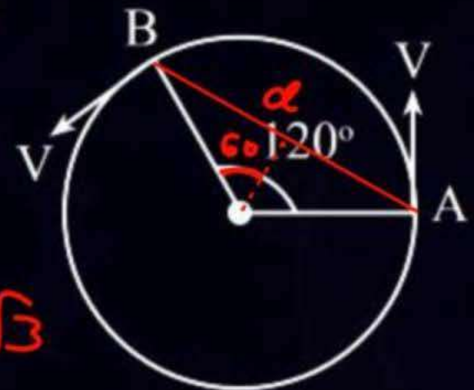
QUESTION

$$v = \pi = \frac{2\pi R}{T}$$

As shown in the figure, a particle is moving with constant speed π m/s. Considering its motion from A to B, the magnitude of the average velocity is: **[06 April, 2023 (shift-II)]**

$$\frac{R\sqrt{3}}{T/3} \equiv \frac{d}{T/3} =$$

$$d = 2R\sin 60^\circ = R\sqrt{3}$$



$$\frac{R3\sqrt{3}}{T} = \frac{\cancel{R}3\sqrt{3}}{2\cancel{R}} = \checkmark = 1.5\sqrt{3}$$

(1) π m/s

(2) $\sqrt{3}$ m/s

(3) $2\sqrt{3}$ m/s

(4) $1.5\sqrt{3}$ m/s

Ans : (4)

QUESTION

An object moves at a constant speed along a circular path in a horizontal plane with centre at the origin. When the object is at x = +2m, its velocity is $-4\,\hat{j}$ m/s. The object's velocity (v) and acceleration (a) at $x = -2$ m will be: **[29 Jan, 2023 (shift-II)]**

(1) $v = 4\hat{i} m/s, a = 8\hat{j} m/s^2$

(2) $v = 4\hat{j} m/s, a = 8\hat{i} m/s^2$

(3) $v = -4\hat{j} m/s, a = 8\hat{i} m/s^2$

(4) $v = -4\hat{i} m/s, a = -8\hat{j} m/s^2$

Ans : (2)

QUESTION

$54 \times \frac{5}{18} = 15 \text{ m/s}$

A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential and centripetal acceleration are equal. Time taken by the car to complete first quarter of revolution, if it is moving with an initial speed of 54 km/hr is $t\left(1-e^{-\pi/2}\right)$s. The value of t is: [29 Jan, 2023 (shift-II)]

speed

$$a_t = \frac{dv}{dt} = \frac{v^2}{R}$$

$$\frac{2\pi R}{4}$$

$$\int_{15}^{v} \frac{dv}{v^2} = \int_0^t \frac{dt}{R}$$

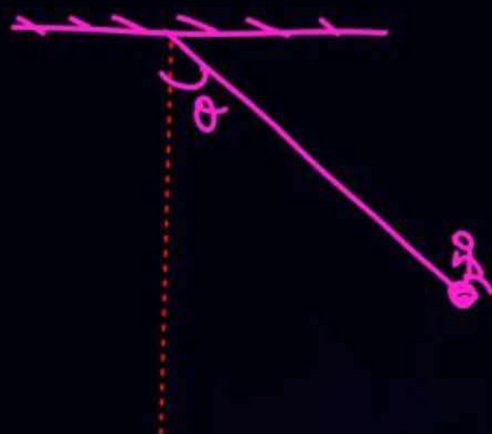
Ans : (40)

QUESTION

A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be:

(Take $g = 10\ \text{m/s}^2$)

[25 Jan, 2023 (shift-I)]



$\tan\theta = \frac{F}{mg} = \frac{mv^2/r}{mg} = \frac{v^2}{rg}$

$\frac{400}{40 \times 10}$

(1) $\pi/6$

(2) $\pi/2$

(3) $\pi/4$

(4) $\pi/3$

Ans : (3)

36. A piece of wire is bent in the shape of a parabola $y = kx^2$ (y-axis vertical) with a bead of mass m on it. The bead can slide on the wire without friction. It stays at the lowest point of the parabola when the wire is at rest. The wire is now accelerated parallel to the x-axis with a constant acceleration a. The distance of the new equilibrium position of the bead, where the bead can stay at rest with respect to the wire, from the y-axis is **[IIT-JEE-2009]**

एक तार के टुकड़े को, एक परवलय $y = kx^2$ (ऊर्ध्वाधर y अक्ष) की आकृति में मोड़ा गया है जिसमें m द्रव्यमान का एक मोती है। मोती, तार पर बिना घर्षण के फिसल सकता है। जब तार विरामावस्था में होता है तब मोती, परवलय के निम्नतम बिन्दु पर होता है। अब तार को x अक्ष के समान्तर नियत त्वरण a से त्वरित किया जाता है। y अक्ष से मोती की नयी साम्यावस्था की स्थिति की दूरी, जहां मोती तार के सापेक्ष विरामावस्था में रूक सकता है, होगी:-

$ma\cos\theta = mg\sin\theta$

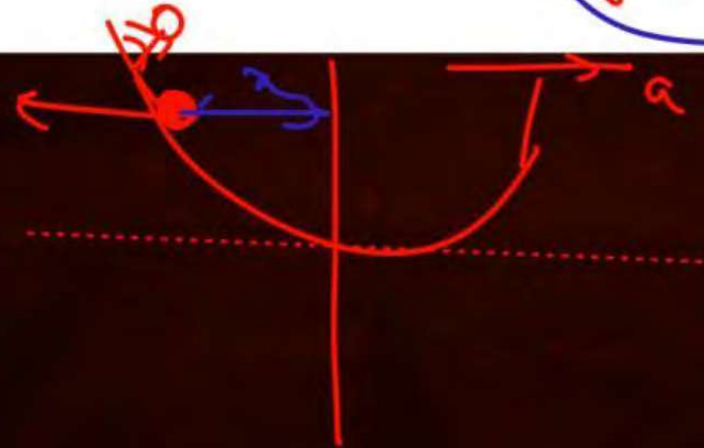
(A) $\frac{a}{gk}$ (B) $\frac{a}{2gk}$ (C) $\frac{2a}{gk}$ (D) $\frac{a}{4gk}$

$g\tan\theta = a$

$y = kx^2$

$g\,2kx = a$

Ans. **(B)**



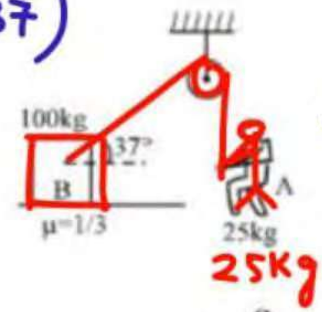
45. Block B of mass 100 kg rests on a rough surface of friction coefficient $\mu = 1/3$. A rope is tied to block B as shown in figure. The maximum acceleration with which boy A of 25 kg can climbs on rope without making block move is :

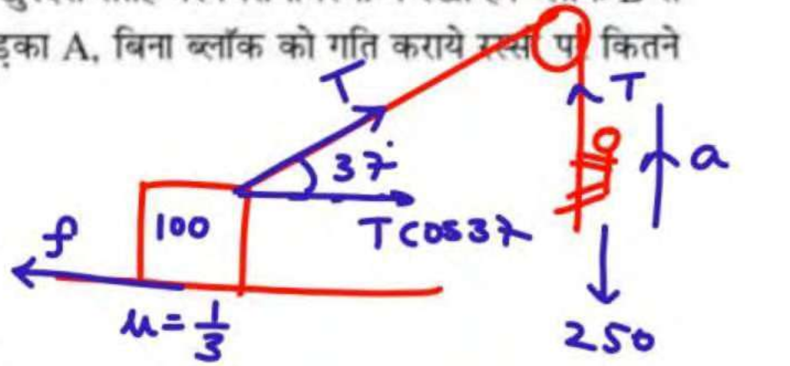
एक 100 kg द्रव्यमान वाला ब्लॉक B घर्षण गुणांक $\mu = 1/3$ वाली खुरदरी सतह पर विरामावस्था में रखा है। ब्लॉक B से चित्रानुसार एक रस्सी को बांधा गया है। एक 25 kg द्रव्यमान का लड़का A, बिना ब्लॉक को गति कराये रस्सी पर कितने अधिकतम त्वरण से चढ़ सकता है?

$$T\cos 37^\circ = \frac{1}{2}\left(1000 - T\sin 37^\circ\right)$$

$$T \times \frac{3}{5} = \frac{1}{2}\left(1000 - T\frac{3}{5}\right)$$

$T = \checkmark$





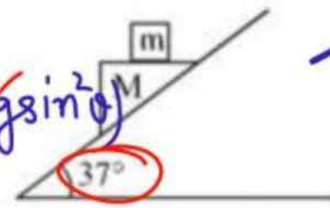
$$T - 250 = 25a$$

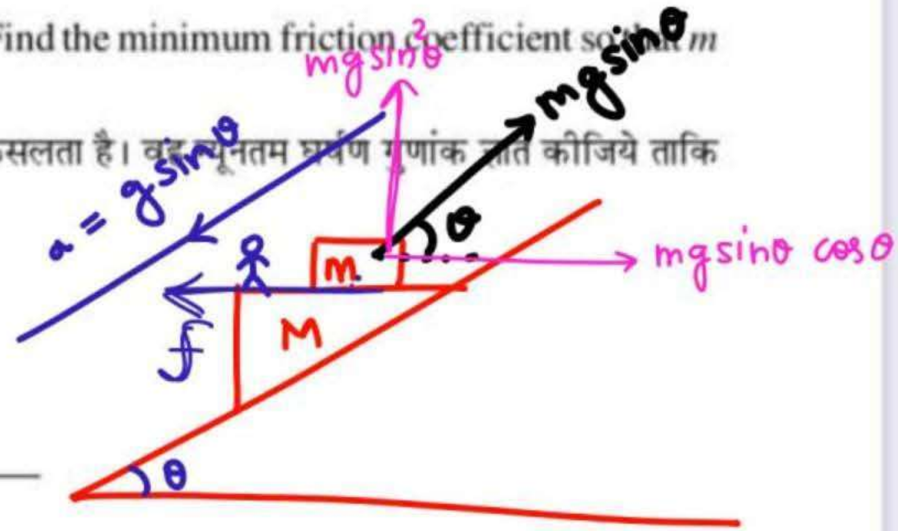
(A) $\frac{4g}{3}$ (B) $\frac{g}{3}$ (C) $\frac{g}{2}$ (D) $\frac{3g}{4}$

Ans. (B)

24. Block M slides down on frictionless incline as shown. Find the minimum friction coefficient so that m does not slide with respect to M.

चित्रानुसार ब्लॉक M एक घर्षणरहित नत तल पर नीचे की ओर फिसलता है। वह न्यूनतम घर्षण गुणांक ज्ञात कीजिये ताकि m, M के सापेक्ष इस पर गति ना करे ?





$$mg\sin\theta\cos\theta = (f_s)_{max}$$

$$\cancel{mg}\sin\theta\cos\theta = \mu(\cancel{m}g - \cancel{m}g\sin^2\theta)$$

$$\frac{\sin\theta\cancel{\cos\theta}}{\cos^2\theta} = \mu$$

Ans. 3/4

$$\mu = \tan\theta = 3/4$$

23. If the string & all the pulleys are ideal, acceleration of mass m is :-
यदि रस्सी तथा सभी घिरनियां आदर्श हैं तो द्रव्यमान m का त्वरण होगा :-

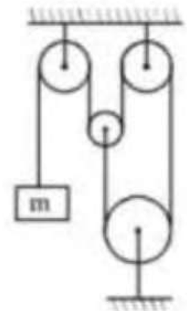
$0 = T$

$a = g$

$2T = T$

$2T - T = 0$

$T = 0$

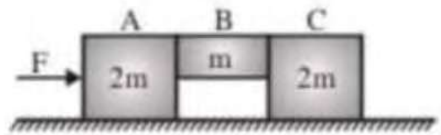


(A) $\frac{g}{2}$ (B) 0 (C) g (D) dependent on m

Ans. (C)

37. The system is pushed by a force F as shown in figure. All surfaces are smooth except between B and C. Friction coefficient between B and C is μ. Minimum value of F to prevent block B from downward slipping is :-

चित्र में प्रदर्शित निकाय को F बल द्वारा धकेला जाता है। B एवं C के मध्य की सतह को छोड़कर सभी सतहें चिकनी है। B एवं C के मध्य घर्षण गुणांक μ है। ब्लॉक B को नीचे की ओर गिरने से रोकने के लिये F का न्यूनतम मान होगा:



(A) $\left(\frac{3}{2\mu}\right)mg$ (B) $\left(\frac{5}{2\mu}\right)mg$ (C) $\left(\frac{5}{2}\right)\mu mg$ (D) $\left(\frac{3}{2}\right)\mu mg$

Ans. **(B)**

$$a = \frac{80 - f}{10} = \frac{80 - 16}{10} = 6.4$$

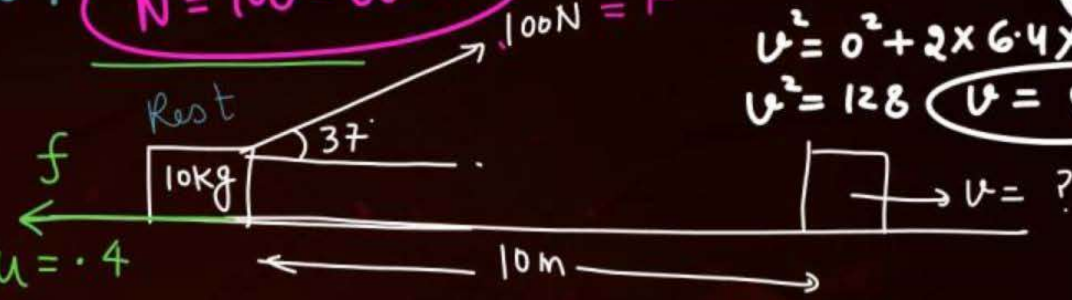
$$N = 100 - 60 = 40$$

$$v^2 = 0^2 + 2 \times 6.4 \times 10$$

$$v^2 = 128 \quad \boxed{v = 8\sqrt{2}}$$

WPE

Q



* $WD = \int \vec{F} \cdot d\vec{s}$

* $F \rightarrow$ const, $WD = \vec{F} \cdot \vec{d} = Fd\cos\theta$,

* $WET \equiv (WD)_{\text{all the force}} = \Delta K.E.$

① $W_F = 100 \times 10 \times \cos 37^\circ = +800$

② $W_g = 0 = W_N$

③ $W_f = -f \times 10 = -\mu N \times 10$

$= -.4 \times 40 \times 10 = -160$

$(WD)_{\text{all the force}} = 800 + 0 + 0 - 160 = 640$

$= \frac{1}{2} \times 10 \times v_f^2 - 0$

$v_f = 8\sqrt{2}$

* $(WD) = \int \vec{F} \cdot d\vec{s}$

* $(WD)_{sp} = -\frac{1}{2}K\left(x_f^2 - x_i^2\right)$

* F हमेशा displacement के ↑↑ या ↑↓ है

  $(WD)_f = \pm(\text{Force} \times \text{path length})$

* $dU = -(WD)_{i.c.F.}$

* $\boxed{F = -\frac{dU}{dr}}$

* $\vec{F_x} = -\frac{\partial U}{\partial x}\hat{i}$

* $\vec{F_y} = -\frac{\partial U}{\partial y}\hat{j}$

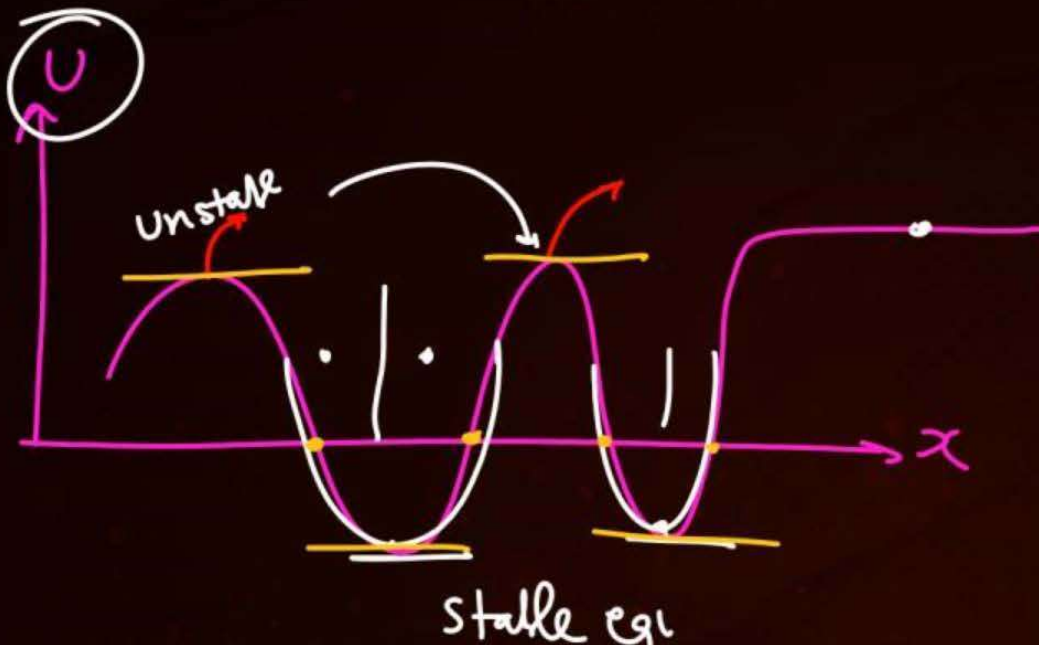
* $\Delta U = -\left[\int F_x \cdot dx + \int F_y \, dy + \ldots\right]$

* Equil. $F_{net} = 0$

  $\frac{dU}{dx} = 0$

  → stable ≡ $\frac{d^2U}{dx^2} > 0$

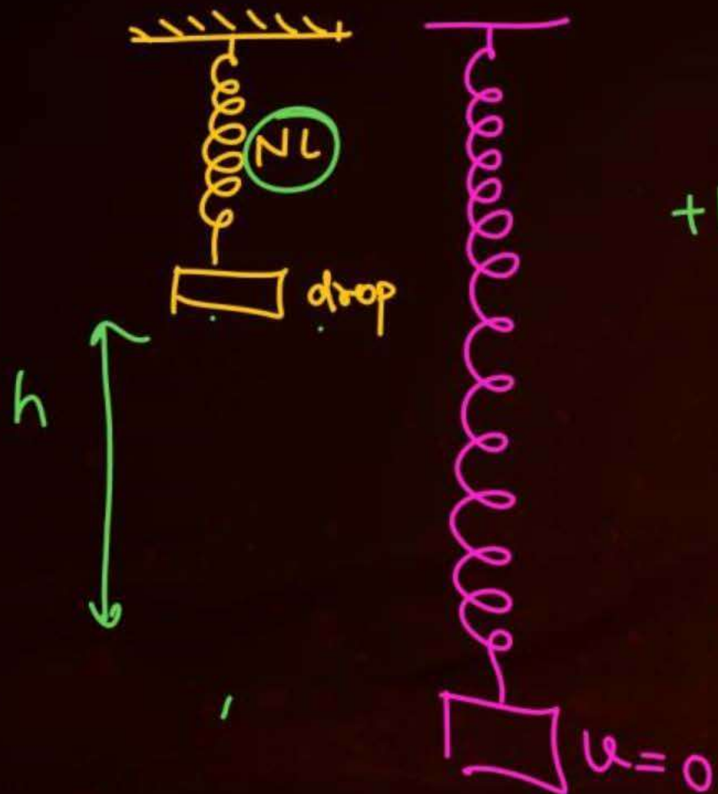
  → Unstable ≡ $\frac{d^2U}{dx^2} < 0$



$$\frac{dU}{dx} = 0$$

$$* \quad \boxed{P = \frac{dW}{dt} = \vec{F}\cdot\vec{v}}$$

1

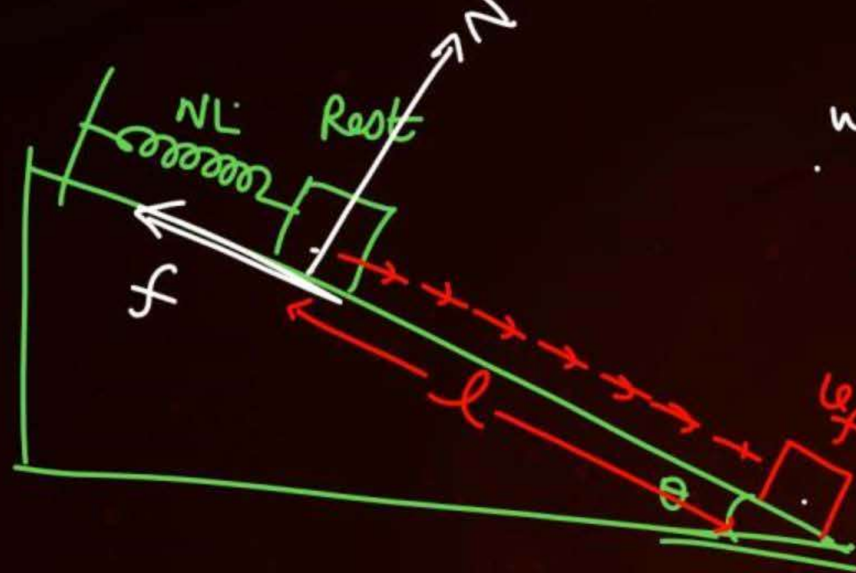


$$W_g + W_{sp} = \Delta K.E$$

$$+mgh - \frac{1}{2}K(h^2 - 0^2) = 0 - 0$$

$$h = \frac{2mg}{K}$$

Q2

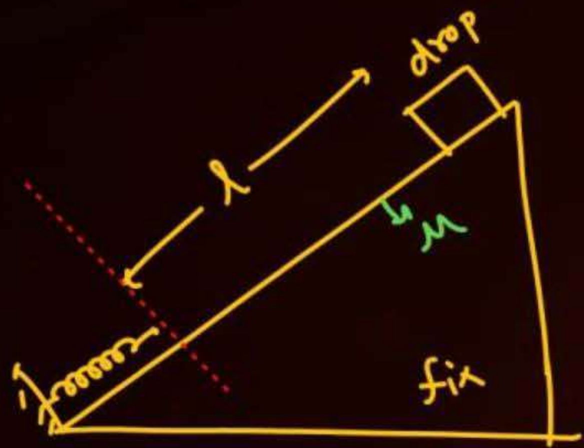


$$w_g + w_N + w_f + w_{sp} = \Delta K.E.$$

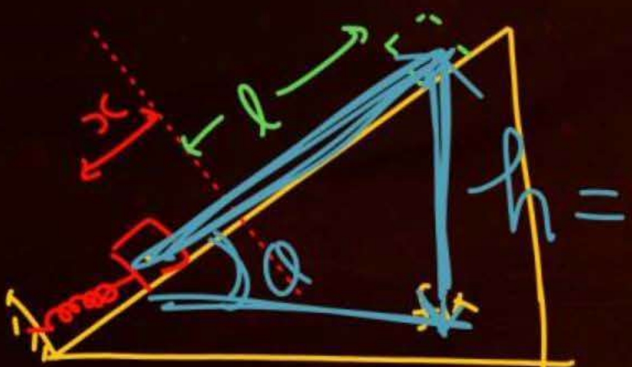
$$+mg\ell\sin\theta + 0 - (\mu mg\cos\theta)\ell$$

$$-\frac{1}{2}K(\ell^2 - 0^2) = 0 - 0$$

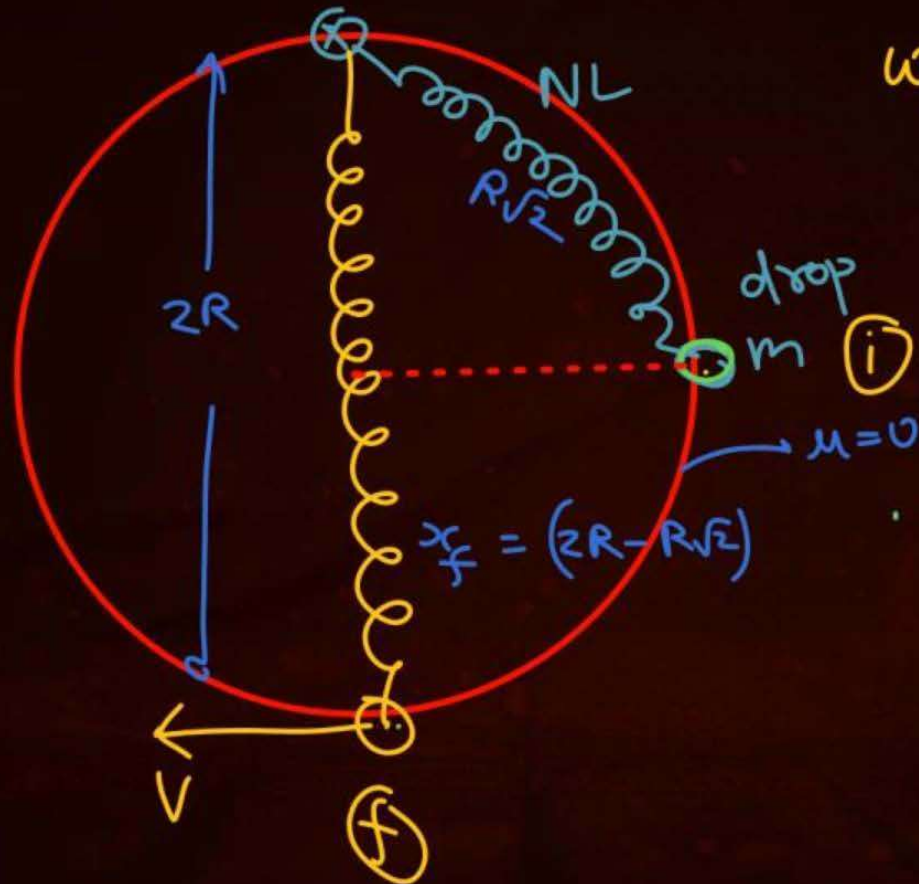
Q



$$+mg(l+x)\sin\theta + 0 - (\mu mg\cos\theta)(l+x)$$
$$-\frac{1}{2}K(x^2-0^2) = 0-0$$



Q

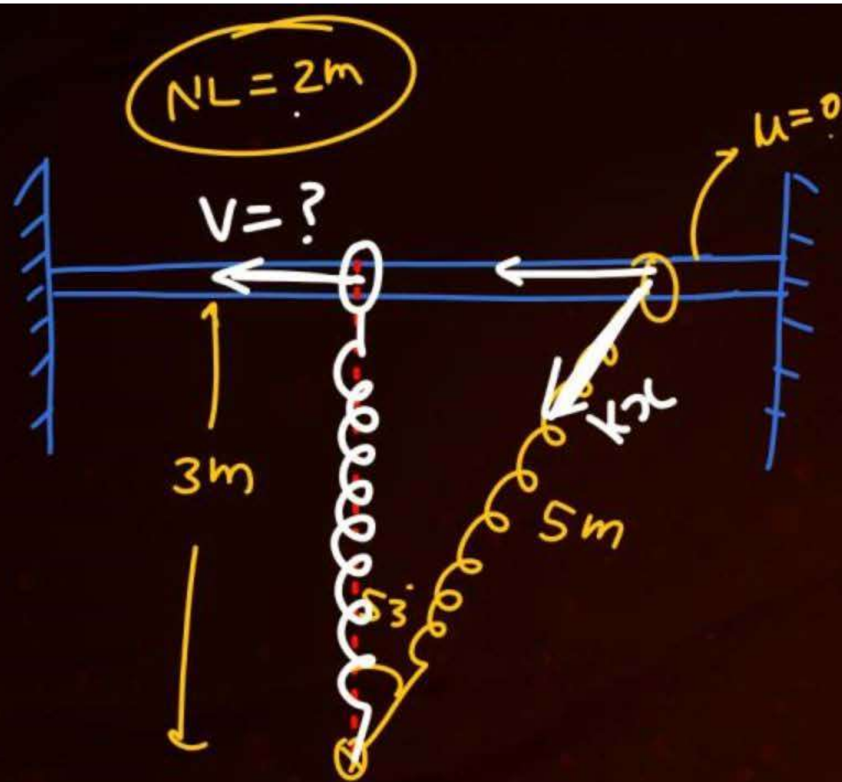


$$\omega_g + \omega_N + \omega_{sp} + \omega_f = \Delta K.E.$$

$$+mgR + 0 - \frac{1}{2}K\left(x_f^2 - 0^2\right)$$

$$+0 = \frac{1}{2}mv^2 - 0$$

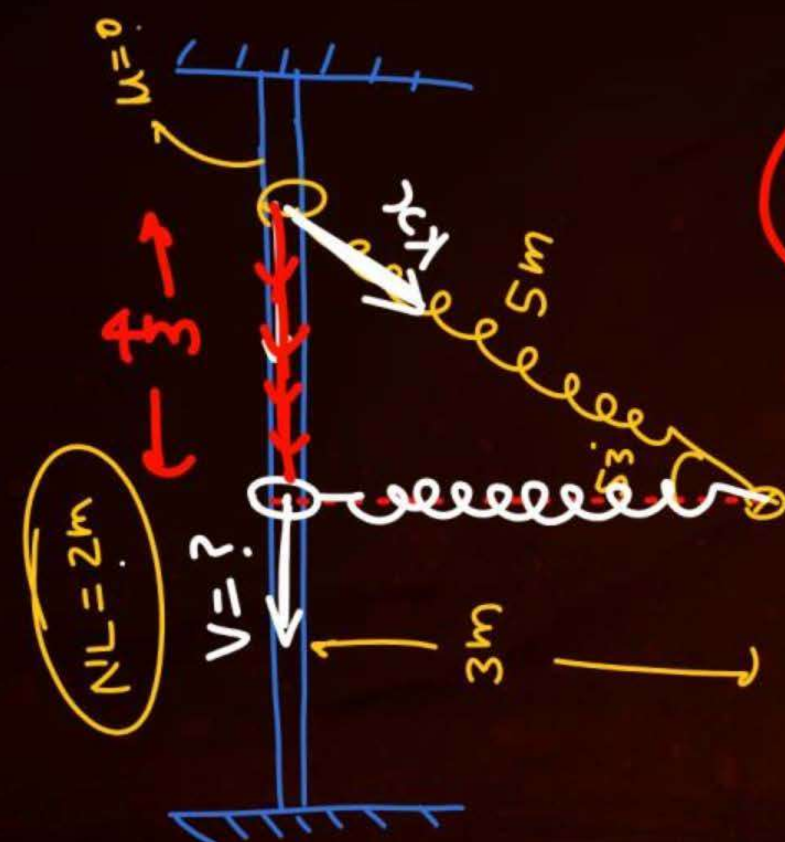
Q



$$W_g + W_N + W_f + W_{sp} = \Delta K.E$$

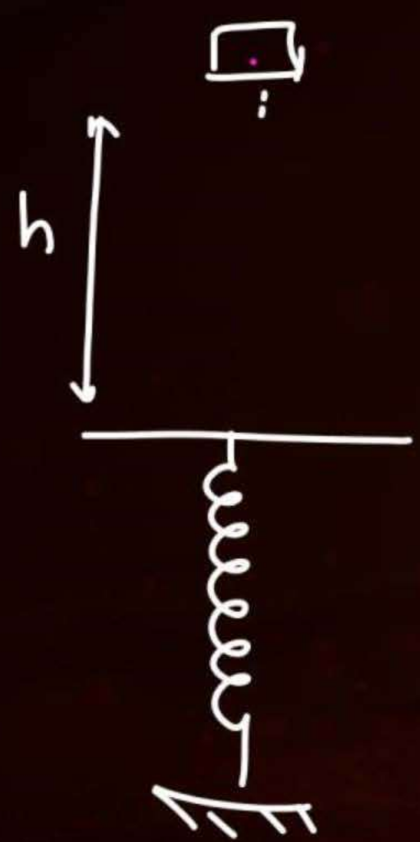
$$0 + 0 + 0 - \frac{1}{2}K\left(1^2 - 3^2\right) = \frac{1}{2}mv^2 - 0$$

Q

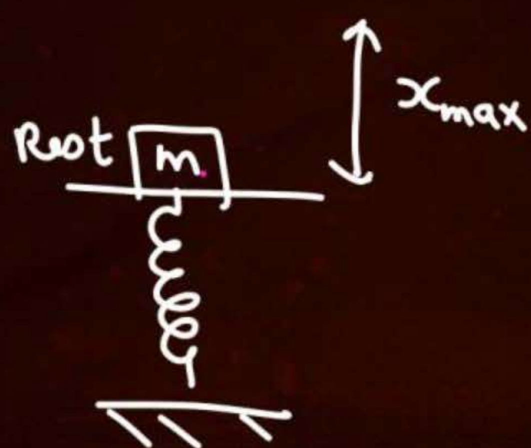


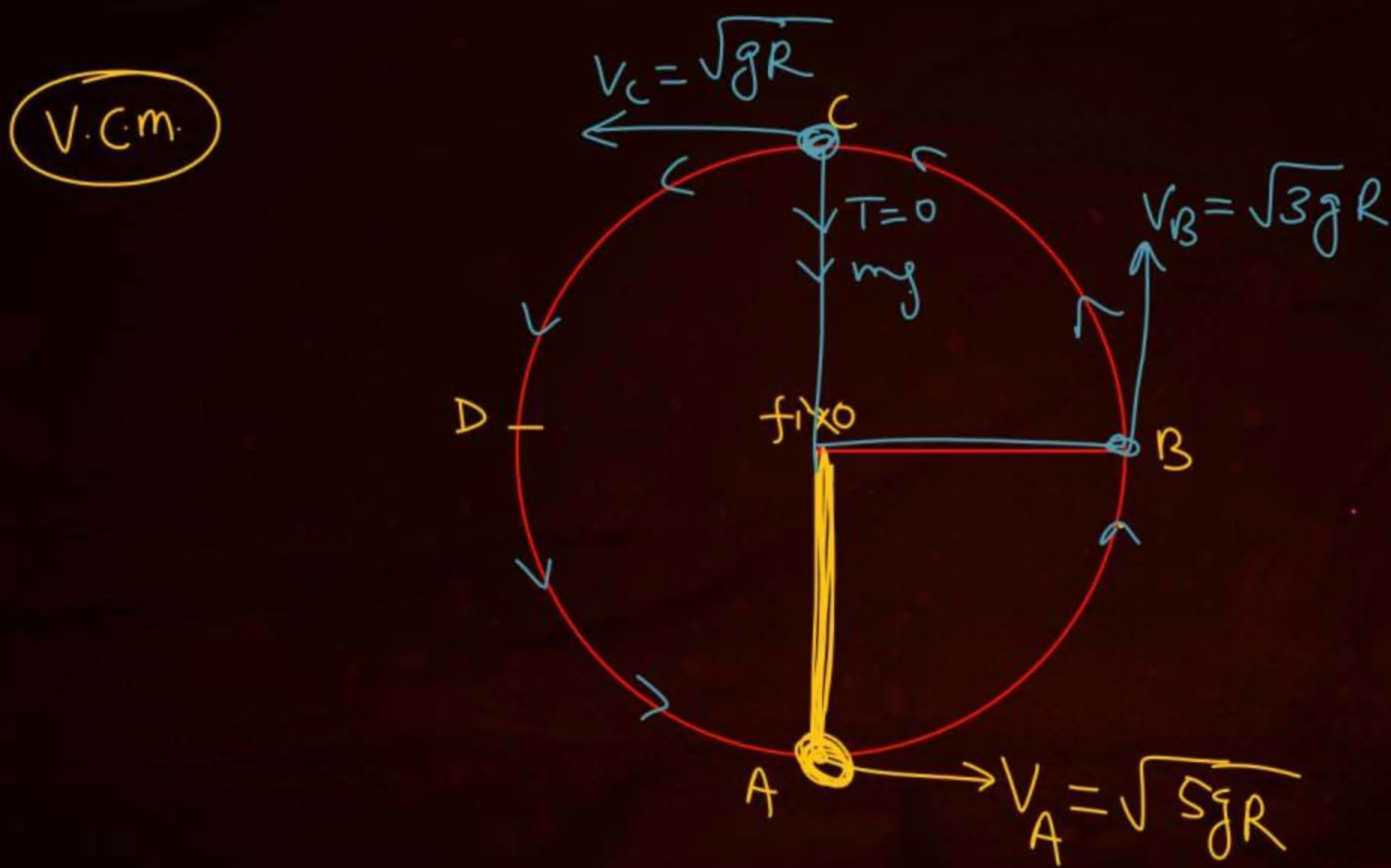
$$w_g + w_N + w_f + w_{sp} = \Delta K.E$$

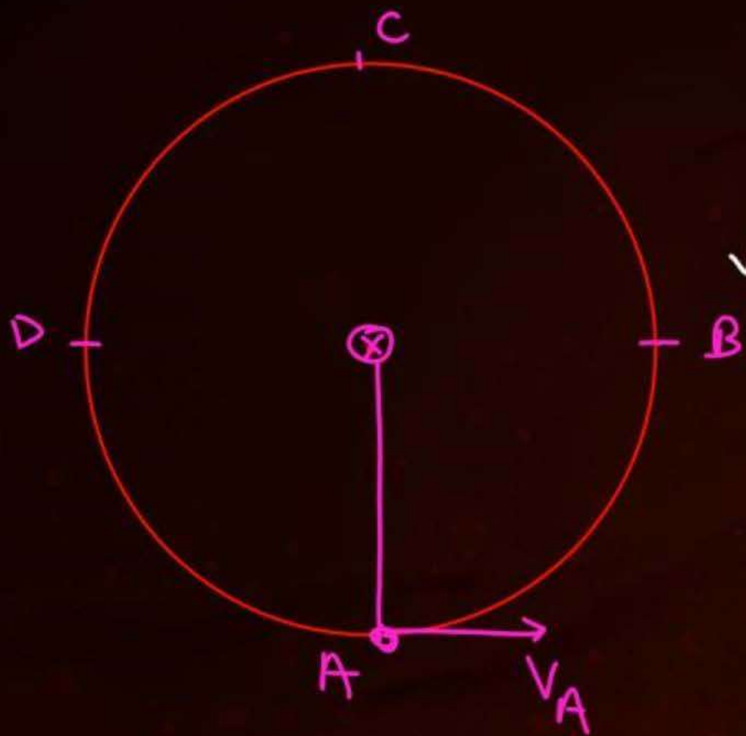
$$mg \times 4 + 0 + 0 - \frac{K}{2}\left(1^2 - 3^2\right) = \frac{1}{2}mv^2 - 0$$



$$mg(h+x_{max}) - \frac{1}{2}k(x_{max}^2 - 0) = 0 - 0$$




V.C.m.
$V_C = \sqrt{gR}$
C
T=0
mg
$V_B = \sqrt{3gR}$
D
fix O
B
A
$V_A = \sqrt{5gR}$



$V_A < \sqrt{2gR} \Rightarrow$ B से पहले $v=0$

$v_A = \sqrt{2gR} \Rightarrow \quad V_B = 0$

$\sqrt{2gR} < v_A < \sqrt{5gR} \Rightarrow$ C.m ✗

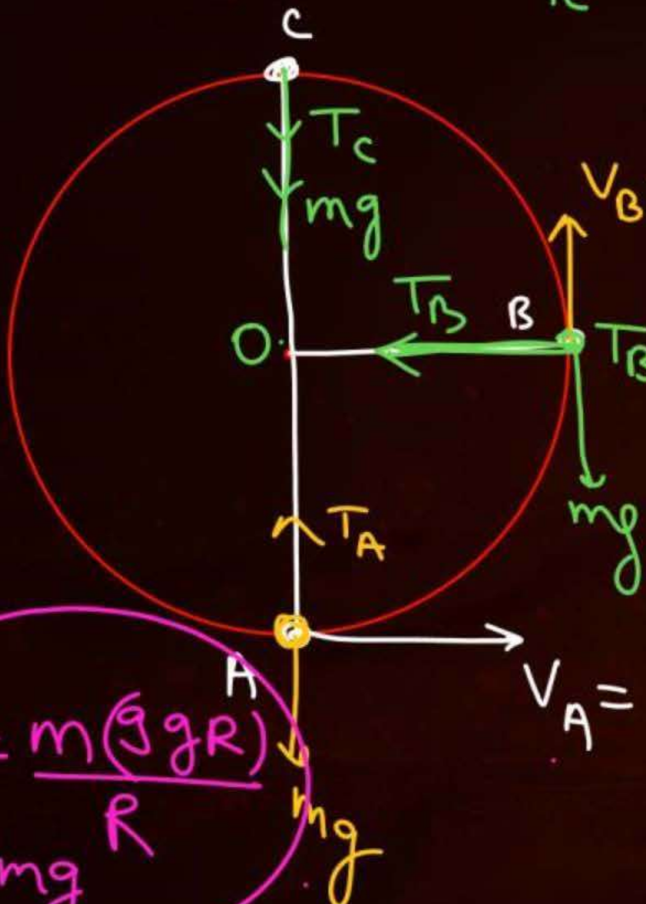
$v_A = \sqrt{5gR} \equiv$ इज्जत वाला

C.m ✓

$v_A > \sqrt{5gR}$ ✓

$V_c = \sqrt{5gR}$

$T_c + mg = \frac{m\,5g\cancel{R}}{\cancel{R}} \rightarrow \boxed{T_c = 4mg}$



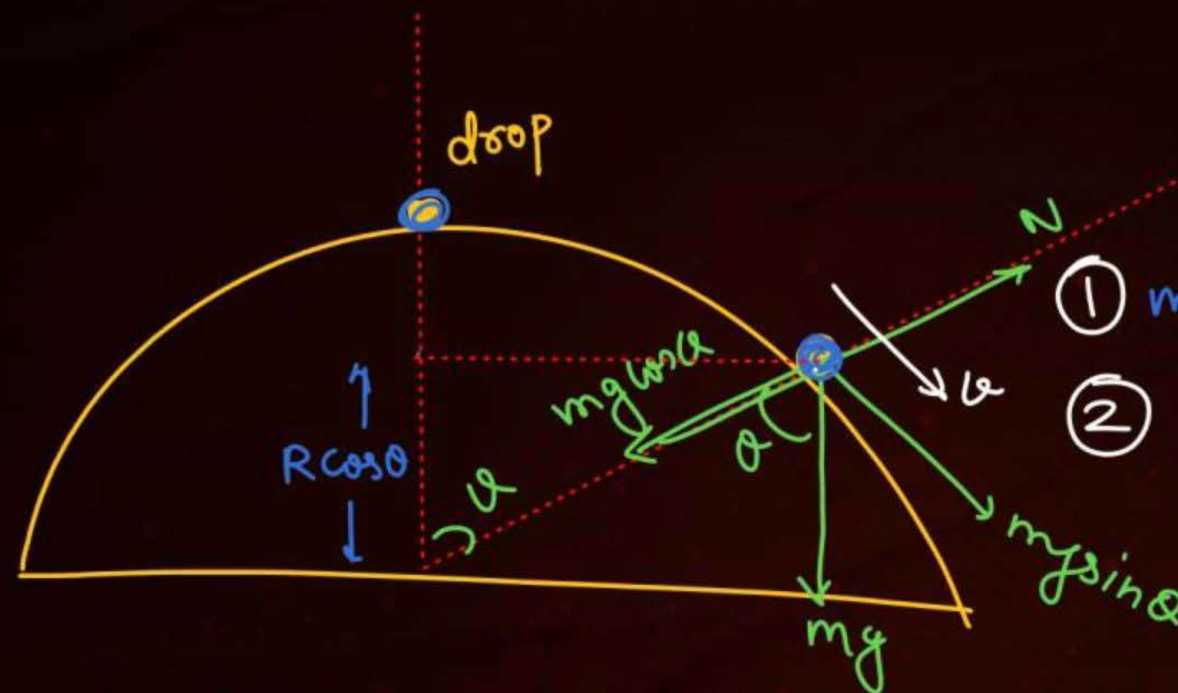
$V_B = \sqrt{7gR}$

$T_B = \frac{m(7gR)}{R} = 7mg$

$V_A = \sqrt{9gR}$

$T_A - mg = \frac{m(9gR)}{R}$

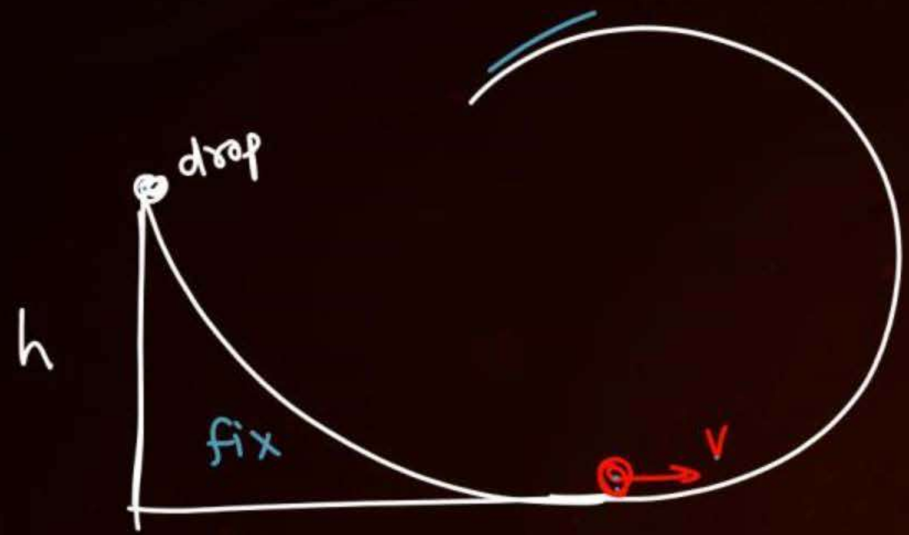
$T_A = 10mg$



$$① \quad mg(R - R\cos\theta) + 0 = \frac{1}{2}mv^2 - 0$$

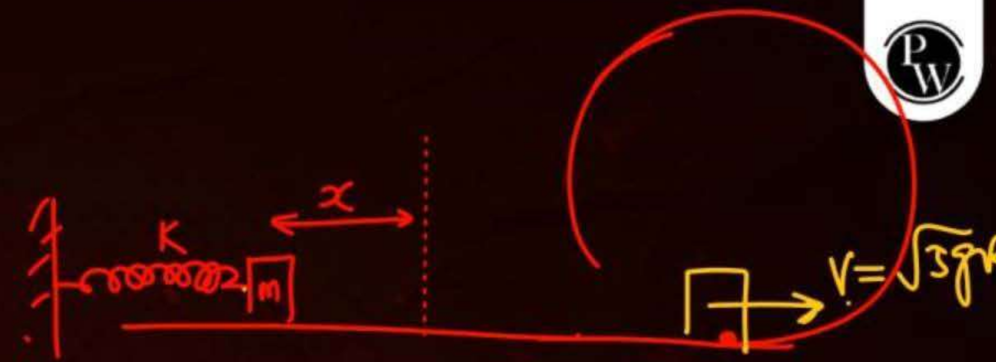
$$② \quad mg\cos\theta - \cancelto{0}{N} = \frac{mv^2}{R}$$

$$\cos\theta = 2/3$$



$$mgh + 0 = \frac{1}{2} m \left(\sqrt{5gR}\right)^2 - 0$$

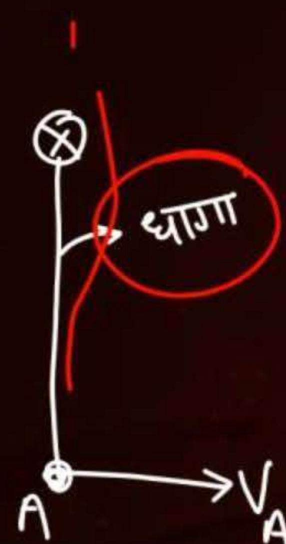
$$h = 5R/2$$



$$0 + 0 + 0 - \frac{1}{2} K\left(0^2 - x^2\right)$$

$$= \frac{1}{2} m (5gR) - 0$$

R



$V_A = \sqrt{5gR}$

$$-mg2l = 0 - \frac{1}{2}mV_A^2$$

$$V_A = \sqrt{4gl}$$

$$V_A = \sqrt{5gR} \times$$

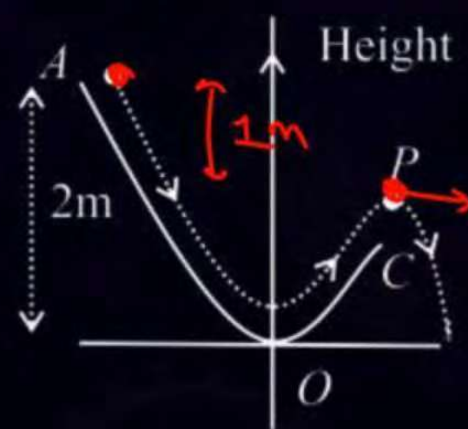
$$= \sqrt{4gR} \checkmark$$

QUESTION

A particle ($m = 1$ kg) slides down a frictionless track (AOC) starting from rest at a point A (height 2 m). After reaching C, the particle continues to move freely in air as a projectile. When it reaching its highest point P (height 1m), the kinetic energy of the particle (in J) is: (Figure drawn is schematic and not to scale; take $g = 10\ ms^{-2}$)

$$mgh = \frac{1}{2}mv^2 - 0$$

[JEE Mains 2020]



Ans : (10)

QUESTION

An elevator in a building can carry a maximum of 10 persons, with the average mass of each person being 68 kg. The mass of the elevator itself is 920 kg and it moves with a constant speed 3 m/s. The frictional force opposing the motion is $\boxed{6000\text{ N.}}$ If the elevator is moving up with its full capacity, the power delivered by the motor to the elevator ($g = 10\text{ m/s}^2$) must be at least

[JEE Mains 2020]

(1) 56300 W

(2) 48000 W

(3) 66000 W

(4) 62360 W

T

920kg

$v = 3\text{ m/s}$

$a = 0$

6000

6800 + 9200

$T = 22000$

$P = Tv =$

Ans : (3)

QUESTION

If the maximum load carried by an elevator is 1400 kg (600 kg-Passengers + 800 kg-elevator), which is moving up with a uniform speed of 3 ms^{-1} and the frictional force acting on it is 2000 N, then the maximum power used by the motor is kW.
(take, $g = 10\ ms^{-2}$)

[10 April 2023 - Shift 2]

Ans : (48)

QUESTION 5 बार 1

A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time 't' is proportional to:-

[JEE Mains 2021]

(1) $t^{2/3}$

(2) $t^{3/2}$

(3) t

(4) $t^{1/2}$

$$P = Fv = \text{const}$$

$$mav = \text{const}$$

$$av = \text{const}$$

$$\frac{dv}{dt} \cdot v = \text{const}$$

$$\int v\,dv = \int K\,dt$$

$$\frac{v^2}{2} = Kt$$

$$v \propto \sqrt{t}$$

$$\frac{dx}{dt} = K'\sqrt{t}$$

$$x = K'' t^{3/2}$$

Ans : (2)

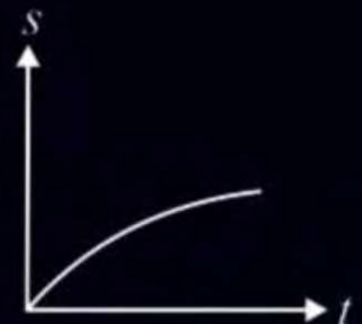
QUESTION

A particle is moving unidirectionally on a horizontal plane under the action of a constant power supplying energy source. The displacement (s) - time (t) graph that describes the motion of the particle is (graphs are drawn schematically and are not to scale):

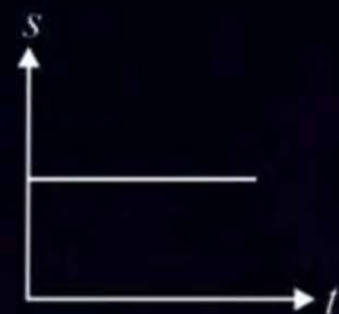
$t^{3/2}$

[JEE Mains 2020]

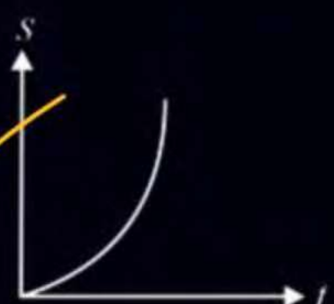
(1)



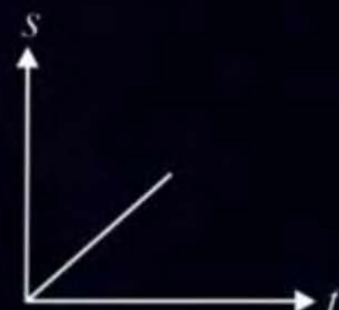
(2)



(3)



(4)



Ans : (3)

QUESTION

A body of mass 2 kg is driven by an engine delivering a constant power 1J/s. The body starts from rest and moves in a straight line. After 9 seconds, the body has moved a distance (in m)_____.

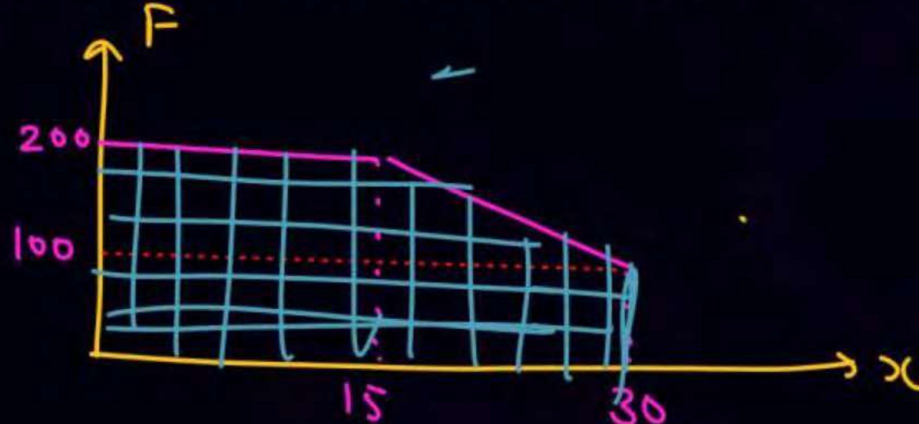
[JEE Mains 2020]

Ans : (18)

QUESTION

A person pushes a box on a rough horizontal platform surface. He applies a force of 200 N over a distance of 15 m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance of 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box?

[JEE Mains 2020]



(1) 5690 J

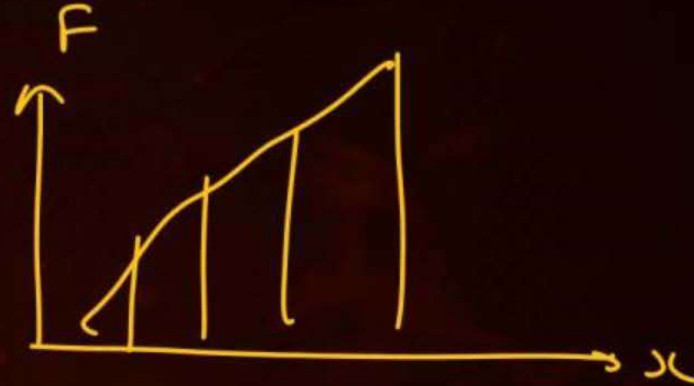
(2) 5250 J

(3) 3280 J

(4) 2780 J

Ans : (2)

$$WD = \int F \cdot dx$$



QUESTION

$\frac{dU}{dr} = 0$ $r =$ ✓

The potential energy (U) of a diatomic molecule is a function dependent on r (interatomic distance) as:

$\boxed{U = \frac{\alpha}{r^{10}} - \frac{\beta}{r^{5}} - 3}$ where, α and β are positive constants. The equilibrium distance between two atoms will be $\left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$, Where a = _____. [JEE Mains 2021]

$$F = -\frac{\partial U}{dr} = 0$$

Ans : (1)

QUESTION

If the potential energy between two molecules is given by $U = \frac{A}{r^6} + \frac{B}{r^{12}}$, then at equilibrium, separation between molecules, and the potential energy are:

[JEE Mains 2020]

(1) $\left(\frac{B}{A}\right)^{1/6}, 0$

(2) $\left(\frac{B}{2A}\right)^{1/6}, -\frac{A^2}{2B}$

(3) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{4B}$

(4) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{2B}$

Ans : (3)

QUESTION

A small bob tied at one end of a thin string of length 1m is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : 1. The velocity of the bob at the height position is ____ m/s. (Take $g = 10\ m/s^2$) **[JEE Mains 2021]**

$V_C = ?$

$$-mg(2R) + 0 = \frac{1}{2}mv_C^2 - \frac{1}{2}mv_A^2$$

$$\frac{1}{2}mv_A^2 = \frac{1}{2}mv_C^2 + 2mgR$$

$$mv_A^2 = mv_C^2 + 4mgR$$

$$T_A - mg = \frac{mv_A^2}{R}$$

$$T_C + mg = \frac{mv_C^2}{R}$$

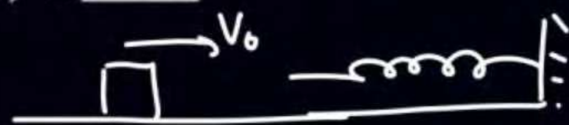
$$\frac{5}{1} = \frac{\frac{mv_A^2}{R} + mg}{\frac{mv_C^2}{R} - mg} = \frac{mv_C^2 + 4mgR + mgR}{mv_C^2 - mgR}$$

Ans : (5)

QUESTION

A ball of mass 4 kg, moving with a velocity of 10 ms^{-1}, collides with a spring of length 8 m and force constant 100 Nm^{-1}. The length of the compressed spring is x m. The value of x, to the nearest integer, is _____.

[JEE Mains 2021]



$$\frac{1}{2} m v_0^2 = \frac{1}{2} k x^2$$

Ans : (6)

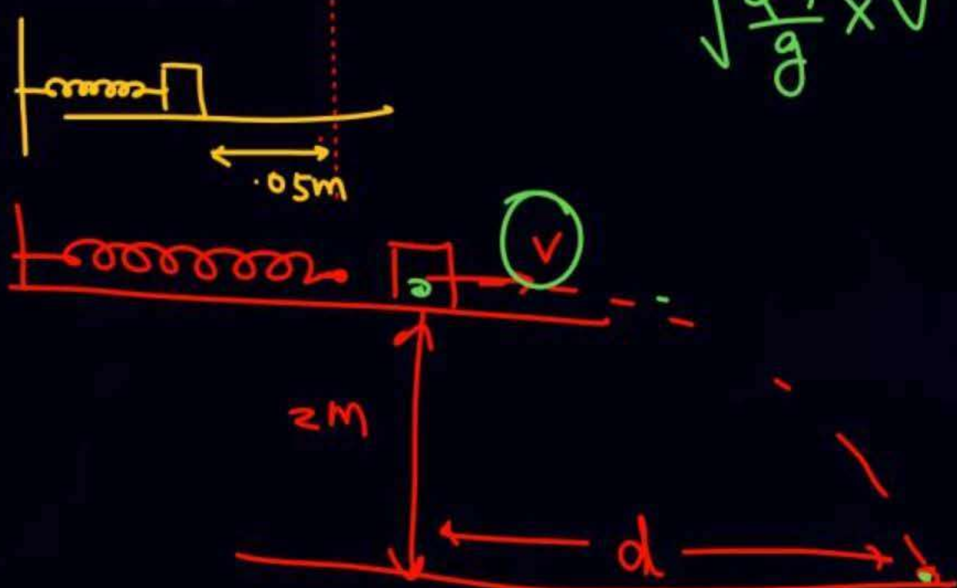
QUESTION

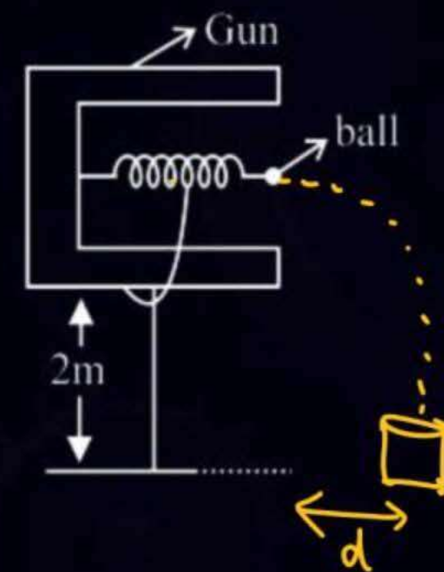
$\frac{1}{2}\times 100\times(.05)^2 = \frac{1}{2}\times\frac{1}{10}\times v^2$

In a spring gun having spring constant 100 N/m a small ball 'B' of mass 100 g is put in its barrel (as shown in figure) by compressing the spring through 0.05 m. There should be a box placed at a distance 'd' on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of 2 m above the ground. The value of d is ____ m. ($g = 10\ m/s^2$)

[JEE Mains 2021]

$\sqrt{\frac{2h}{g}}\times V = d$





Ans : (1)

QUESTION

JA

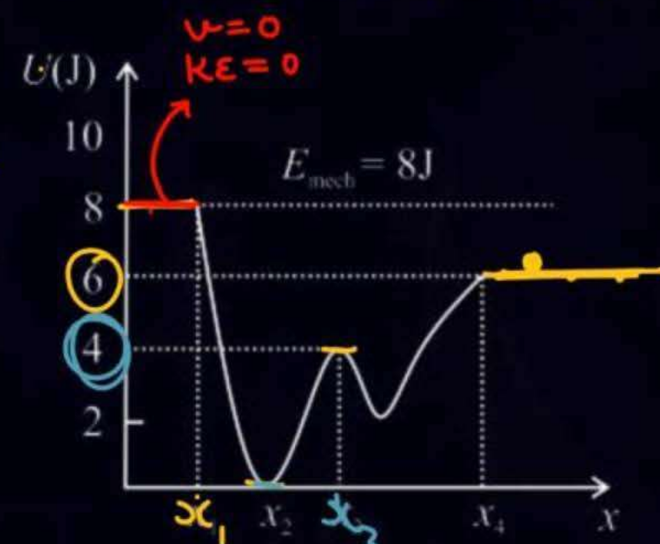
$T.E. = KE + PE = 8$

max min

Given below is the plot of a potential energy function $U(x)$ for a system, in which a particle is in one dimensional motion, while a conservative force $F(x)$ acts on it. Suppose that $E_{mech} = 8$ J, the incorrect statement for this system is: **[JEE Mains 2021]**

1. at $x > x_4$, K.E. is constant throughout the region.
2. at $x < x_1$, K.E. is smallest and the particle is moving at the slowest speed.
3. at $x = x_2$, K.E. is greatest and the particle is moving at the fastest speed.
4. at x = x3, K.E. = 4 J.

2



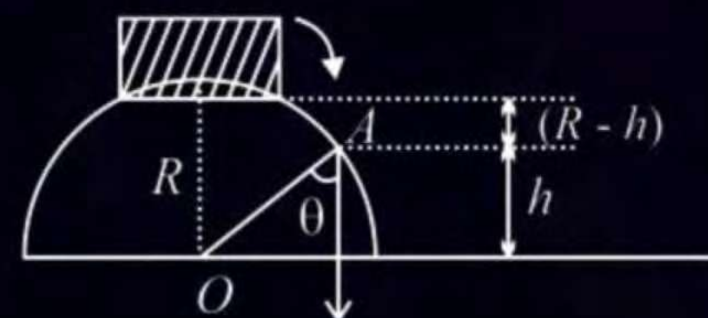
[where K.E. = kinetic energy]

Ans : (2)

QUESTION

A small block slides down from the top of hemisphere of radius $R = 3$ m as shown in the figure. The height 'h' at which the block will lose contact with the surface of the sphere is ______ m.

(Assume there is no friction between the block and the hemisphere) **[JEE Mains 2021]**

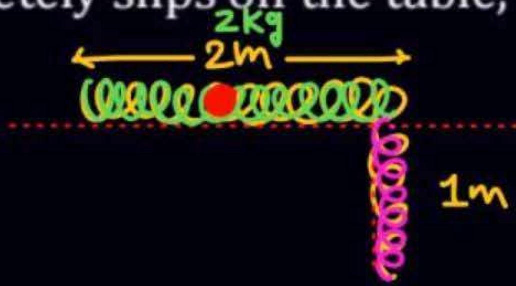


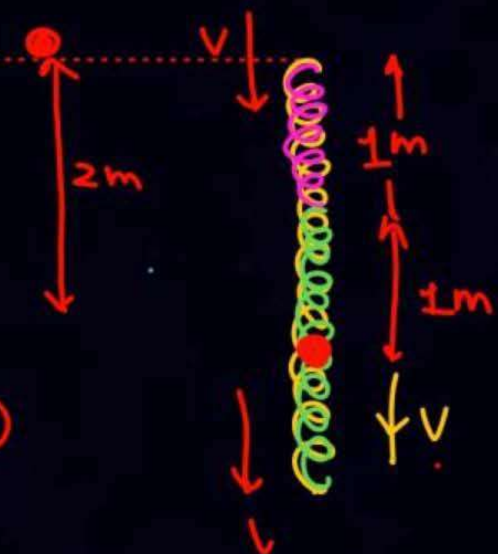
Ans : (2)

QUESTION A

A uniform chain of length 3 meter and mass 3 kg overhangs a smooth table with 2 meter laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is 40 (Take $g = 10\ m/s^2$)

[JEE Mains 2021]





$$2 \times 10 \times 2 = K_f - 0$$

Ans : (40)

QUESTION

A particle experience a variable force $\vec{F} = (4x\hat{\imath} + 3y^2\hat{\jmath})$ in a horizontal x - y plane. Assume distance in meters and force is newton. If the particle moves from point (1, 2) to point (2, 3) in the x – y plane, the Kinetic Energy changes by. [JEE Mains 2022]

$$(WD) = \Delta KE = \int_1^2 4x\,dx + \int_2^3 3y^2\,dy =$$

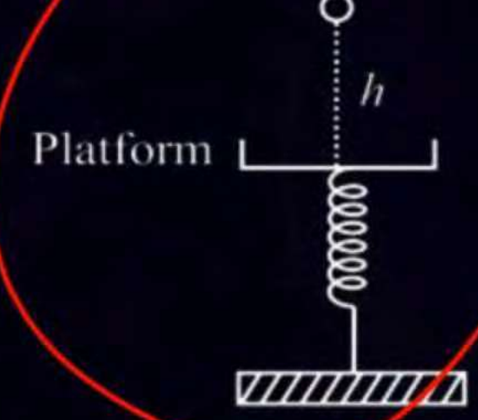
1. 50.0 J
2. 12.5 J
3. 25.0 J
4. 0 J

Ans : (3)

QUESTION

A ball of mass 100 g is dropped from a height $h = 10$ cm on a platform fixed at the top of vertical spring (as shown in figure). The ball stays on the platform and the platform is depressed by a distance $h/2$. The spring constant is _____ Nm^{-1}.
(Use $g = 10\ ms^{-2}$)

[JEE Mains 2022]



Ans : (120)

QUESTION

Potential energy as a function of r is given by $U = \frac{A}{r^{10}} - \frac{B}{r^5}$, where r is the interatomic distance, A and B are positive constants. The equilibrium distance between the two atoms will be:

[JEE Mains 2022]

(1) $\left(\frac{A}{B}\right)^{\frac{1}{5}}$

(2) $\left(\frac{B}{A}\right)^{\frac{1}{5}}$

(3) $\left(\frac{2A}{B}\right)^{\frac{1}{5}}$

(4) $\left(\frac{B}{2A}\right)^{\frac{1}{5}}$

Ans : (3)

QUESTION

Arrange the four graphs in descending order of total work done, where W_1, W_2, W_3 and W_4 are the work done corresponding to figure a, b, c and d respectively. **[JEE Mains 2022]**

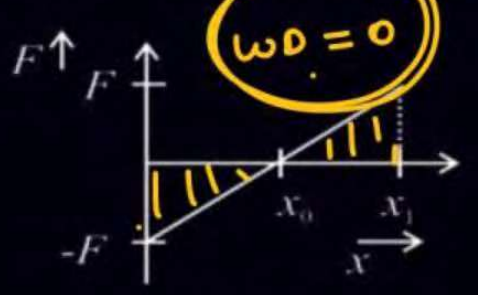


Figure - a

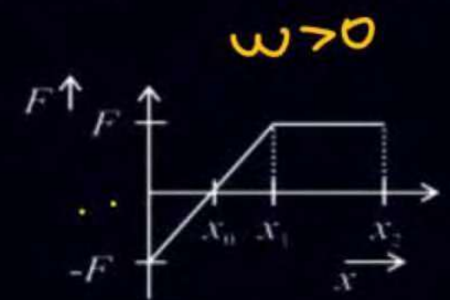


Figure - b

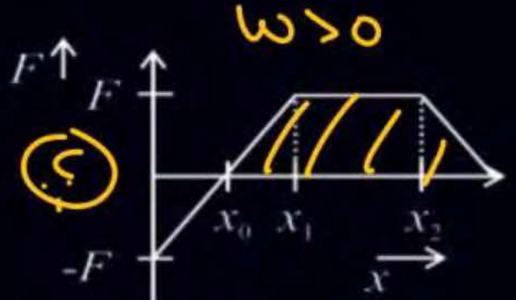


Figure - c

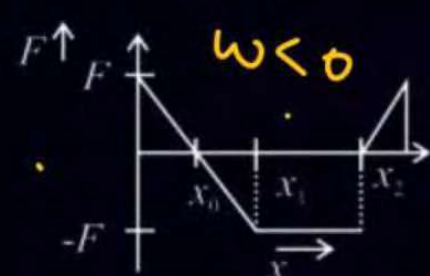


Figure - d

(1) $W_3 > W_2 > W_1 > W_4$

(2) $W_3 > W_2 > W_4 > W_1$

(3) $\cancel{W_2} > W_3 > W_4 > W_1$

(4) $\cancel{W_2} > W_3 > W_1 > W_4$

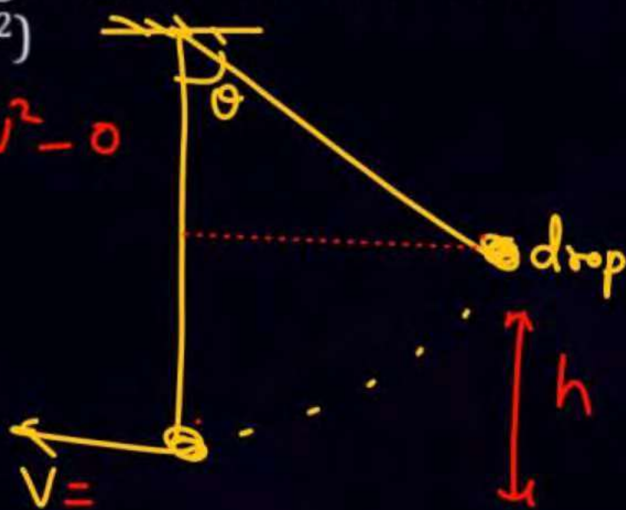
Ans : (1)

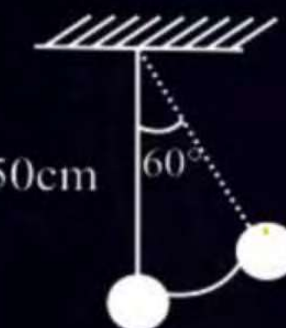
QUESTION

A pendulum is suspended by a string of length 250 cm. The mass of the bob of the pendulum is 200 g. The bob is pulled aside until the string is at 60° with vertical as shown in the figure. After releasing the bob. the maximum velocity attained by the bob will be ______ ms^{-1}. (if $g = 10\ m/s^2$) **[JEE Mains 2022]**

$$mg(R - R\cos\theta) = \frac{1}{2}mv^2 - 0$$

$$v = \sqrt{gR}$$





Ans : (5)

QUESTION

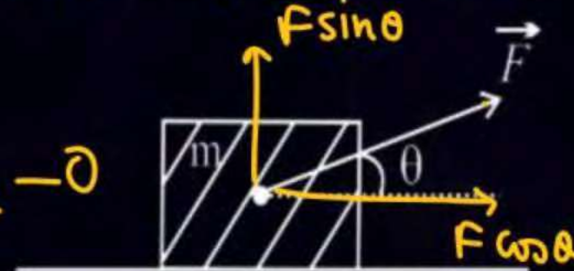
An object of mass 'm' initially at rest on a smooth horizontal plane starts moving under the action of force F = 2 N. In the process of its linear motion, the angle θ (as shown in figure) between the direction of force and horizontal varies as $\theta = kx$, where k is a constant and x is the distance covered by the object from its initial position. The expression of kinetic energy of the object will be $E = \frac{n}{k}\sin\theta$. The value of n is:

[25 January 2023 - Shift 1]

$$w_F = \int F\cos\theta \cdot dx$$

$$= \int_0^x F\cos kx \cdot dx = \frac{F}{K}\sin kx = K_f - 0$$

$$\frac{2}{K}\sin kx = (K_f)$$



Smooth horizontal surface

Ans : (2)

QUESTION

A force $\vec{F} = (2 + 3x)\hat{\imath}$ acts on a particle in the x direction where F is in Newton and x is in meter. The work done by this force during a displacement from x = 0 to x = 4 m is J.

[11 April 2023 - Shift 1]

Ans : (32)

QUESTION

A body at rest is moved along a horizontal straight line by a machine delivering a constant power. The distance moved by the body in time 't' is proportional to:

[JEE Mains 2021]

1. $t^{3/2}$
2. $t^{1/2}$
3. $t^{1/4}$
4. $t^{3/4}$

Ans : (1)

QUESTION

An automobile of mass 'm' accelerates starting from origin and initially at rest, while the engine supplies constant power P. The position is given as a function of time by:

[JEE Mains 2021]

(1) $\left(\frac{9P}{8m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

(2) $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} \cancel{t^{\frac{2}{3}}}$

(3) $\left(\frac{9P}{8P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

(4) $\left(\frac{8P}{9P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

Ans : (4)

QUESTION

If the Kinetic energy of a moving body becomes four times its initial Kinetic energy, then the percentage change in its momentum will be: **[JEE Mains 2021]**

(1) 100%

(2) ~~200%~~

(3) 300%

(4) 400%

$$KE = \frac{P^2}{2m}$$

Ans : (1)

QUESTION

A force of $F = (5y + 20)\hat{j}$ N acts on a particle. The work done by this force when the particle is moved from y = 0 m to y = 10 m is _____ J.

[JEE Mains 2021]

Ans : (450)

QUESTION

A body of mass 'm' dropped from a height 'h' reaches the ground with a speed of $0.8\sqrt{gh}$. The value of workdone by the air-friction is: [JEE Mains 2021]

(1) -0.68 mgh

(2) mgh

(3) 1.64 mgh

(4) 0.64 mgh

Ans : (1)

QUESTION

Two bodies of mass 4 g and 25 g are moving with equal kinetic energies. The ratio of magnitude of their linear momentum is: [27 January 2024 - Shift 1]

(1) 3 : 5

(2) 5 : 4

(3) 2 : 5

(4) 4 : 5

Ans : (3)

QUESTION

The potential energy function (in J) of a particle in a region of space is given as $U = (2x^2 + 3y^3 + 2z)$. Here x, y and z are in meter. The magnitude of x-component of force (in N) acting on the particle at point P(1, 2, 3)m is: **[29 January 2024 - Shift 1]**

(1) 2 $F_x = -\frac{\partial U}{\partial x} = -4x$

(2) 6

(3) 4

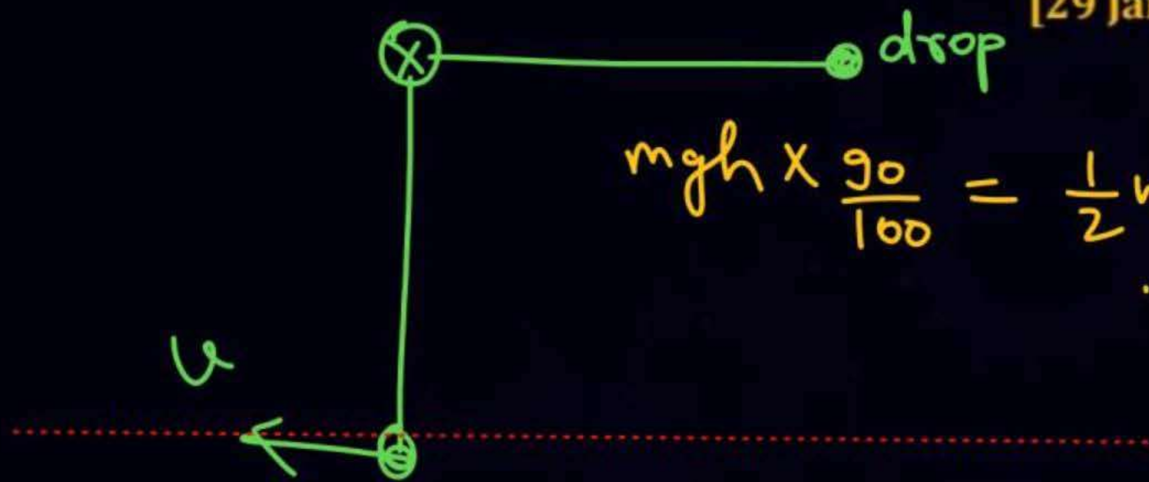
(4) 8

Ans : (3)

QUESTION

The bob of a pendulum was released from a horizontal position. The length of the pendulum is 10 m. If it dissipates 10% of its initial energy against air resistance, the speed with which the bob arrives at the lowest point is: [Use, $g = 10\ \text{ms}^{-2}$]

[29 January 2024 - Shift 2]



$$mgh \times \frac{90}{100} = \frac{1}{2} m v^2$$

(1) $6\sqrt{5}\ \text{ms}^{-1}$

(2) $5\sqrt{6}\ \text{ms}^{-1}$

(3) $5\sqrt{5}\ \text{ms}^{-1}$

(4) $2\sqrt{5}\ \text{ms}^{-1}$

Ans : (1)

Com

* $x_{com} = \dfrac{m_1 x_1 + m_2 x_2 + \dots}{m_1 + m_2 + \dots}$

* $\vec{v}_{com} = \dfrac{m_1 \vec{v}_1 + m_2 \vec{v}_2 + \dots}{m_1 + m_2 + \dots}$

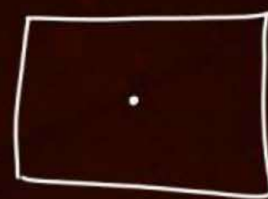
* $\vec{a}_{cm} = \dfrac{m_1 \vec{a}_1 + m_2 \vec{a}_2 + \dots}{m_1 + m_2 + \dots}$

* $\vec{P}_{net} = m \vec{v}_{com}$

* $\vec{F}_{net} = m \vec{a}_{com}$

$dm = \lambda dx$

$\lambda = \lambda_0 x$

 & 

$$x_{cm} = \frac{\int x \, dm}{\int dm} = \frac{\int_0^L x \lambda dx}{\int_0^L \lambda dx}$$

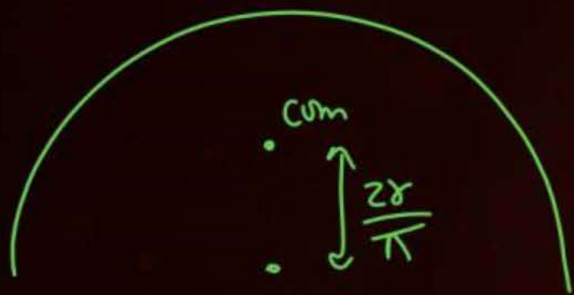
$$x_{cm} = \frac{\int_0^L x \lambda_0 x \, dx}{\int_0^L \lambda_0 x \, dx} = \frac{\lambda_0 L^3/3}{\lambda_0 L^2/2}$$

Q

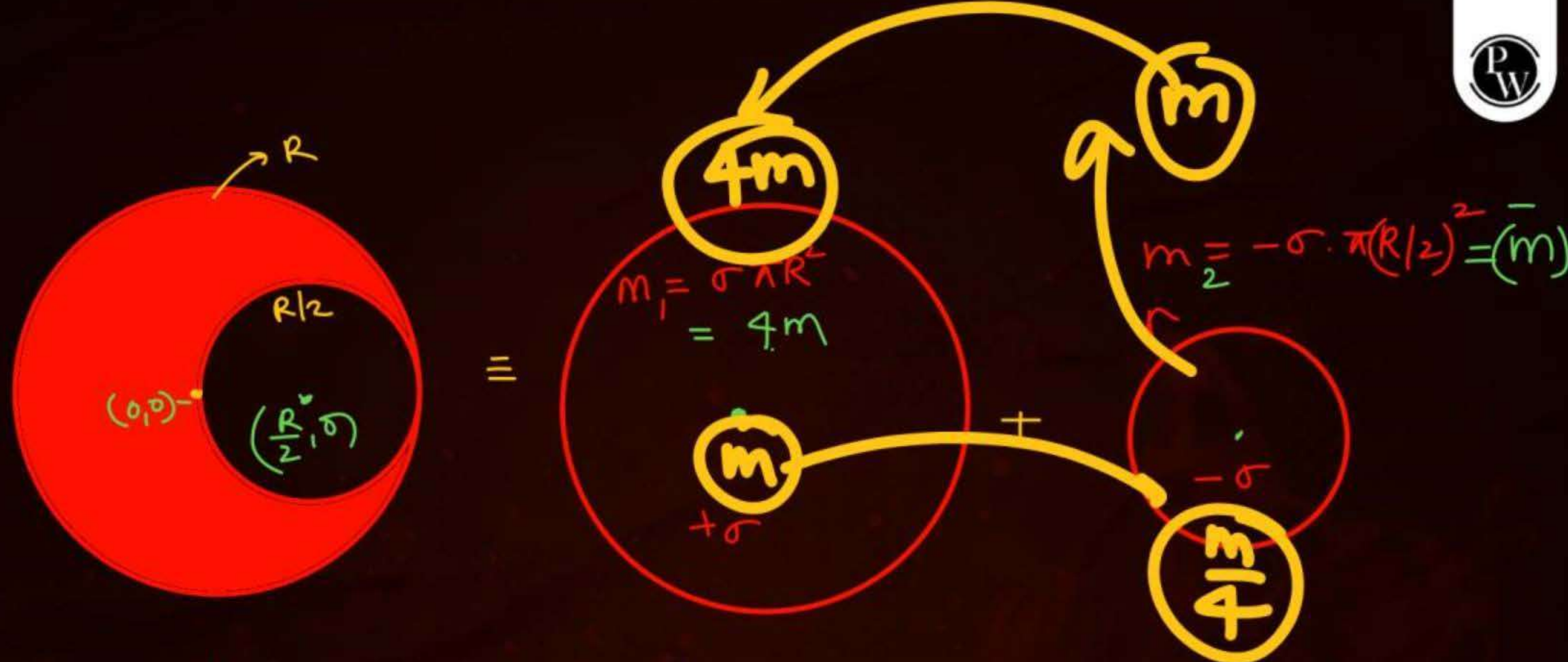
$\lambda = 2x + 3$

$x = 0$ $\qquad$ $x = 2$

$$x_{com} = \frac{\int_0^2 x(2x+3)\,dx}{\int_0^2 (2x+3)\,dx} =$$


com
2r/π

Q.



$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{4\cancel{m} \times 0 + (-\cancel{m}) R/2}{4\cancel{m} + (-m)} =$$

Collision

(1) $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

(2) $e = \dfrac{v_2 - v_1}{u_1 - u_2}$

(*) $\Delta KE = \dfrac{1}{2}\mu u_{rel}^2 (1 - e^2)$

$\mu = \dfrac{m_1 m_2}{m_1 + m_2}$

$u_{rel} = u_1 - u_2$

(i) $\underset{2\,kg}{\bigcirc} \xrightarrow{10\,m/s}$ $\underset{3\,kg}{\bigcirc} \xrightarrow{8\,m/s}$ $\Rightarrow$ $\underset{2\,kg}{\bigcirc} \xrightarrow{V_1}$ $\underset{3\,kg}{\bigcirc} \xrightarrow{V_2}$

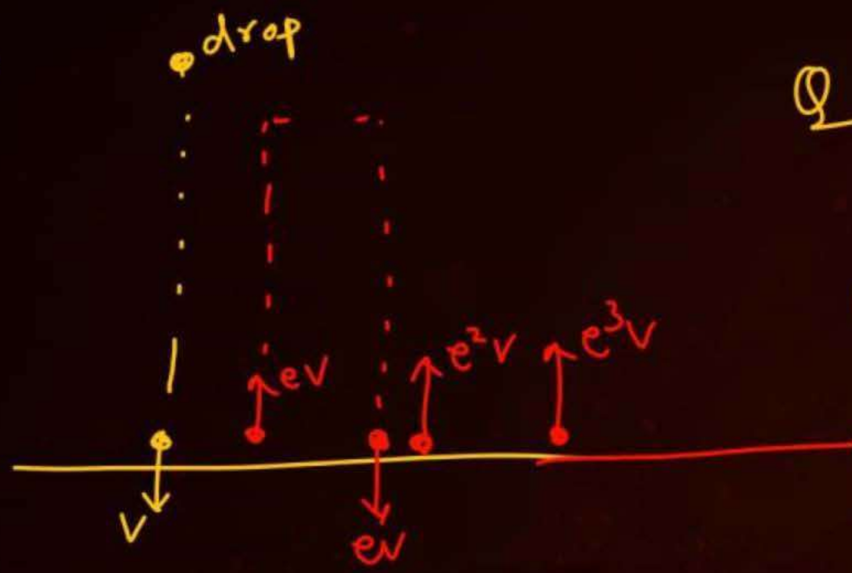
$e = \frac{1}{2}$

$$20 + 24 = 2V_1 + 3V_2 \quad — (1)$$

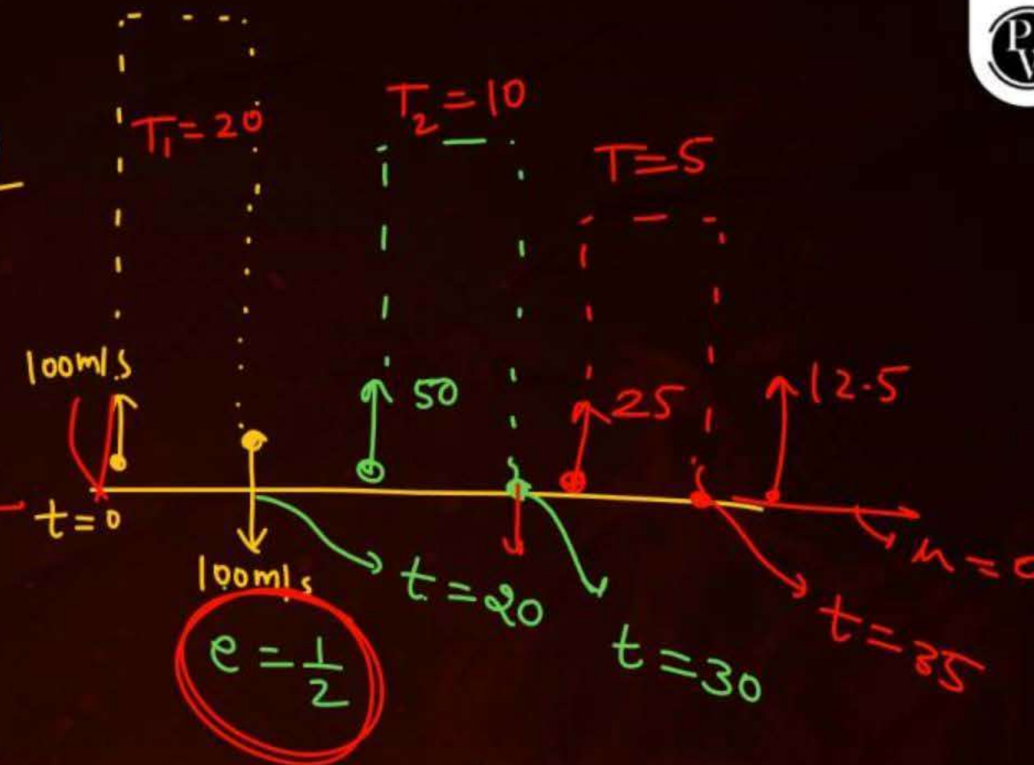
$$e = \frac{1}{2} = \frac{V_2 - V_1}{2} \quad — (2)$$

$$(\Delta KE)_{loss} = \frac{1}{2} \times \frac{6}{5} \times 2^2 \left(1 - \left(\frac{1}{2}\right)^2\right) = \checkmark$$

#

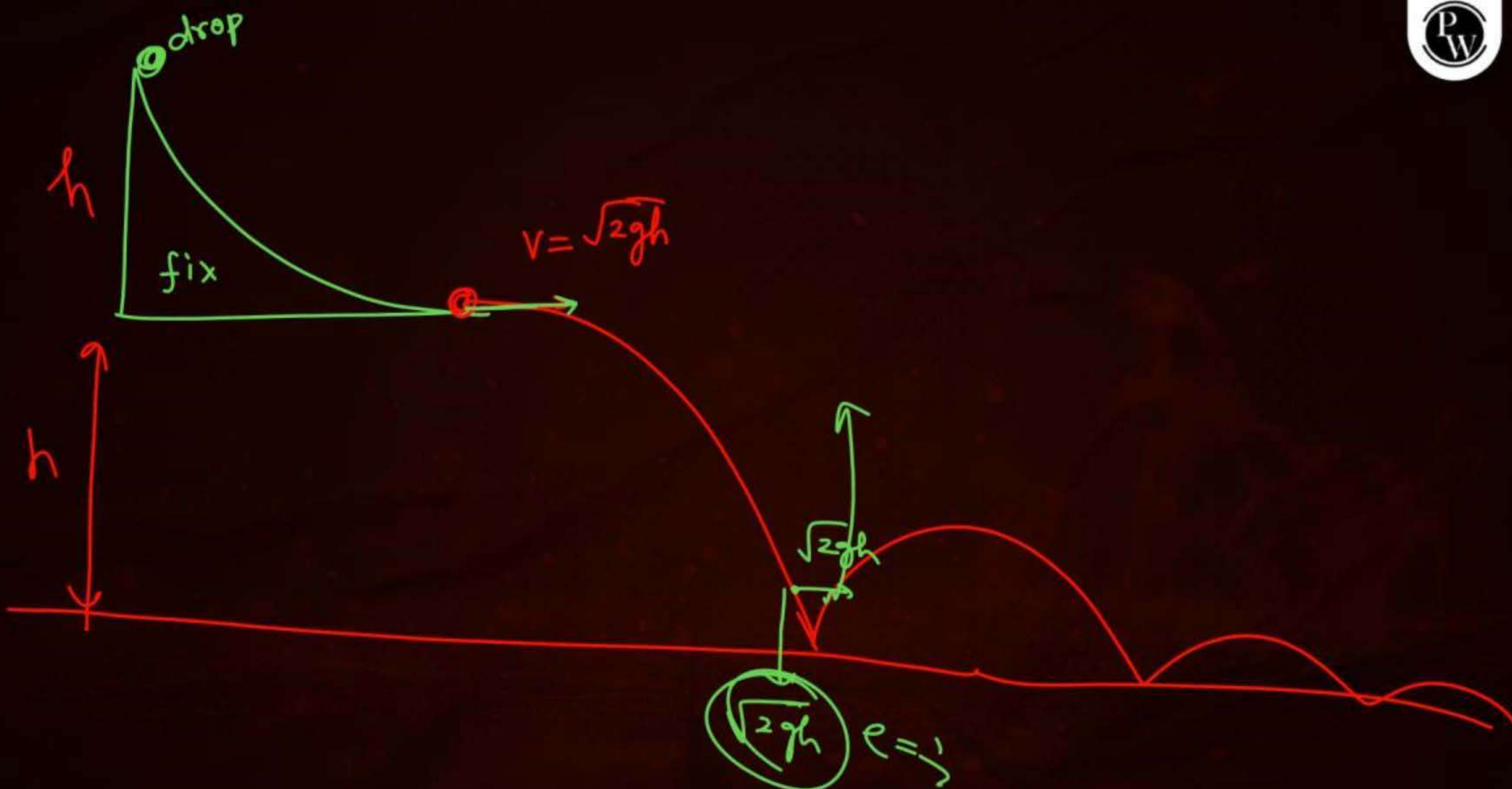

drop
ev
e^2v
e^3v
v
ev

Q


$T_1=20$
$T_2=10$
$T=5$
100m/s
50
25
12.5
t=0
100m/s
t=20
t=30
t=35
n=0
$e=\frac{1}{2}$

$t = 32$ location

$e = \frac{1}{2}$


drop
h
fix
$v=\sqrt{2gh}$
h
$\sqrt{2gh}$
$\sqrt{2gh}$
e = 1

Q

$m \longrightarrow v$ $\quad m$ (Rest) $\quad \equiv \quad 2m \longrightarrow V/2$

$e = 0$

Q

$2\,kg \longrightarrow 10\,m/s$

$3\,kg \uparrow 20\,m/s$

$e = 0$

$$\Rightarrow \quad 2\times 10\,\hat{i} + 3\times 20\,\hat{j} = 5\cdot\vec{v}_f$$

$$\boxed{\vec{v}_f = 4\hat{i} + 12\hat{j}}$$

Q*

QUESTION

A body of mass 2 kg begins to move under the action of a time dependent force given by $\vec{F} = (6t\hat{i} + 6t^2\hat{j})$ N. The power developed by the force at the time t is given by:

[31 January 2024 - Shift 2]

$\rightarrow a = \checkmark \quad v = \checkmark \qquad P = \vec{F} \cdot \vec{v}$

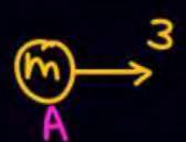
1. $(6t^4 + 9t^5)$ W
2. $(3t^3 + 6t^5)$ W
3. $(9t^5 + 6t^3)$ W
4. $(9t^3 + 6t^5)$ W

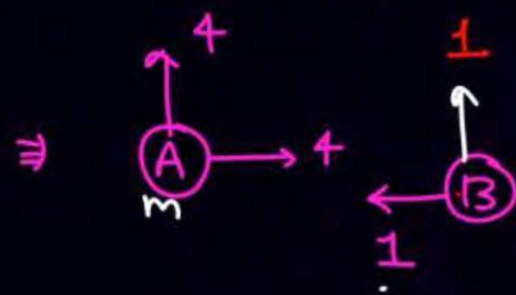
Ans : (4)

QUESTION

A body A, of mass m = 0.1 kg has an initial velocity of $3\hat{\imath}\ \mathrm{ms}^{-1}$. It collides elastically with another body, B of the same mass which has an initial velocity of $5\hat{\jmath}\ \mathrm{ms}^{-1}$. After collision, A moves with a velocity $\vec{v} = 4(\hat{\imath} + \hat{\jmath})$. The energy of B after collision is written as $\frac{x}{10}$ J. The value of x is ______.

[JEE Mains 2020]





$$\frac{1}{2} \times .1 \times (\sqrt{2})^2 = \frac{1}{10} = \frac{x}{10}$$

$$x = 1$$

Ans : (1.00)

QUESTION

Two particles of equal mass m have respective initial velocities $u\hat{i}$ and $u\left(\frac{\hat{i}+\hat{j}}{2}\right)$. They collide completely inelastically. The energy lost in the process is: [JEE Mains 2020]

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

(2) $\frac{1}{8}mu^2$

(3) $\sqrt{\frac{2}{3}}mu^2$

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

$$mu\hat{i} + mu\frac{(\hat{i}+\hat{j})}{2} = 2m\vec{u_f}$$

$$v_f = \checkmark$$

$$K_f = \checkmark = \frac{1}{2}(2m)v_f^2$$

Ans : (2)

QUESTION

λ

A rod of length L has non-uniform linear mass density given by $\rho_{(x)} = a + b\left(\frac{x}{L}\right)^2$, where a and b are constants and $0 \le x \le L$. The value of x for the centre of mass of the rod is at:

[JEE Mains 2020]

(1) $\frac{4}{3}\left(\frac{a+b}{2a+3b}\right)L$

(2) $\frac{3}{2}\left(\frac{a+b}{2a+b}\right)L$

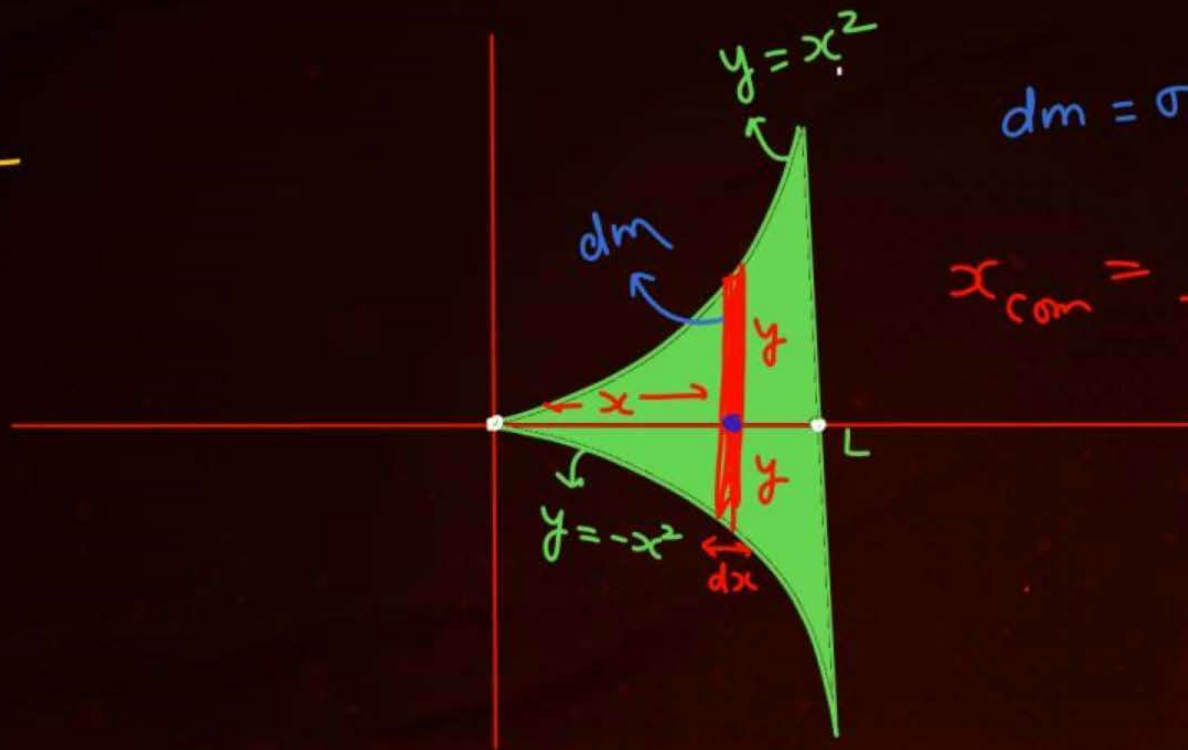
(3) $\frac{3}{2}\left(\frac{2a+b}{3a+3b}\right)L$

(4) $\frac{3}{4}\left(\frac{2a+b}{3a+b}\right)L$

$$\frac{\int_0^L x \cdot \left(a + \frac{bx^2}{L^2}\right) dx}{\int_0^L \left(a + b\frac{x^2}{L^2}\right) dx}$$

Ans : (4)

Q



$$dm = \sigma\, dA = \sigma\, 2y \cdot dx$$

$$x_{com} = \frac{\int x\, dm}{\int dm} = \frac{\int_0^L x\, \sigma\, 2x^2\, dx}{\int_0^L \sigma\, 2x^2\, dx}$$

QUESTION

A particle of mass m is projected with a speed u from the ground at an angle $\theta = \frac{\pi}{3}$ w.r.t. horizontal (x-axis). When it has reached its maximum height, it collides completely inelastically with another particle of the same mass and velocity $u\hat{i}$. The horizontal distance covered by the combined mass before reaching the ground is:

[JEE Mains 2020]

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

(2) $2\sqrt{2}\frac{u^2}{g}$

(3) $\frac{3\sqrt{3}}{8}\frac{u^2}{g}$

(4) $\frac{5}{8}\frac{u^2}{g}$

Ans : (3)

QUESTION

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + \frac{1}{2}(3m)\left(\frac{u}{3}\right)^2 + \frac{1}{2}3m\left(\frac{v}{3}\right)^2$$

A particle of mass m with an initial velocity $u\hat{i}$ collides perfectly elastically with a mass 3 m at rest. It moves with a velocity $v\hat{j}$ after collision, then, v is given by: **[JEE Mains 2020]**

m $\longrightarrow$ u 3m Rest $\Rightarrow$ m $\uparrow$ v 3m $\longrightarrow \frac{u}{3}$, $\downarrow \frac{v}{3}$

(1) $v = \sqrt{\frac{2}{3}}u$

(2) $v = \frac{1}{\sqrt{6}}u$

(3) $v = \frac{u}{\sqrt{3}}$

(4) $v = \frac{u}{\sqrt{2}}$

$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + \frac{1}{2}\frac{mu^2}{3} + \frac{1}{2}m\frac{v^2}{3}$$

$$\frac{1}{2}mu^2 - \frac{1}{6}mu^2 = \frac{1}{2}mv^2 + \frac{1}{2}\times\frac{mv^2}{3}$$

$$3mu^2 - mu^2 = 3mv^2 + mv^2$$

$$2\cancel{m}u^2 = 4\cancel{m}v^2$$

Ans : (4)

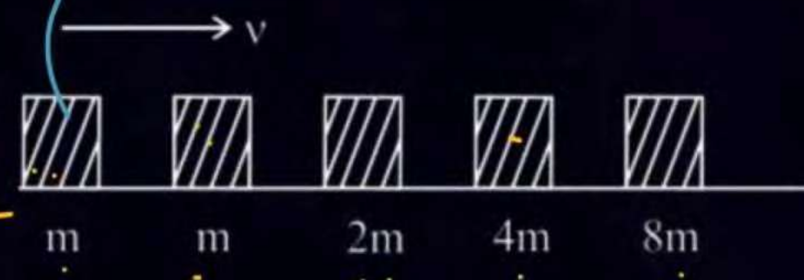
QUESTION

$$\frac{K_f - K_i}{K_i} \times 100 = \frac{\frac{K}{16} - K}{K} \times 100 = \frac{15}{16} K \times 100 =$$

Blocks of masses m, 2 m, 4 m and 8 m are arranged in a line on a frictionless floor. Another block of mass m, moving with speed v along the same line (see figure) collides with mass m in perfectly inelastic manner. All the subsequent collisions are also perfectly inelastic. By the time the last block of mass 8 m starts moving the total energy loss is p% of the original energy. Value of 'p' is close to:

[JEE Mains 2020]

K



(1) 77

(2) 37

(3) 87

(4) 94

$$mv = (16m) v_f$$

$$v_f = \frac{v}{16}$$

$$K_f = \frac{1}{2}(16m)\left(\frac{v}{16}\right)^2$$

$$= \frac{mv^2}{32} = \frac{K}{16}$$

Ans : (4)

QUESTION

A spaceship in space sweeps stationary interplanetary dust. As a result, its mass increases at a rate $\frac{dM_{(t)}}{dt} = bv^2_{(t)}$, where $v_{(t)}$ is its instantaneous velocity. The instantaneous acceleration of the satellite is: [JEE Mains 2020]

$a = \frac{v_{rel} \frac{dm}{dt}}{m} = \frac{v b v^2}{m}$

(1) $-\frac{2bv^3}{M_{(t)}}$

(2) $-\frac{bv^3}{2M_{(t)}}$

(3) $-bv^3_{(t)}$

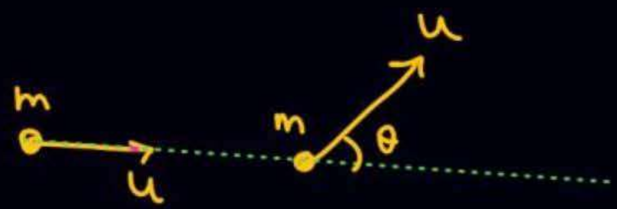
(4) $-\frac{bv^3}{M_{(t)}}$

Ans : (4)

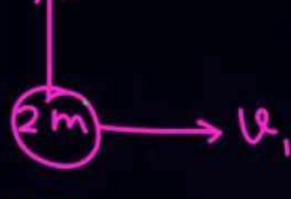
QUESTION

Two bodies of the same mass are moving with the same speed, but in different directions in a plane. They have a completely inelastic collision and move together thereafter with a final speed which is half of their initial speed. The angle between the initial velocities of the two bodies (in degree) is.

[JEE Mains 2020]



$V_2 = \frac{u\sin\theta}{2}$



$v_f = \sqrt{u_1^2 + u_2^2}$

$\frac{\cancel{u}}{\cancel{2}} = \sqrt{\left(\frac{\cancel{u}+\cancel{u}\cos\theta}{\cancel{2}}\right)^2 + \left(\frac{\cancel{u}\sin\theta}{\cancel{2}}\right)^2}$

$mu + mu\cos\theta = 2mv_1$

$v_1 = \frac{u + u\cos\theta}{2}$

$\theta = 120$

$1 = (1+\cos\theta)^2 + (\sin\theta)^2$

$\cancel{1} = \cancel{1^2} + \cancel{\cos^2\theta} + 2\cos\theta + \cancel{\sin^2\theta}$

$\cos\theta = -\frac{1}{2}$

Ans : (120.00)

QUESTION

$m_2 = m$
$m_1 = 2m$

Particle A of mass m_1 moving with velocity $(\sqrt{3}\hat{\imath} + \hat{\jmath})\,ms^{-1}$ collides with another particle B of mass m_2 which is at rest initially. Let $\vec{V_1}$ and $\vec{V_2}$ be the velocities of particles A and B after collision respectively. If $m_1 = 2m_2$ and after collision $\vec{V_1} = (\hat{\imath} + \sqrt{3}\hat{\jmath})\,ms^{-1}$, the angle between $\vec{V_1}$ and $\vec{V_2}$ is: [JEE Mains 2020]

$$2m(\sqrt{3}\hat{i} + \hat{j}) + 0 = 2m\underbrace{(\hat{i} + \sqrt{3}\hat{j})}_{}^{V_1} + m\vec{v_2}$$

(1) 60°

(2) 15°

(3) – 45°

(4) 105°

Ans : (4)

QUESTION

A circular hole of radius (a/2) is cut out of a circular disc of radius 'a' as shown in figure. The centroid of the remaining circular portion with respect to point 'O' will be:

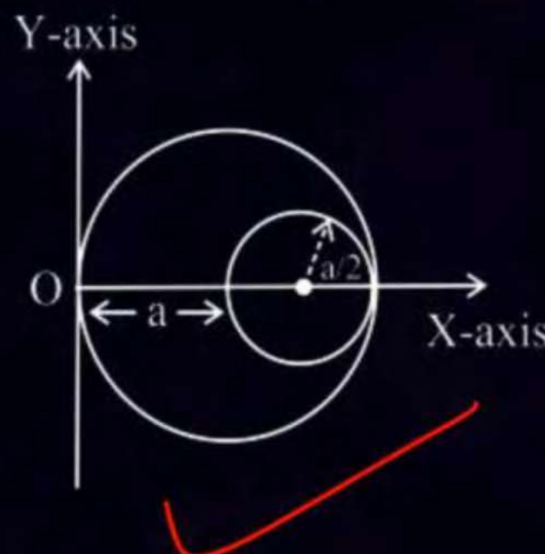
[JEE Mains 2021]

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

(2) $\frac{10}{11}a$

(3) $\frac{5}{6}a$

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



Ans : (1)

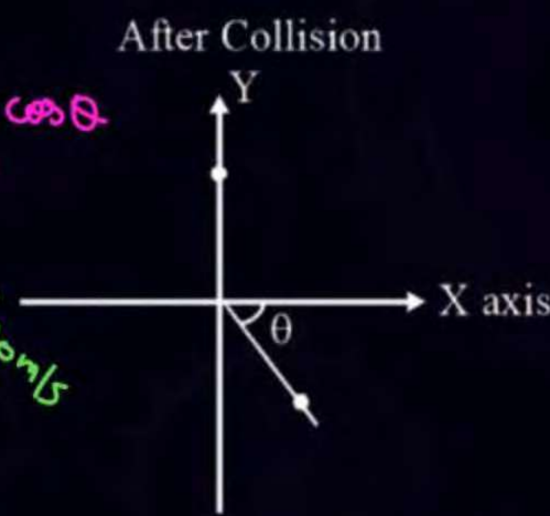
QUESTION

$10 = 20\sin\theta$ $\quad \boxed{\theta = 30^\circ}$

A ball of mass 10 kg moving with a velocity $10\sqrt{3}$ ms^{-1} along X-axis, hits another ball of mass 20 kg which is at rest. After collision, the first ball comes to rest and the second one disintegrates into two equal pieces. One of the pieces starts moving along Y-axis at a speed of 10 m/s. The second piece starts moving at a speed of 20 m/s at an angle θ (degree) with respect to the X-axis. The configuration of pieces after collision is shown in the figure. The value of θ to the nearest integer is ______.

[JEE Mains 2021]

10 $\longrightarrow$ $10\sqrt{3}$ $\qquad$ 20kg Rest $\Rightarrow$ 10kg Rest



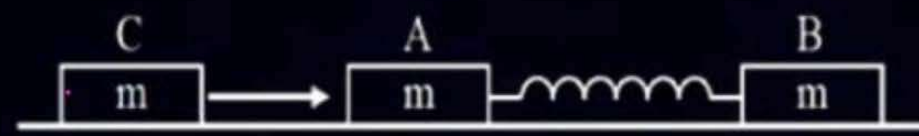
Ans : (30.00)

QUESTION

JEE 24

Two identical blocks A and B each of mass m resting on the smooth horizontal floor are connected by a light spring of natural length L and spring constant K. A third block C of mass m moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is:

[JEE Mains 2021]

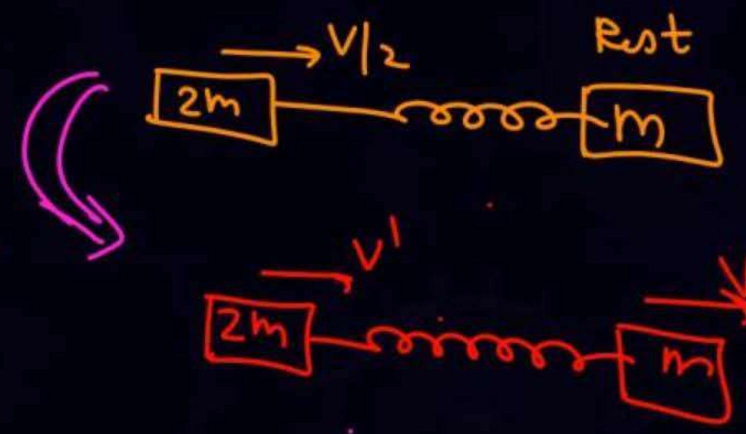


1. $v\sqrt{\frac{M}{2K}}$
2. $\sqrt{\frac{mv}{2K}}$
3. $\sqrt{\frac{mv}{K}}$
4. $\sqrt{\frac{m}{2K}}$

$$2m\frac{v}{2}+0 = 2mv'+mv'$$

$$\boxed{v'=\frac{v}{3}}$$

$$-\frac{1}{2}K\left(x_{max}^2-0^2\right)=\frac{1}{2}(3m)\left(\frac{v}{3}\right)^2-\frac{1}{2}(2m)\left(\frac{v}{2}\right)^2$$

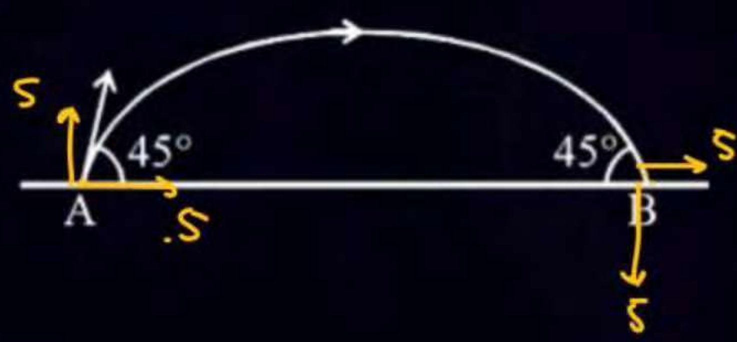


Ans : (1)

QUESTION

The projectile motion of a particle of mass 5 g is shown in the figure. The initial velocity of the particle is $5\sqrt{2}\,ms^{-1}$ and the air resistance is assumed to be negligible. The magnitude of the change in momentum between the points A and B is $x \times 10^{-2}$ kg ms^{-1}. The value of x, to the nearest integer, is ______. [JEE Mains 2021]

$$2mv = 2 \times \frac{5}{1000} \times 5$$



Ans : (5.00)

QUESTION

A bullet of '4g' mass is fired from a gun of mass 4 kg. If the bullet moves with the muzzle speed of 50 ms^{-1}, the impulse imparted to the gun and velocity of recoil of gun are:

[JEE Mains 2021]

$$0+0 = \frac{4}{1000}\times 50 - 4\times v$$

(1) 0.4 kg ms^{-1}, 0.1 ms^{-1}

$$v = \frac{50}{1000} = .05$$

(2) 0.2 kg ms^{-1}, 0.05 ms^{-1}

$$J = 4\times .05$$

(3) 0.2 kg ms^{-1}, 0.1 ms^{-1}

(4) 0.4 kg ms^{-1}, 0.05 ms^{-1}

Ans : (2)

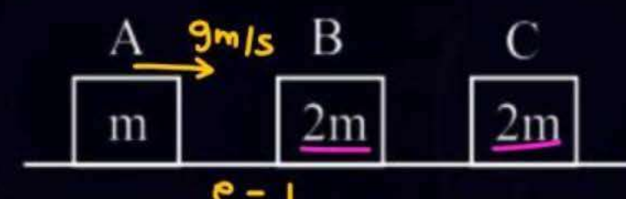
QUESTION

$\overset{\longrightarrow v}{m}$ $\quad e=1 \quad$ $\overset{\text{Rest}}{2m}$ $\Rightarrow$ $\frac{v}{3} \longleftarrow m$ $\quad$ $2m \longrightarrow \frac{2v}{3}$

Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. The masses of A, B and C are m, 2 m and 2 m respectively. A moves towards B with a speed of 9 m/s and makes an elastic collision with it. Thereafter B makes a completely inelastic collision with C. All motions occur along same straight line. The final speed of C is:

JA

[JEE Mains 2021]



(1) 6 m/s

(2) 9 m/s

(3) 4 m/s

(4) 3 m/s

$\overset{\xrightarrow{6\,m/s}}{B}$ $\quad$ $\overset{\text{Rest}}{C}$

$\overset{\xrightarrow{\quad}}{B+C}$ $v_f = 3\,m/s$

Ans : (4)

QUESTION

Two billiard balls of mass 0.05 kg each moving in opposite directions with 10 ms^{-1} collide and rebound with the same speed. If the time duration of contact is t = 0.005 s, then what is the force exerted on the ball due to each other?

$\xrightarrow{10}\ \xleftarrow{10}$

m m

[JEE Mains 2022]

(1) 100 N

(2) 200 N

(3) 300 N

(4) 400 N

$$\langle F\rangle = \frac{2mv}{t} = 2\times\frac{\cancel{5}}{1\cancel{00}}\times\frac{10\times10\cancel{00}}{\cancel{5}}$$

Ans : (2)

QUESTION

The distance of centre of mass from end A of a one-dimensional rod (AB) having mass density $\rho = \rho_0\left(1 - \frac{x^2}{L^2}\right)$ kg/m and length L (in meter) is $\frac{3L}{\alpha}$ m. The value of α is ____.
(where x is the distance form ed A)

[JEE Mains 2022]

Ans : (8.00)

QUESTION

Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i} + 2\hat{j} + \hat{k}$ and $-3\hat{i} - 2\hat{j} + \hat{k}$ respectively. The magnitude of position vector of centre of mass of this system will be similar to the magnitude of vector: [JEE Mains 2022]

(1) $\hat{i} - 2\hat{j} + \hat{k}$

(2) $-3\hat{i} - 2\hat{j} + \hat{k}$

(3) $-2\hat{i} + 2\hat{k}$

(4) $-2\hat{i} - \hat{j} + 2\hat{k}$

Ans : (1)

QUESTION

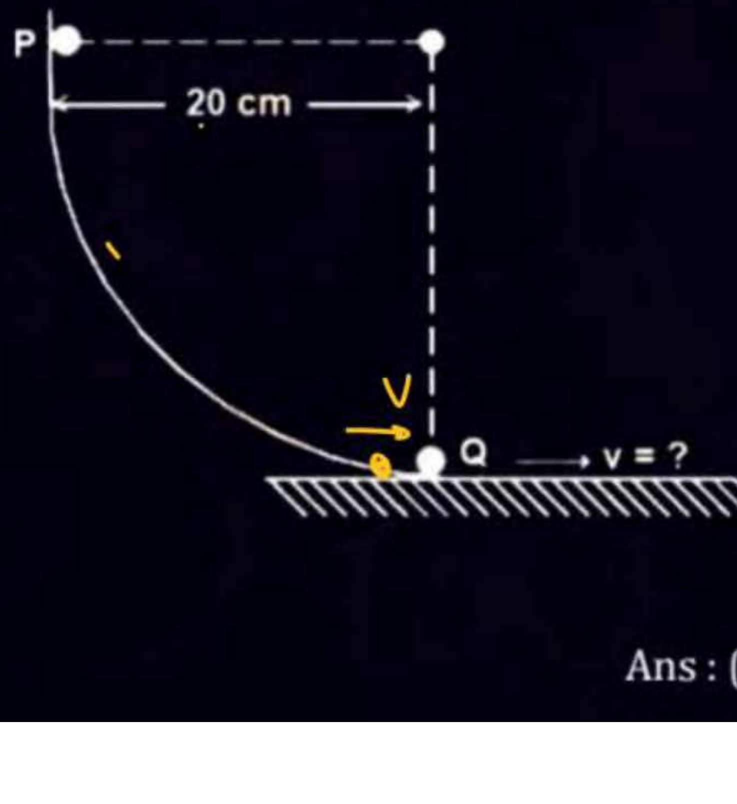
As per the given figure, a small ball P slides down the quadrant of a circle and hits the other ball Q of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball Q after collision will be:

$(g = 10\ m/s^2)$

[30 January 2023 - Shift 1]

$v = \sqrt{2gh}$

$\sqrt{2 \times 10 \times \frac{20}{100}}$



(1) 0

(2) 0.25 m/s

(3) 2 m/s

(4) 4 m/s

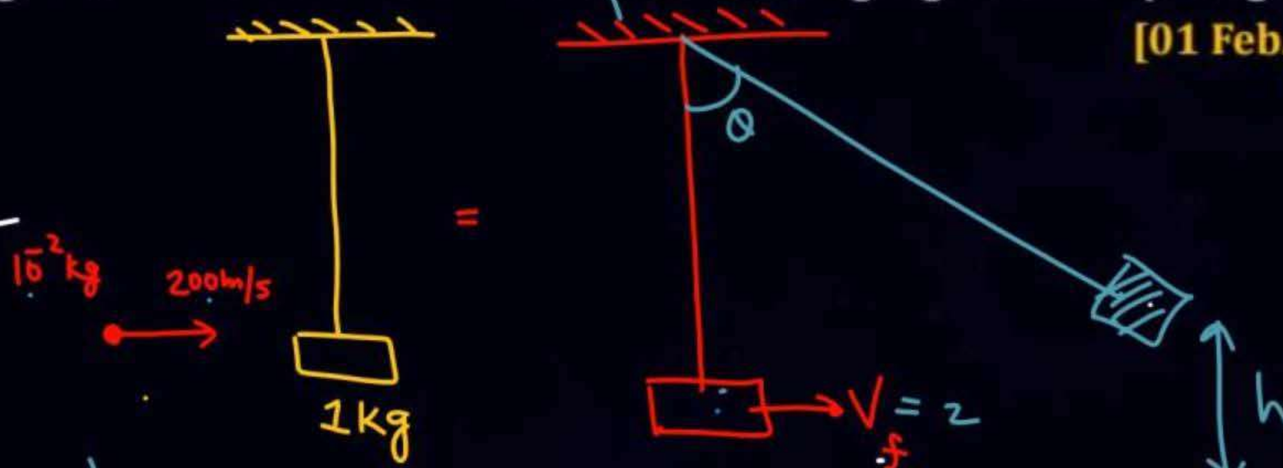
Ans : (3)

QUESTION

$\frac{1}{2}\times\cancel{1}\times 2^2 = \cancel{1}\times\cancel{g}\times h$

A simple pendulum of length 1 m has a wooden bob of mass 1 kg. It is struck by a bullet of mass 10^{-2} kg moving with a speed of $2\times10^{2}\ \mathrm{ms^{-1}}$. The bullet gets embedded into the bob. The height to which the bob rises before swinging back is. (use $g = 10\ \mathrm{m/s^2}$)

[01 Feb. 2024 - Shift 1]



(1) 0.30 m

(2) 0.20 m

(3) 0.35 m

(4) 0.40 m

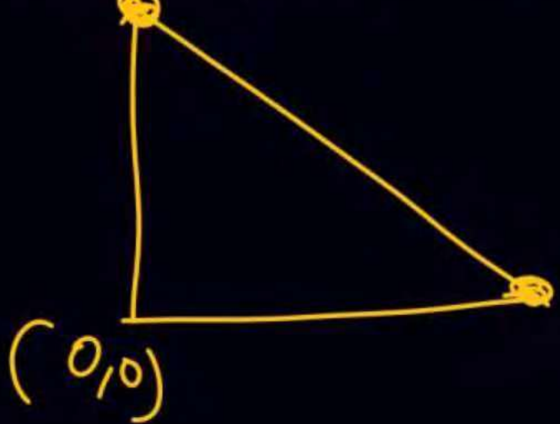
$\frac{1}{100}\times 200 + 0 = (1.01)\,v_f$

$v_f \simeq 2$

Ans : (2)

QUESTION

The identical spheres each of mass 2 M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 4 m each. Taking point of intersection of these two sides as origin, the magnitude of position vector of the centre of mass of the system is $\frac{4\sqrt{2}}{x}$, where the value of x is ________. **[01 Feb. 2024 - Shift 1]**



Ans : (3)

QUESTION

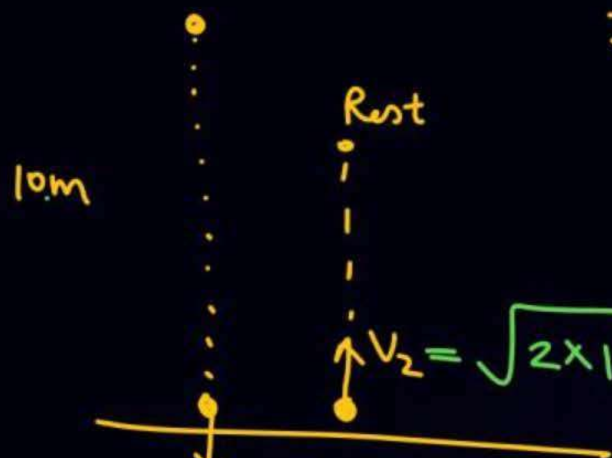
A spherical body of mass 100 g is dropped from a height of 10 m from the ground. After hitting the ground, the body rebounds to a height of 5 m. The impulse of force imparted by the ground to the body is given by: (given $g = 9.8\ m/s^2$) [30 Jan. 2024 - Shift 1]

(1) $4.32\ kg\ ms^{-1}$

(2) $43.2\ kg\ ms^{-1}$

(3) $23.9\ kg\ ms^{-1}$

(4) $2.39\ kg\ ms^{-1}$



$V_2 = \sqrt{2 \times 10 \times 5}$

$V_1 = \sqrt{2 \times 10 \times 10}$

$$J = mV_2 - (-mV_1) = m(V_1 + V_2)$$

$$= .1 \times (\sqrt{200} + \sqrt{100})$$

$$= (\sqrt{2} + 1)$$

Ans : (4)

WPE

A small block of mass 1 kg is released from rest at the top of a rough track. The track is a circular arc of radius 40 m. The block slides along the track without toppling and a frictional force acts on it in the direction opposite to the instantaneous velocity. The work done in overcoming the friction up to the point Q, as shown in the figure below, is 150 J. (Take the acceleration due to gravity, $g = 10\ m\ s^{-2}$) $R=40,\ m=1kg$ **[JEE-Advance-2013]**

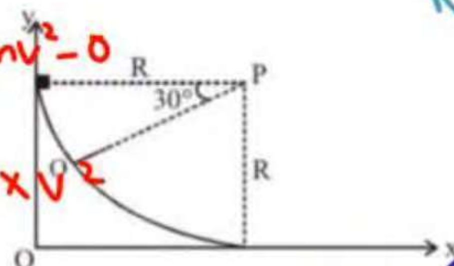
एक रूक्ष पथ के उच्चतम बिन्दु से एक 1 kg द्रव्यमान के गुटके को विरामावस्था से छोड़ा जाता है। यह पथ 40 m त्रिज्या का वृत्तीय चाप है। गुटका अपने पथ पर बिना लुढ़के हुए सरकता है। इस गुटके पर एक घर्षण बल तात्क्षणिक वेग की विपरीत दिशा में लगता है। चित्र में दर्शाये अनुसार, बिन्दु Q तक आने के लिए घर्षण को अतिक्रम करने के लिए 150 J कार्य करना पड़ता है। (गुरूत्वीय त्वरण $g = 10\ m\ s^{-2}$ लीजिए)

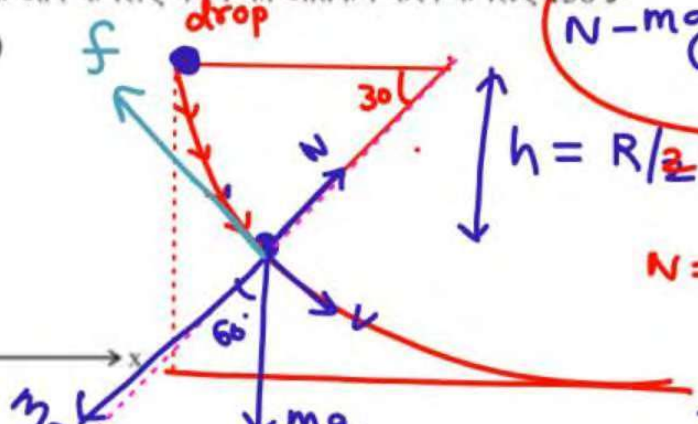
$w_g + w_N + w_f = \Delta KE$

$mg\frac{R}{2} + 0 - 150 = \frac{1}{2}mv^2 - 0$

$\frac{1\times10\times40}{2} - 150 = \frac{1}{2}\times1\times v^2$

$\boxed{v = 10\ m/s}$





$N - mg\cos\theta = \frac{mv^2}{R}$

$N = 5 + \frac{1\times10^2}{40}$

5. The magnitude of the normal reaction that acts on the block at the point Q is

बिन्दु Q पर, गुटके पर लगने वाले अभिलंब बल का परिमाण है :-

(A) 7.5 N (B) 8.6 N (C) 11.5 N (D) 22.5 N

Ans. **(A)**

6. The speed of the block when it reaches the point Q is

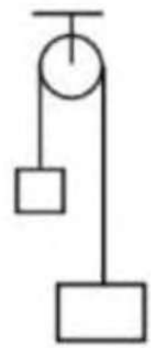
जब गुटका बिन्दु Q पर पहुँचता है, इसकी गति है :-

(A) $5\ ms^{-1}$ (B) $10\ ms^{-1}$ (C) $10\sqrt{3}ms^{-1}$ (D) $20\ ms^{-1}$

Ans. **(B)**

1. A light inextensible string that goes over a smooth fixed pulley as shown in the figure connects two blocks of masses 0.36 kg and 0.72 kg. Taking $g = 10\ m/s^2$, find the work done (in **joules**) by the string on the block of mass 0.36 kg during the first second after the system is released from rest.

चित्र में दर्शाये अनुसार एक चिकनी स्थिर घिरनी पर से गुजरती हुई एक हल्की अवितान्य रस्सी से 0.36 kg तथा 0.72 kg द्रव्यमान के दो ब्लॉक जुड़े हुए हैं। निकाय को विरामावस्था से छोड़ने के बाद प्रथम सैकण्ड के दौरान 0.36 kg द्रव्यमान के ब्लॉक पर रस्सी द्वारा किया गया कार्य (जूल में) ज्ञात कीजिये। **[IIT-JEE-2009]**



Ans. 8

22. A skier starts from rest at the top of a hill. The skier coasts down the hill and up a second hill, as the drawing illustrates. The crest of the second hill is circular, with a radius of $r = 36$ m. Neglect friction and air resistance. What must be the height h (in m) of the first hill so that the skier just loses contact with the snow at the crest of the second hill?

एक आदमी बर्फ की पहाड़ी के शीर्ष से विरामावस्था से प्रारम्भ होता है। आदमी पहली पहाड़ी से नीचे आता है तथा चित्रानुसार दूसरी पहाड़ी पर चढ़ता है। दूसरी पहाड़ी का शिखर (crest) वृत्ताकार है, जिसकी त्रिज्या $r = 36$ m है। घर्षण तथा वायु प्रतिरोधों को नगण्य मानिये। पहली पहाड़ी की ऊंचाई h (मीटर में) क्या होनी चाहिए ताकि आदमी दूसरी पहाड़ी के शिखर पर बर्फ से सम्पर्क छोड़ सकें?

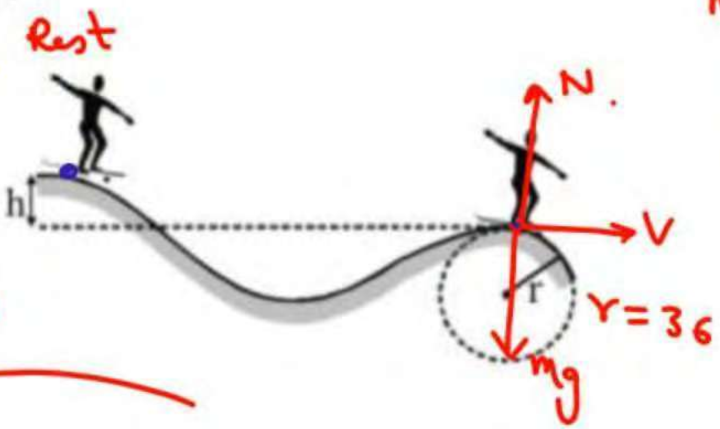
$$mg - \underbrace{N}_{0} = \frac{mv^2}{R}$$

$$v = \sqrt{Rg}$$

$$mgh + 0 + 0 = \frac{1}{2}mv^2 - 0$$

$$\cancel{m}gh = \frac{1}{2}\cancel{m}Rg$$

$$h = R/2 = 18$$



Ans. 018

140. A small bar A resting on a smooth horizontal plane is attached by threads to a point P (Fig. 1.34) and, by means of a weightless pulley, to a weight B possessing the same mass as the bar itself.

Besides, the bar is also attached to a point O by means of light non-deformed spring of length $l_0 = 50$ cm and stiffness $x = 5\ mg/l_0$, where m is the mass of the bar. The thread PA having been burned, the bar starts moving. Find its velocity at the moment when it is breaking off the plane.

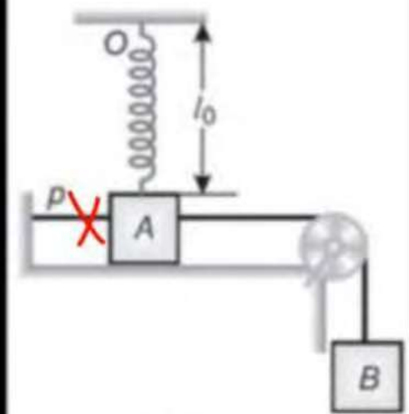
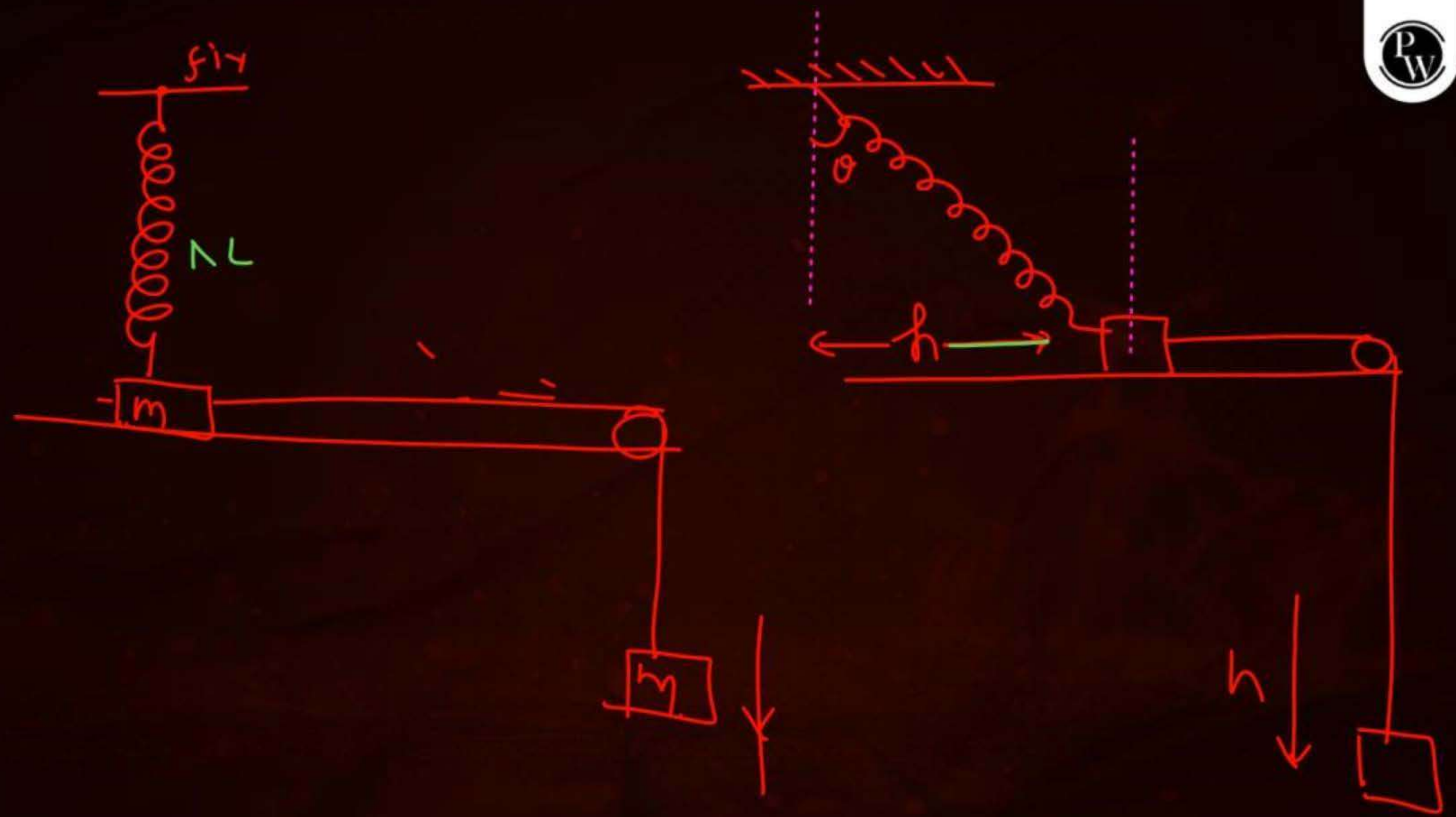


Fig. 1.34

Ans. **140.** $v = \sqrt{19gl_0/32} = 1.7$ m/s.


fix
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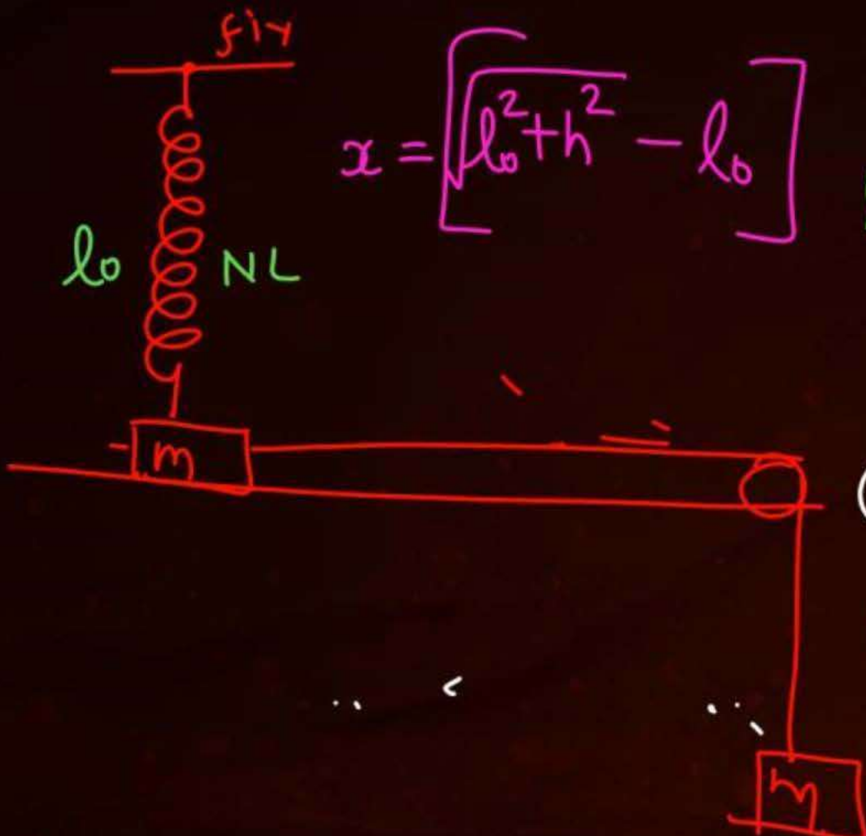
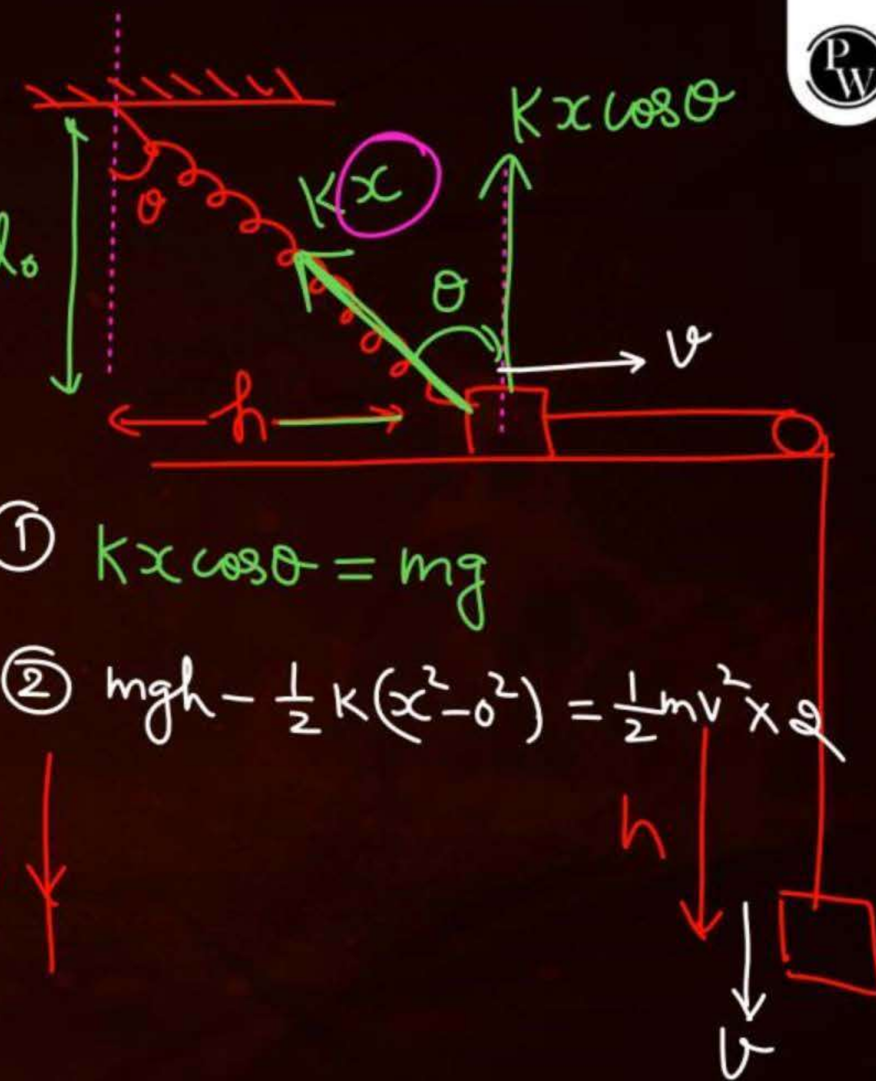
h



$$x = \left[\sqrt{l_0^2 + h^2} - l_0\right]$$



① $Kx\cos\theta = mg$

② $mgh - \frac{1}{2}K(x^2 - 0^2) = \frac{1}{2}mv^2 \times 2$

151. Two bars of masses m_1 and m_2 connected by a weightless spring of stiffness x (Fig. 1.39) rest on a smooth horizontal plane.

Bar 2 is shifted a small distance x to the left and then released. Find the velocity of the centre of inertia of the system after bar 1 breaks off the wall.

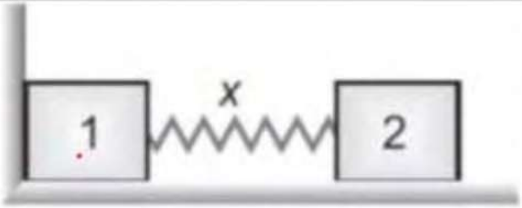
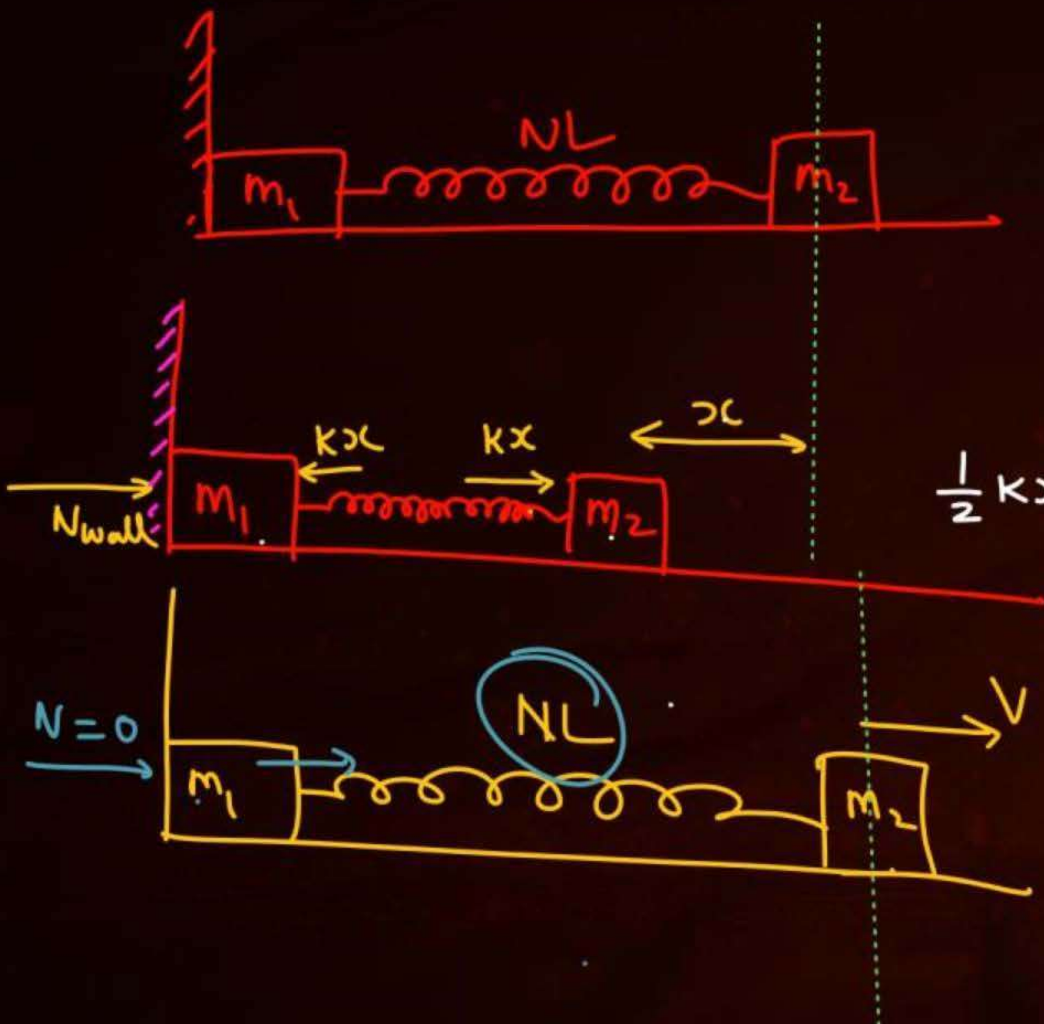


Fig. 1.39

Ans. **151.** $v_C = x\sqrt{xm_2}/(m_1 + m_2)$.



$$N_{wall} = Kx$$

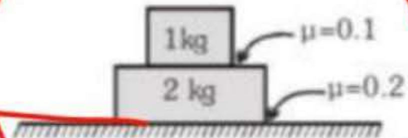
$$a_{com} = \frac{N_{wall}}{m_1+m_2} = \frac{Kx}{m_1+m_2}$$

$$\frac{1}{2}Kx^2 = \frac{1}{2}m_2V^2$$

$$v_{com} = \frac{m_1 \times 0 + m_2 V_2}{m_1+m_2}$$

26. If both the blocks as shown in the given arrangement are given together a horizontal velocity towards right. If a_{cm} be the subsequent acceleration of the centre of mass of the system of blocks then a_{cm} equals

$\longleftarrow f_{\text{घर्षण}}$

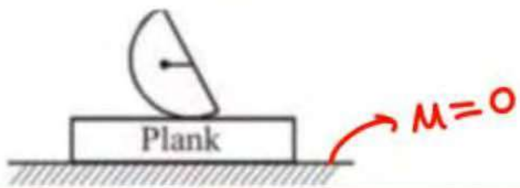


(A) 0 m/s² (B) $\frac{5}{3}$ m/s² (C) $\frac{7}{3}$ m/s² (D) 2 m/s²

$$a_{cm} = \frac{f_{\text{घर्षण}}}{\text{total mass}} = \frac{.2 \times 30}{3} = 2$$

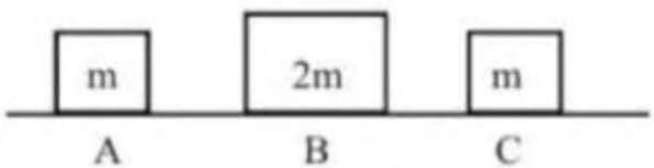
24. Lower surface of a plank is rough and lying at rest on a rough horizontal surface. Upper surface of the plank is smooth and has a smooth hemisphere placed over it through a light string as shown in the figure. After the string is burnt, trajectory of centre of mass of the sphere is :-

(A) a circle (B) an ellipse (C) a straight line (D) a parabola

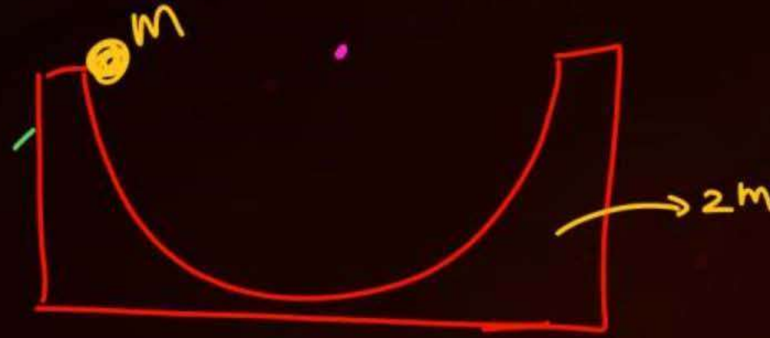


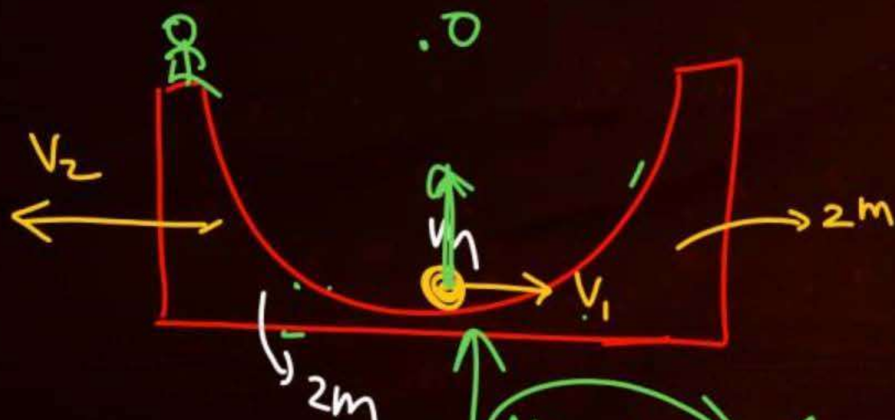
Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. These have masses m, 2m and m, respectively. The object A moves towards B with a speed 9 m/s and makes an elastic collision with it. Thereafter, B makes completely inelastic collision with C. All motions occur on the same straight line. Find the final speed (in m/s) of the object C. **[IIT-JEE-2009]**

तीन वस्तुओं A, B तथा C को घर्षणरहित क्षैतिज सतह पर सरल रेखा में रखा गया है। उनके द्रव्यमान क्रमशः m, 2 m तथा m हैं। वस्तु A, B की तरफ 9 m/s की चाल से गति करती है तथा उससे प्रत्यास्थ टक्कर करती है। उसके पश्चात् B, C के साथ पूर्णतया अप्रत्यास्थ टक्कर करती है। सभी गतियाँ समान सरल रेखा में होती है। वस्तु C की अन्तिम चाल (m/s में) ज्ञात कीजिये।



ns. **4m/s**





① $0+0 = mV_1 - 2mV_2$

$$V_1 = 2V_2$$

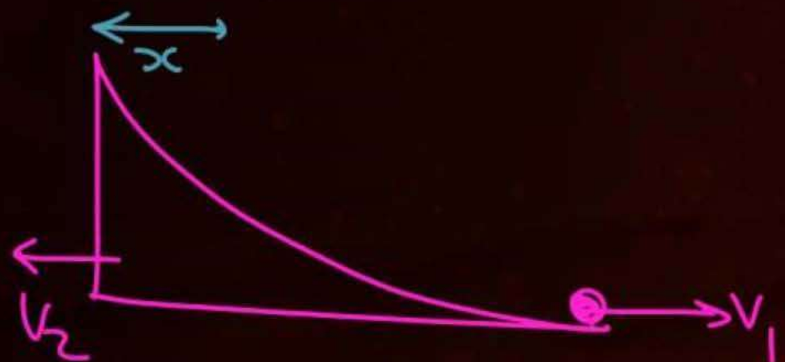
② $mgR = \left(\frac{1}{2}mV_1^2 + \frac{1}{2}2mV_2^2\right)$

$$N - 3mg = (3m)a_{com} - 0$$

$$N = 3mg + 3m\,a_{com}$$

$$N > 3mg$$

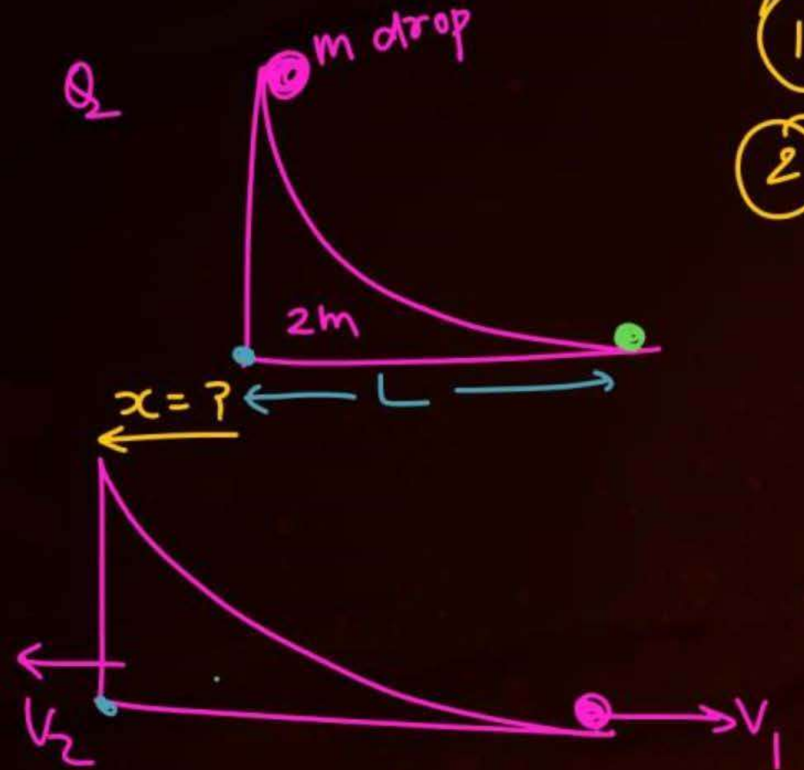
Q2



(1) $0+0 = mv_1 - 2mv_2$ —— (1)

(2) $mgh + 0 = \frac{1}{2}mv_1^2 + \frac{1}{2}2mv_2^2$ —— (2)

Q2



(1) $0+0 = mv_1 - 2mV_2$ —— (1)

(2) $mgh + 0 = \frac{1}{2}mv_1^2 + \frac{1}{2}2mv_2^2$ —— (2)

$m_1\vec{d_1} + m_2\vec{d_2} = 0$

$2mx + m(L+x) = 0$

$x = -\frac{L}{3}$

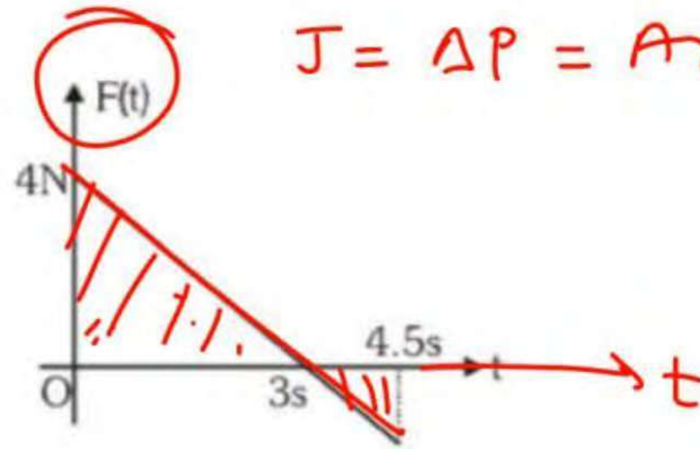
5. A block of mass 2 kg is free to move along the x–axis. It is at rest and from t=0 onwards it is subjected to a time–dependent force F(t) in the x–direction. The force F(t) varies with t as shown in the figure. The kinetic energy of the block after 4.5 second is **[IIT-JEE-2010]**

2kg द्रव्यमान का एक गुटका x- अक्ष पर गति के लिए स्वतंत्र है। यह विश्रामावस्था में है और t = 0 से इस पर x-दिशा में एक कालाश्रित बल F(t) लगाया जाता है। बल F(t) समय के साथ चित्रानुसार बदलता है। 4.5 सेकण्ड के बाद गुटके की गतिज ऊर्जा है :-

$J = \Delta P = \text{Area} = mV_f - 0$

$A_1 - A_2 = 2V_f$

$V_f =$



(A) 4.50 J (B) 7.50 J (C) 5.06 J (D) 14.06 J

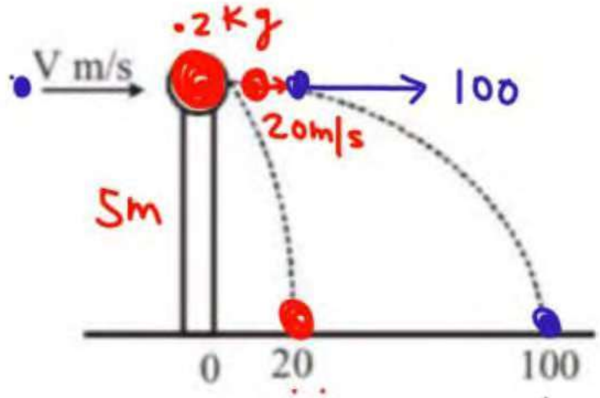
Ans. (C)

6. A ball of mass 0.2 kg rests on a vertical post of height 5m. A bullet of mass 0.01 kg, traveling with a velocity V m/s in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The initial velocity V of the bullet is **[IIT-JEE 2011]**

एक 0.2 kg द्रव्यमान की गेंद 5m ऊंचे एक ऊर्ध्वाधर खम्बे पर विश्रामावस्था में है। एक 0.01 kg की गोली V m/s के क्षैतिज वेग से चलते हुए गेंद के केन्द्र पर टकराती है। टक्कर के बाद गेंद व गोली स्वतंत्र रूप से चलती है। गेंद खम्बे से 20m की दूरी पर तथा गोली 100 m की दूरी पर जमीन पर गिरती है। गोली का प्रारम्भिक वेग V है

$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 5}{10}} = 1$

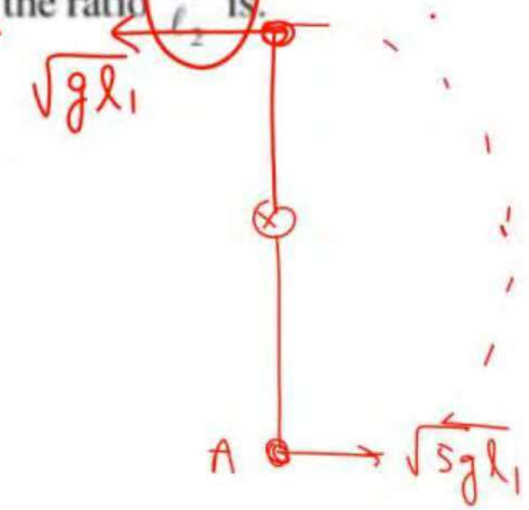
$.01 \times V = .01 \times 100 + .2 \times 20$



(A) 250 m/s (B) $250\sqrt{2}$ m/s (C) 400 m/s (D) 500 m/s

Ans. (D)

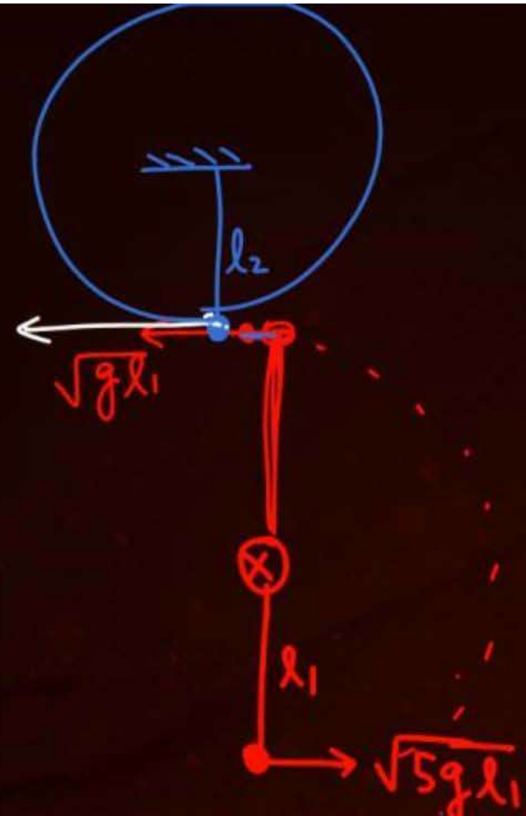
8. A bob of mass m, suspended by a string of length ℓ_1 is given a minimum velocity required to complete a full circle in the vertical plane. At the highest point, it collides elastically with another bob of mass m suspended by a string of ~~length~~ ℓ_2, which is initially at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum sped required to complete a full circle in the vertical plane, the ratio $\frac{\ell_1}{\ell_2}$ is. **[JEE Advanced-2013]**



Ans. 5

$$\sqrt{5gl_2} = \sqrt{gl_1}$$

$$\frac{l_1}{l_2} = 5$$

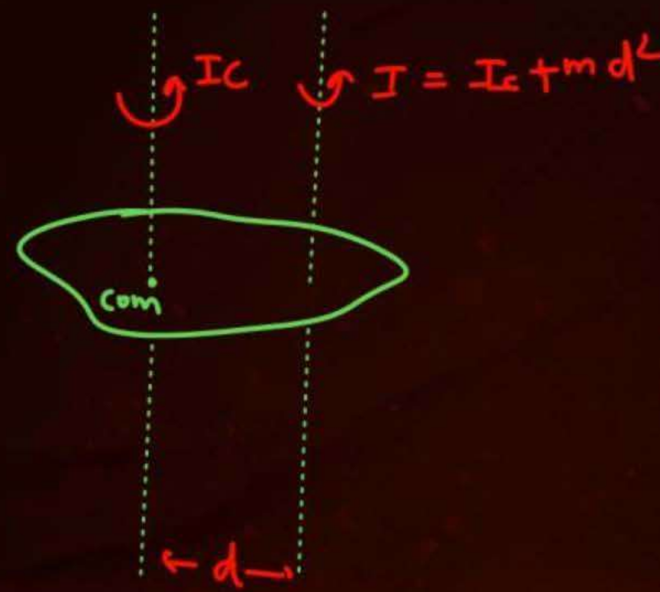


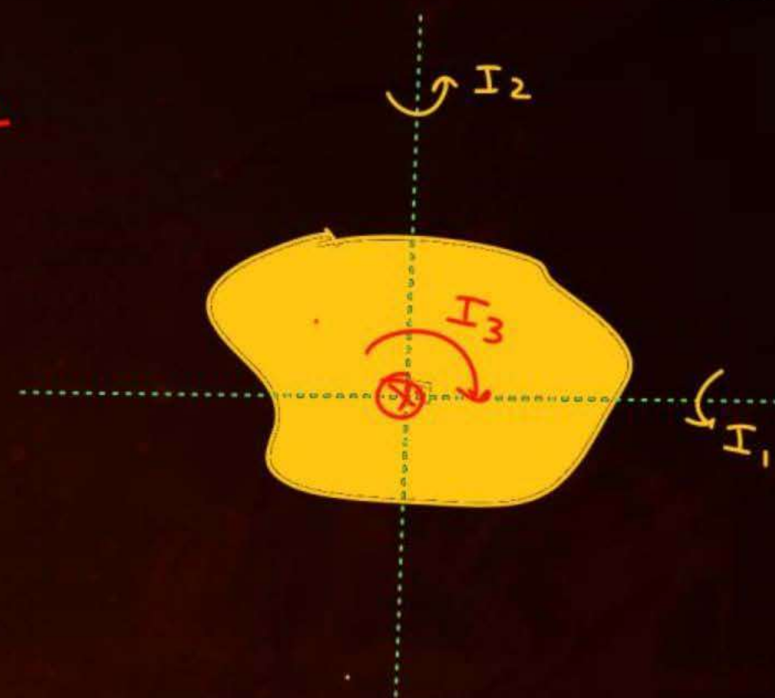
Rotation

* moI

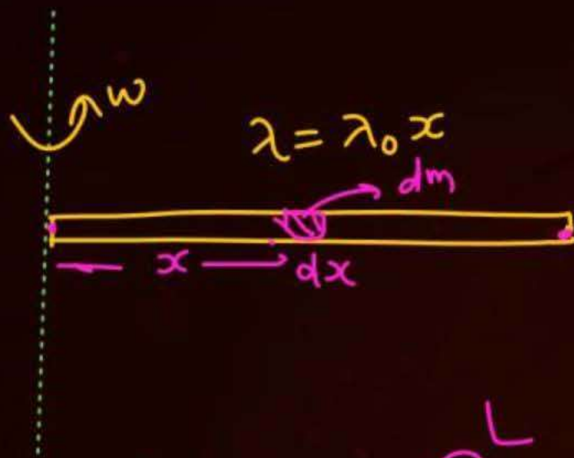
* $I = I_c + md^2$

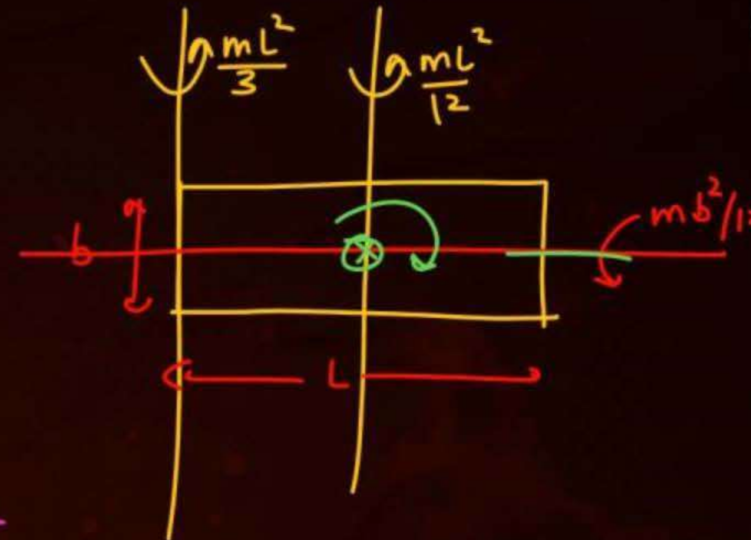
* $I_3 = I_1 + I_2$





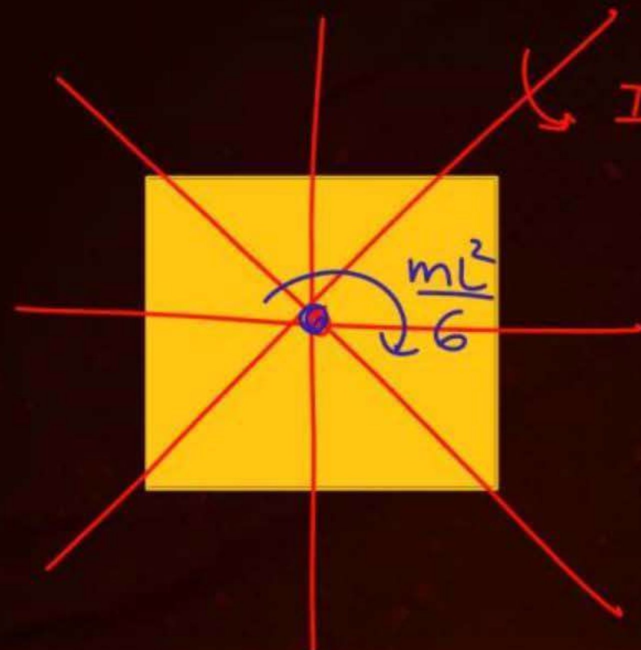
Q





$$I = \int dm \cdot r^2 = \int_0^L \lambda_0 x \cdot dx \cdot x^2$$

Square plate

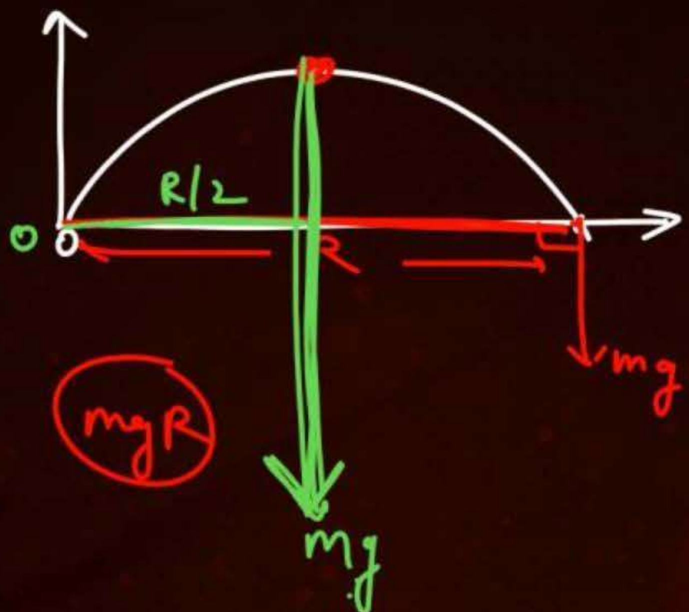


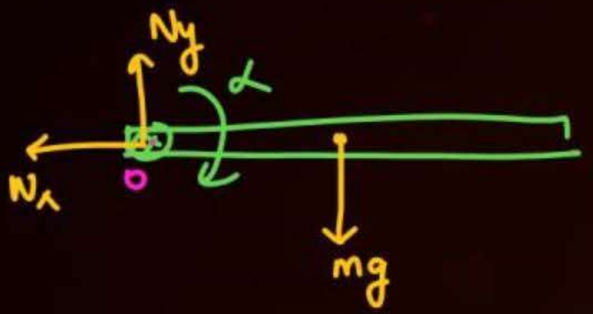
$I = \frac{mL^2}{12}$

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\tau = r F_{\perp} = r_{\perp} F$$

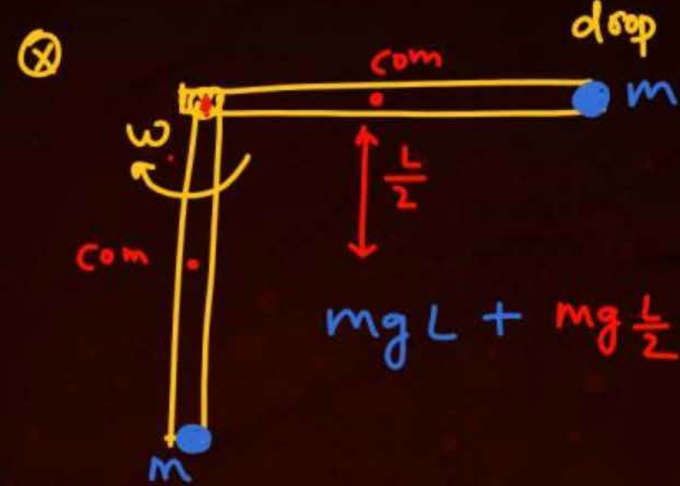
$$\vec{\tau} = I_{Axis} \vec{\alpha}$$





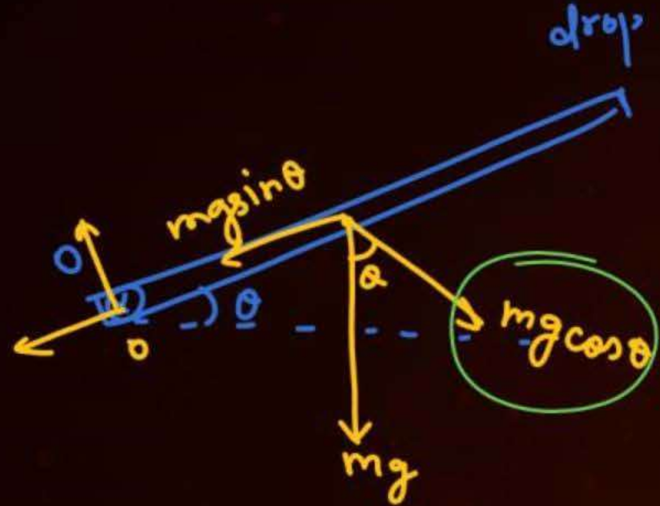
$$\tau = mg\frac{L}{2} = \frac{mL^2}{3}\alpha$$

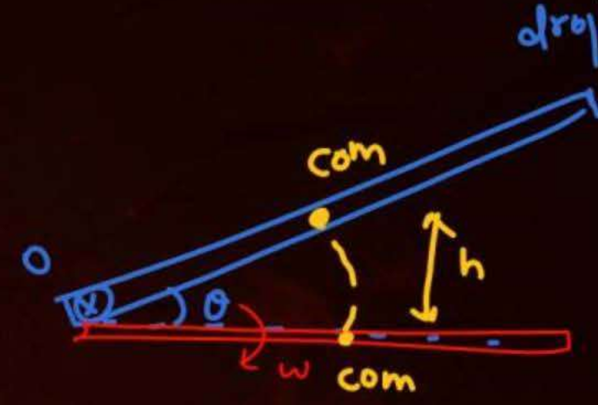
$$\alpha = \frac{3g}{2L}$$



$$mgL + mg\frac{L}{2} = \frac{1}{2}\left(\frac{mL^2}{3} + mL^2\right)\omega^2$$

Q





$$\tau_0 = mg\cos\alpha \cdot \frac{L}{2} = \frac{mL^2}{3}\cdot\alpha$$

$$\alpha = \frac{3}{2}\frac{g}{L}\cos\alpha$$

$$mgh + 0 = \frac{1}{2}\cdot\frac{mL^2}{3}\cdot\omega^2 - 0$$

(1) $\vec{\tau} = \vec{r} \times \vec{F}$

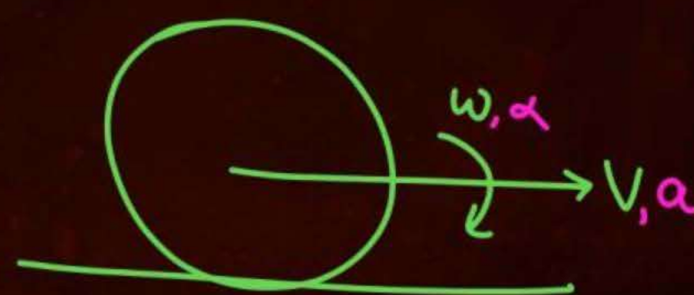
$\tau = r F_{\perp} = r_{\perp} F$

(2)
$$\left.\begin{aligned} \vec{\tau} &= I\vec{\alpha} \\ KE &= \frac{1}{2} I\omega^2 \\ L &= I\omega \end{aligned}\right\} \text{Fix Axis}$$

$\vec{L} = \vec{r} \times m\vec{v}$

CRTM

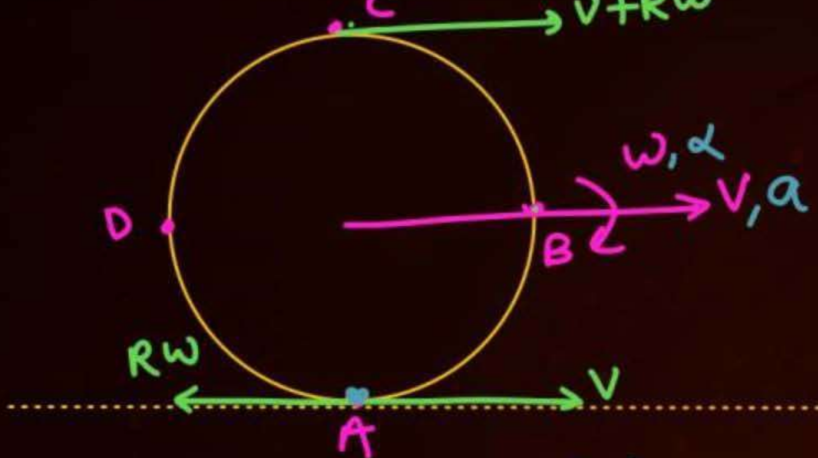
$$\boxed{\begin{aligned} KE &= \frac{1}{2} mv^2 + \frac{1}{2} I\omega^2 \\ \vec{L} &= I\vec{\omega} + \vec{r} \times m\vec{v}_c \end{aligned}}$$



$$\vec{V_A} = (V - R\omega)\hat{i}$$

$$\vec{V_B} = V\hat{i} - R\omega\hat{j}$$

$$\vec{V_C} = (V + R\omega)\hat{i}$$

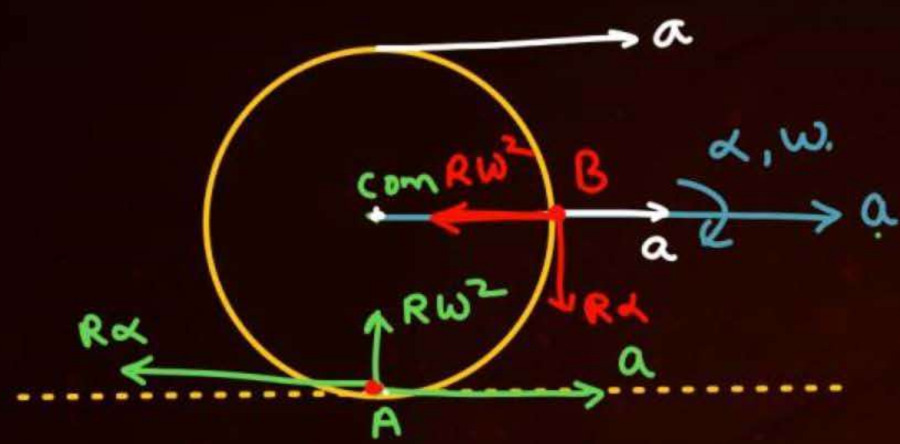


$V_A = 0$ rolling

$\vec{a_A} =$

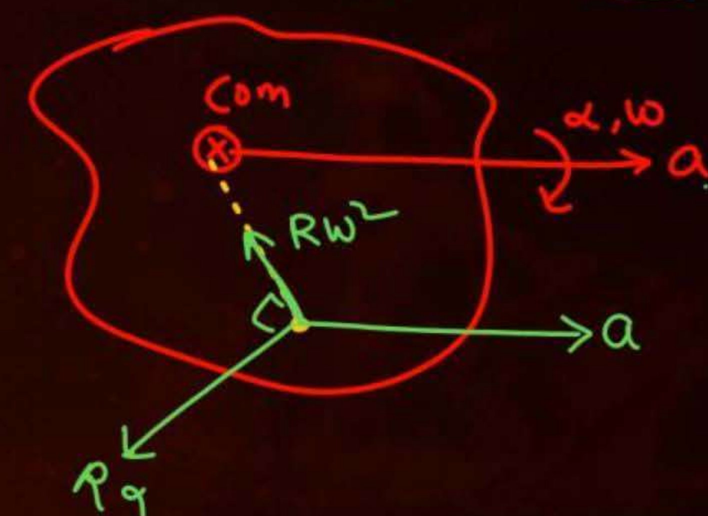
Rolling $V_1 - R\omega = V_2$

$$\vec{a}_{P/g} = \vec{a}_{P/com} + \vec{a}_{com/g}$$



$$\vec{a}_A = a\hat{i} - R\alpha\hat{i} + R\omega^2\hat{j}$$

$$\vec{a}_B = a\hat{i} - R\alpha\hat{j} - R\omega^2\hat{j}$$



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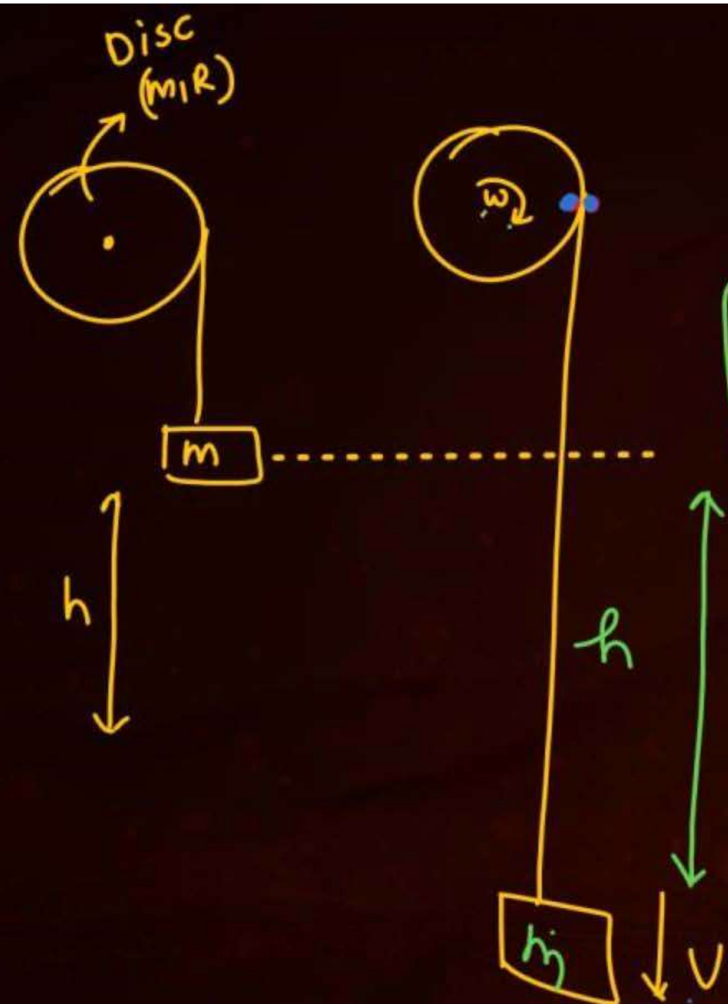


$$mgh + 0 = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

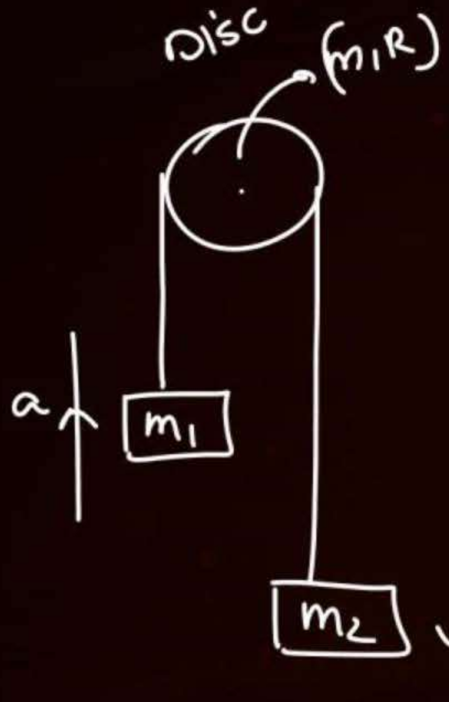
$$V = R\omega$$
$$\omega = \frac{V}{R}$$

$$I = mR^2/2$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\frac{m\cancel{R^2}}{2}\cdot\frac{V^2}{\cancel{R^2}}$$

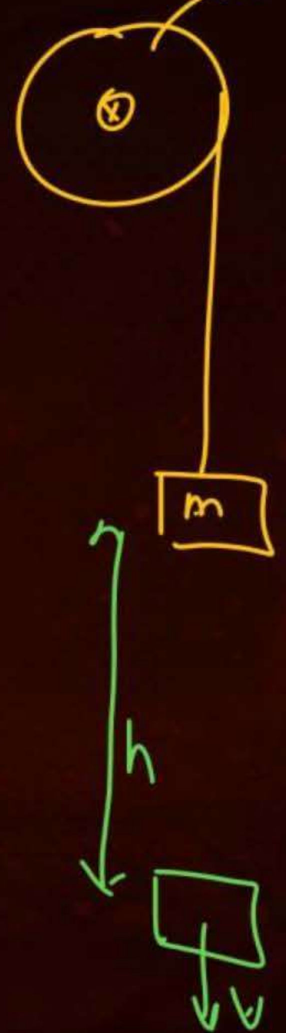
$$\cancel{m}gh = \frac{3}{4}\cancel{m}V^2$$

$$V = \sqrt{\frac{4gh}{3}}$$



$$a = \frac{m_2 g - m_1 g}{m_1 + m_2 + \frac{I}{R^2}}$$

(M, R, Disc)

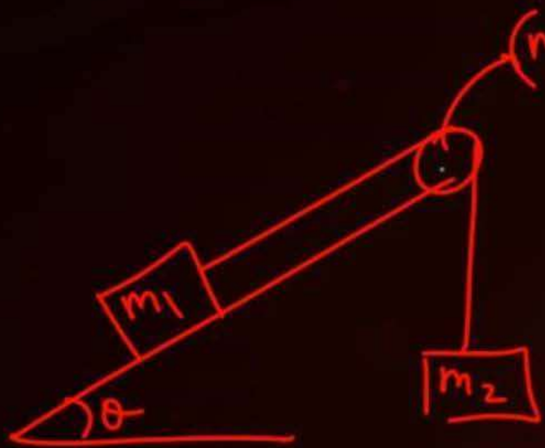


$$v^2 = 0^2 + 2 \times \frac{2g}{3} \times h$$

$$v = \sqrt{\frac{4gh}{3}}$$

$$a = \frac{mg - 0}{m + 0 + \frac{mR^2}{2R^2}}$$

$$a = 2g/3$$



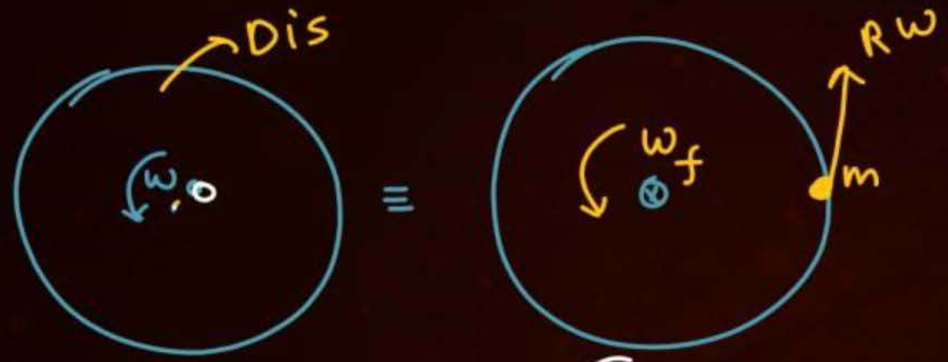
$$a = \frac{m_2 g - m_1 g \sin\theta}{m_1 + m_2 + \frac{I}{R^2}}$$

Jm

(*) $L_i = L_f$

mvr

(1)



$L_i = L_f$ (abt hinged)

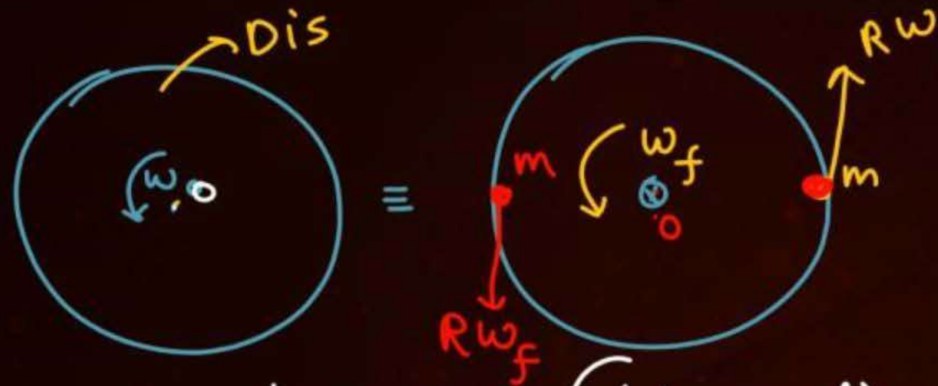
$$\frac{MR^2}{2}\omega_0 = \frac{MR^2}{2}\cdot\omega_f + m\cdot R\omega_f\cdot R$$

Jm

$L_i = L_f$

mvr

(1)



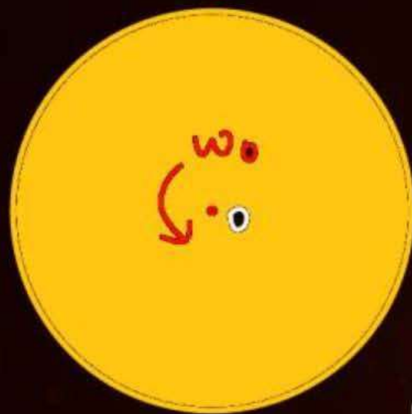
$L_i = L_f$ (abt hinged)

$$\frac{MR^2}{2}\omega_0 = \frac{MR^2}{2}\cdot\omega_f + m\cdot R\omega_f\cdot R + m(R\omega_f)\cdot R$$

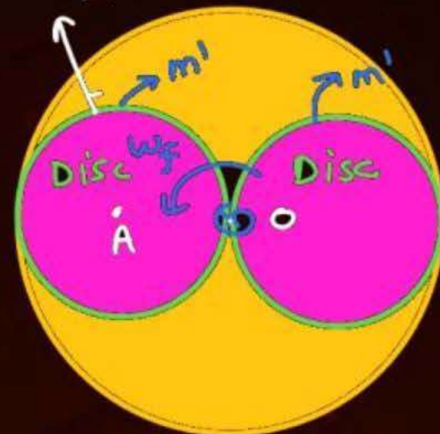
Q

Dis

(m, R)



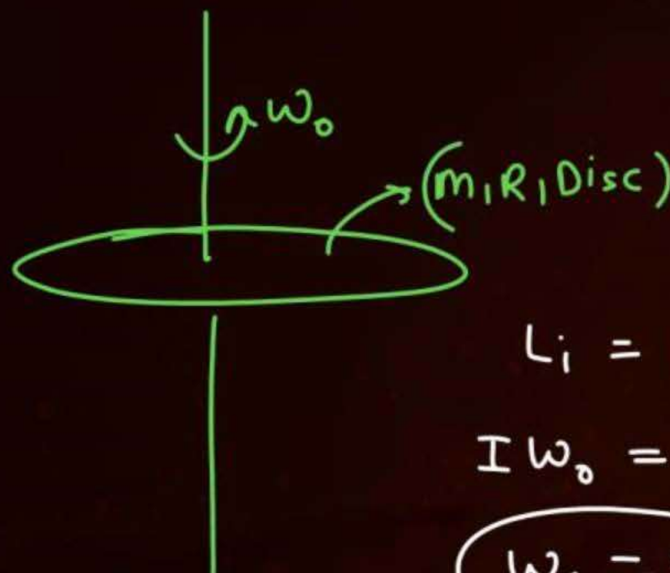
$\Rightarrow$



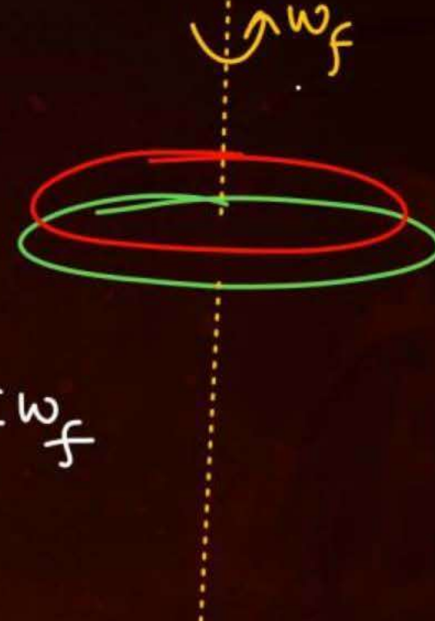
$$L_i = L_f$$

$$\frac{mR^2}{2}\omega_0 = \frac{mR^2}{2}\omega_f + \left[\frac{m(R/2)^2}{2} + m(R/2)^2\right] \times 2\,\omega_f$$

$$(WD)_f = \frac{1}{2} I\omega_f^2 \times 2 - \frac{1}{2} I\omega_0^2$$



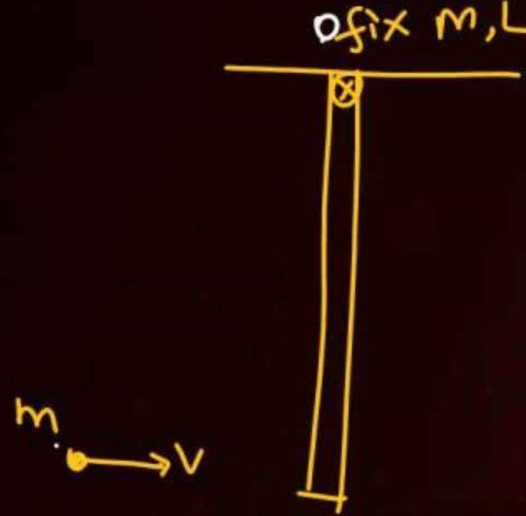
$=$



$$L_i = L_f$$

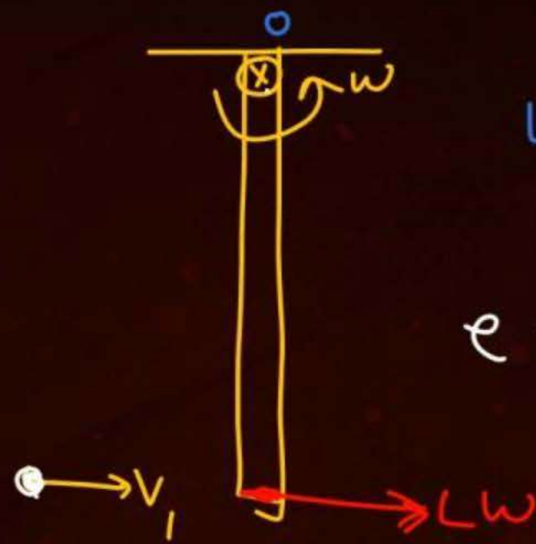
$$I\omega_0 = I\omega_f + I\omega_f$$

$$\omega_f = \omega_0/2$$



$e = 1$

$\Rightarrow$



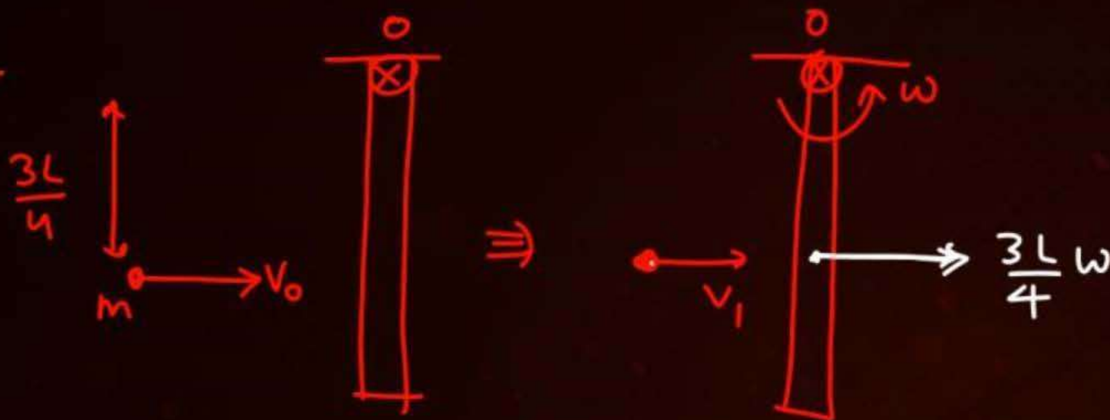
$L_i = L_f$

$e = 1 = \dfrac{L\omega - v_1}{v}$

$L_i = L_f$

$$mvL + 0 = mv_1L + \frac{mL^2}{3}\omega$$

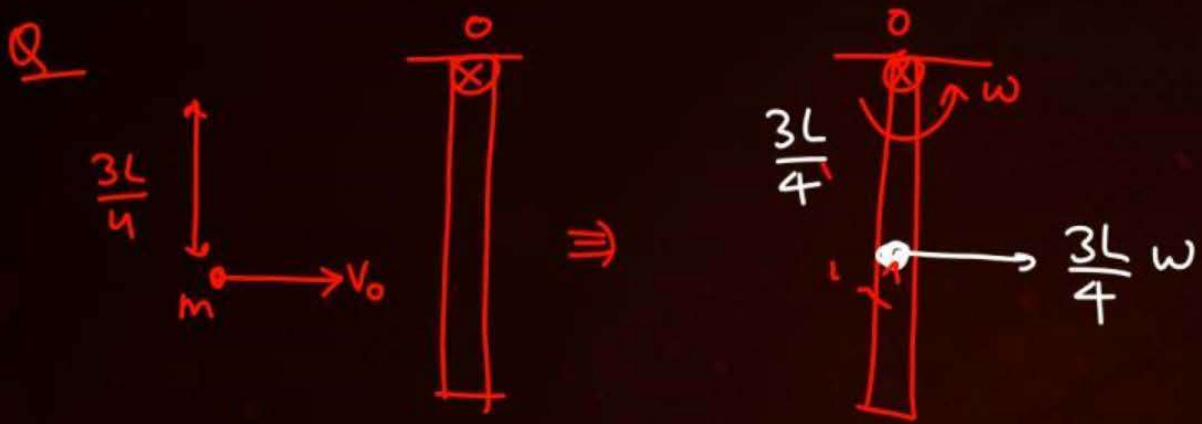
Q



$e = 3/4$

① $mV_0 \frac{3L}{4} + 0 = mV_1 \frac{3L}{4} + \frac{mL^2}{3}\omega$

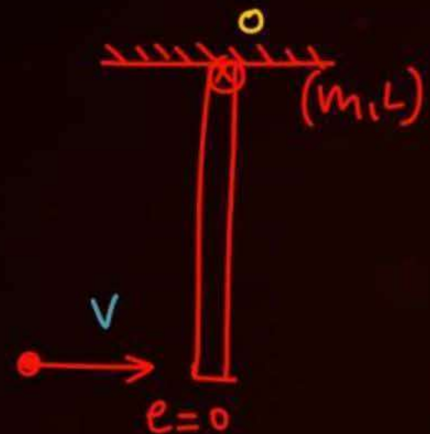
$e = \frac{3}{4} = \frac{\frac{3L}{4}\omega - V_1}{V_0}$

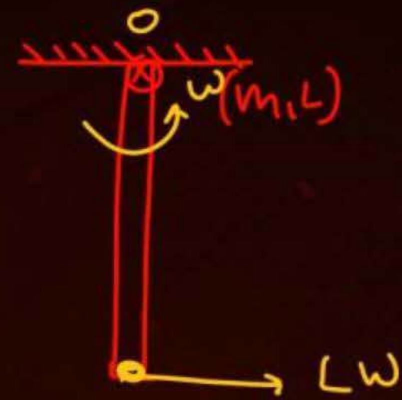


$e = 0$

(1) $mV_0 \frac{3L}{4} + 0 = m \cdot \frac{3L\omega}{4} \frac{3L}{4} + \frac{mL^2}{3}\omega$

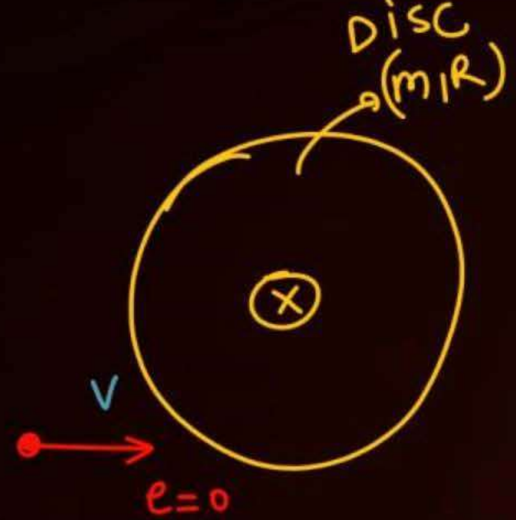
Q





$$mvL + 0 = m(L\omega)L + \frac{mL^2}{3}\cdot\omega$$

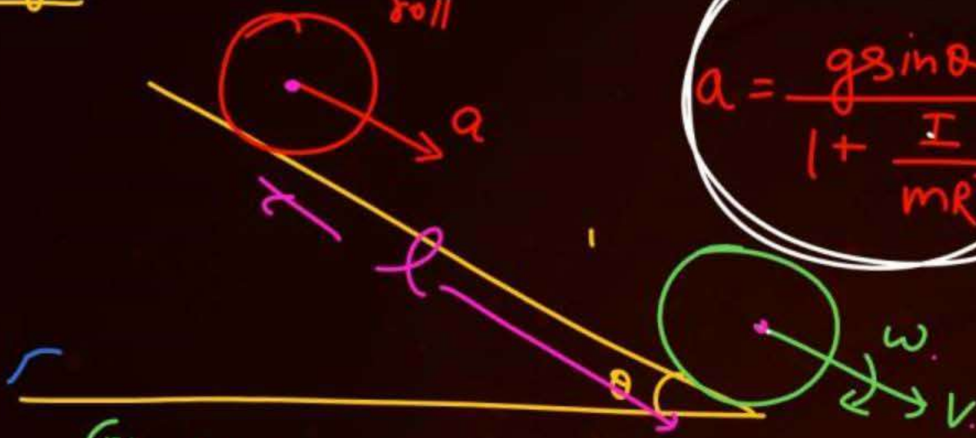
Q



$$mvR + 0 = m(R\omega)R + \frac{mR^2}{2}\omega$$

Rolling . inclined plane → (20 दR)

$$V = R\omega$$
$$a = R\alpha$$



$$a = \frac{g\sin\theta}{1 + \frac{I}{mR^2}}$$

$$v^2 = 0^2 + 2 \times a \times l$$
$$\omega = v/R$$

(Ring, Disc, SS, H.S . . .)

$I \uparrow$, $a \downarrow$, slowly, $v_f \downarrow$, $\omega_f \downarrow$

time ↑

$a_1 = \checkmark$

$a_2 = \checkmark$ $\quad a_{rel} = \checkmark$

Disc Rolling

$a = R\alpha$

$F - f = ma$

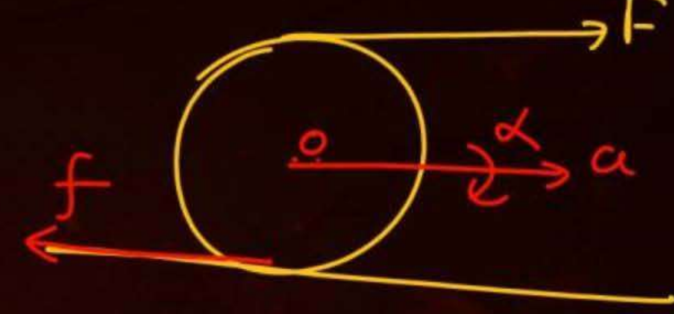
$fR = \frac{mR^2}{2}\alpha = \frac{mR^2}{2}\frac{a}{R}$

$a = R\alpha$

$f = ma/2$

$F = ma + \frac{ma}{2}$

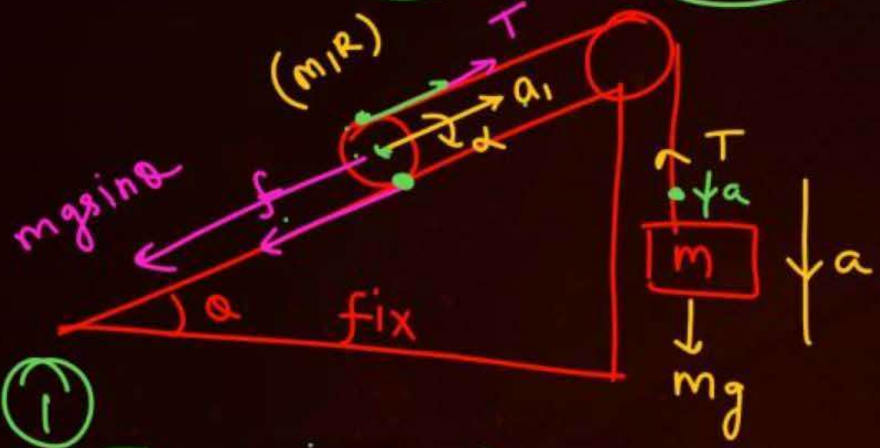
$a = 2F/3m$



$F - f = ma$

$FR + fR = \frac{mR^2}{2}\cdot\frac{a}{R}$

Q2



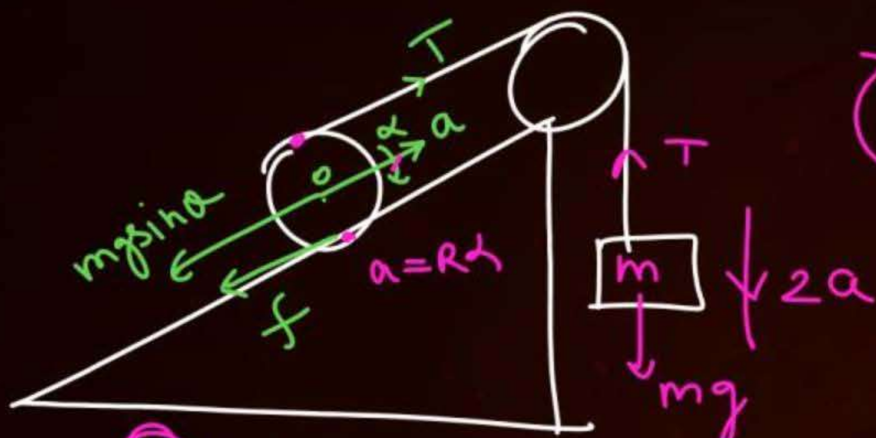
③ $a_1 + R\alpha = a$

④ $a_1 = R\alpha$

$mg - T = ma$

① $T - mg\sin\theta - f = ma_1$

② $TR + fR = \frac{mR^2}{2} \cdot \alpha$



(3) $$mg - T = m2a$$

(1) $$T - f - mg\sin\theta = ma$$

(2) $$TR + fR = \frac{mR^2}{2}\cdot\frac{a}{R}$$

JA JM

Rolling

Disc $\equiv \frac{1}{2} mR^2$

Solid sph $\frac{2}{5} mR^2$

$$W_g + W_N + W_f = \Delta KE$$

$$-mgh + 0 + 0 = 0 - \left(\frac{1}{2}mv^2 + \frac{mR^2}{2\times 2}\left(\frac{V}{R}\right)^2\right)$$

Disc rol $\frac{mR^2}{2}$

$$R.K.E. = \frac{1}{2} I\omega^2 = \frac{1}{2}\frac{mR^2}{2}\cdot\left(\frac{v}{R}\right)^2 = \frac{1}{4}mv^2$$

$$T.K.E. = \frac{1}{2}mv^2$$

$$\frac{RKE}{T.KE} = \frac{1}{2}$$

QUESTION

Mass per unit area of a circular disc of radius a depends on the distance r from its centre as $\boxed{\sigma(r) = A + Br.}$ The moment of inertia of the disc about the axis, perpendicular to the plane and passing through its centre is:

[JEE Main 2020]

$dm = \sigma dA$

(1) $2\pi a^4 \left(\frac{A}{4} + \frac{aB}{5}\right)$ ✓

$dI = (dm)\, r^2$

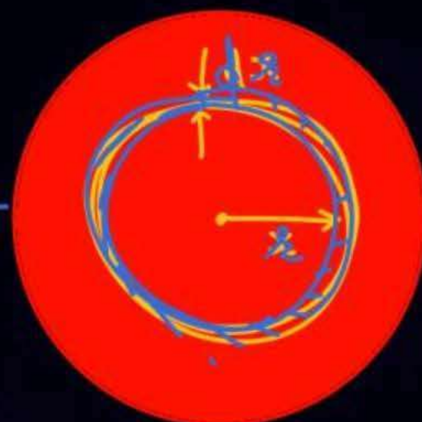
(2) $\pi a^4 \left(\frac{A}{4} + \frac{aB}{5}\right)$

$I = \int_0^R (A + Br)\, 2\pi r\, dr \cdot r^2$

(3) $2\pi a^4 \left(\frac{aA}{4} + \frac{B}{5}\right)$

$= A 2\pi \frac{R^4}{4} + \frac{B 2\pi R^5}{5}$

(4) $2\pi a^4 \left(\frac{A}{4} + \frac{B}{5}\right)$



Ans. (1)

QUESTION

$m v_{\perp} r$

Consider a uniform rod of mass M = 4 m and length l pivoted about its centre. A mass m moving with velocity V making angle $\theta = \frac{\pi}{4}$ to the rod's long axis collides with one end of the rod and sticks to it. The angular speed of the rod-mass system just after the collision is:

[JEE Main 2020]

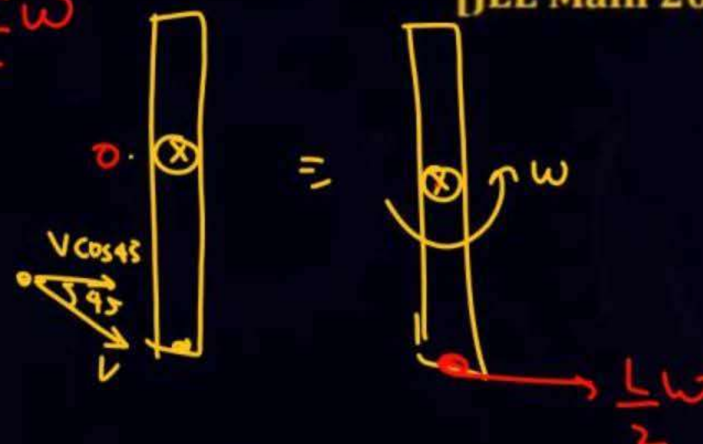
$$m(V\cos 45)\frac{L}{2} + 0 = m \cdot \frac{L}{2}\omega \cdot \frac{L}{2} + \frac{ML^2}{12}\omega$$

(1) $\frac{3}{7\sqrt{2}}\frac{v}{\ell}$

(2) $\frac{3\sqrt{2}}{7}\frac{v}{\ell}$

(3) $\frac{4}{7}\frac{v}{\ell}$

(4) $\frac{3}{7}\frac{v}{\ell}$



Ans. (2)

QUESTION

A uniformly thick wheel with moment of inertia I and radius R is free to rotate about its centre of mass (see fig). A massless string is wrapped over its rim and two blocks of masses m_1 and m_2 $(m_1 > m_2)$ are attached to the ends of the string. The system is released from rest. The angular speed of the wheel when m_1 descents by a distance h is:

ω

[JEE Main 2020]

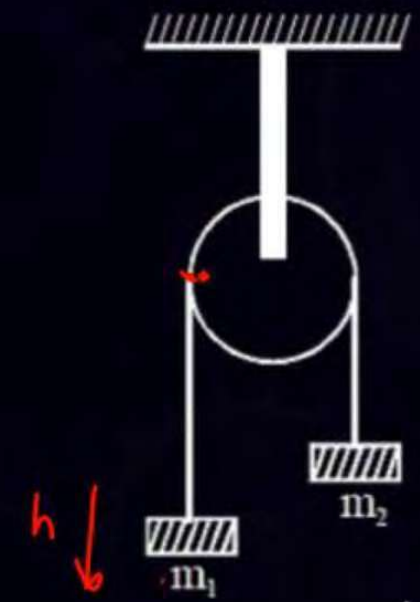
(1) $\left[\frac{m_1+m_2}{(m_1+m_2)R^2+1}\right]^{\frac{1}{2}} gh$

(2) $\left[\frac{2(m_1-m_2)gh}{(m_1+m_2)R^2+1}\right]^{\frac{1}{2}}$

(3) $\left[\frac{2(m_1+m_2)gh}{(m_1+m_2)R^2+1}\right]^{\frac{1}{2}}$

(4) $\left[\frac{(m_1+m_2)gh}{(m_1+m_2)R^2+1}\right]^{\frac{1}{2}} gh$

$v^2 = 0^2 + 2 \times a \times h = (R\omega)^2$



Ans. (2)

QUESTION

Shown in the figure is rigid and uniform one-meter long rod AB held in horizontal position by two strings tied to its ends and attached to the ceiling. The rod is of mass 'm' and has another weight of mass 2 m hung at a distance of 75 cm from A. The tension in the string at A is:

[JEE Main 2020]

$T_1 = mg$

$T_1 + T_2 = 3mg$

$\tau_A = 0$

$mg \times .5 + 2mg \times .75 = T_2 \times 1$

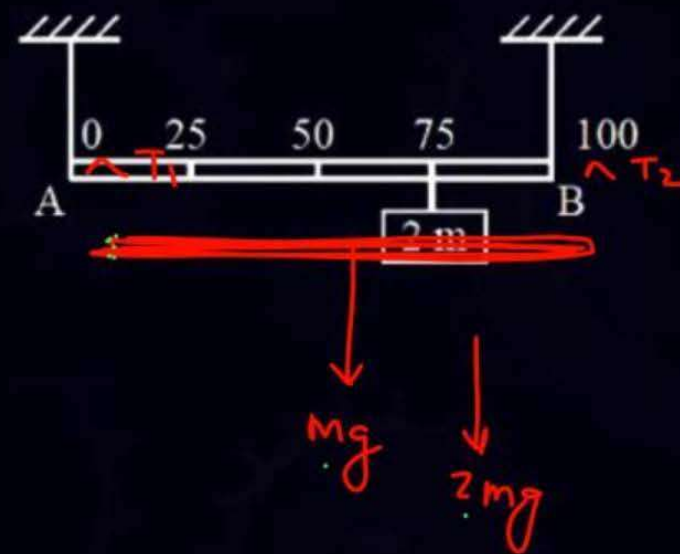
$T_2 = 2mg$

(1) 2 mg

(2) 0.5 mg

(3) 0.7 mg

(4) 1 mg



Ans. (4)

QUESTION

$\cos\theta = \frac{R-a}{R}$

A uniform cylinder of mass M and radius R is to be pulled over a step of height a(a < R) by applying a force F at its centre 'O' perpendicular to the plane through the axes of the cylinder on the edge of the step (see figure). The minimum value of F required is:

$\tau_A = 0$

[JEE Main 2020]

(1) $Mg\sqrt{1-\frac{a^2}{R^2}}$

$mgx = F\cdot R$

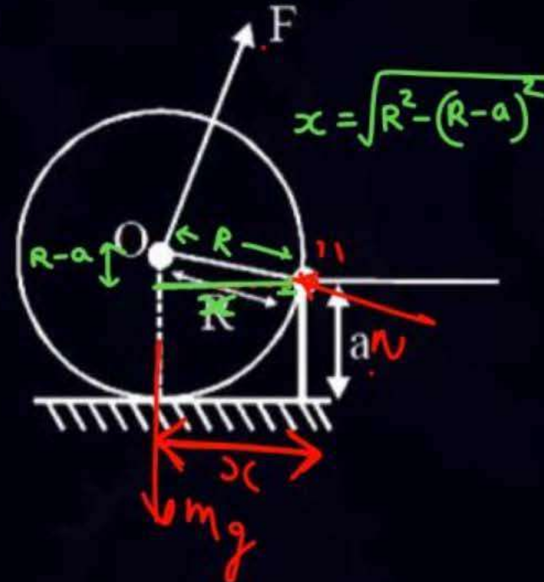
(2) $Mg\sqrt{\left(\frac{R}{R-a}\right)^2-1}$

$F_m = \frac{mgx}{R}$

(3) $Mg\frac{a}{R}$

(4) $Mg\sqrt{1-\left(\frac{R-a}{R}\right)^2}$

$F = mg\sqrt{\frac{R^2-(R-a)^2}{R^2}}$



Ans. (4)

QUESTION

$(I, \omega = 10)$ $\frac{1}{2} \times 3 \times \left(\frac{20}{3}\right)^2 = \frac{\cancel{3}}{\cancel{10} \times \cancel{2}} \times \frac{\cancel{400}\,20}{\cancel{9}\,3}$

Two uniform circular discs are rotating independently in the same direction around their common axis passing through their centres. The moment of inertia and angular velocity of the first disc are 0.1 kg-m^2 and 10 rads^{-1} respectively while those for the second one are 0.2 kg-m^2 and 5 rads^{-1} respectively. At some instant they get stuck together and start rotating as a single system about their common axis with some angular speed. The Kinetic energy of the combined system is: **[JEE Main 2020]**

$(2I, \omega = 5)$

$\cancel{I} \times 10 + 2\cancel{I} \times 5 = 3\cancel{I}\,\omega_f$

$\omega_f = \frac{20}{3}$

(1) $\frac{10}{3}$J

(2) $\frac{2}{3}$J

(3) $\frac{5}{3}$J

(4) $\frac{20}{3}$J

Ans. (4)

QUESTION

I $\quad$ $I/4$

A circular disc of mass M and radius R is rotating about its axis with angular speed ω_1. If another stationary disc having radius $\frac{R}{2}$ and same mass M is dropped co-axially on to the rotating disc. Gradually both discs attain constant angular speed ω_2. The energy lost in the process is p% of the initial energy. Value of p is ______.

$$I\omega_1 + 0 = \left(I + \frac{I}{4}\right)\omega_f$$

[JEE Main 2020]

Ans. (20)

QUESTION

A wheel is rotating freely with an angular speed ω on a shaft. The moment of inertia of the wheel is I and the moment of inertia of the shaft is negligible. Another wheel of moment of inertia 3I initially at rest is suddenly coupled to the same shaft. The resultant fractional loss in the kinetic energy of the system is: [JEE Main 2020]

(1) 0

(2) 1/4

(3) 3/4

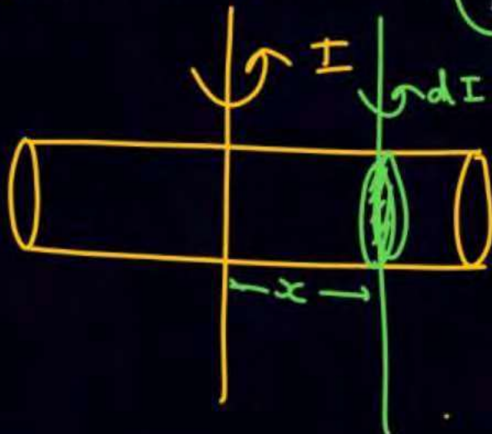
(4) 5/6

Ans. (3)

QUESTION

Moment of inertia of a cylinder of mass M, length L and radius R about an axis passing through its centre and perpendicular to the axis of the cylinder is $I = M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)$. If such a cylinder is to be made for a given mass of material, the ratio $\frac{L}{R}$ for it to have minimum possible I is: **[JEE Main 2020]**

?



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

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

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

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

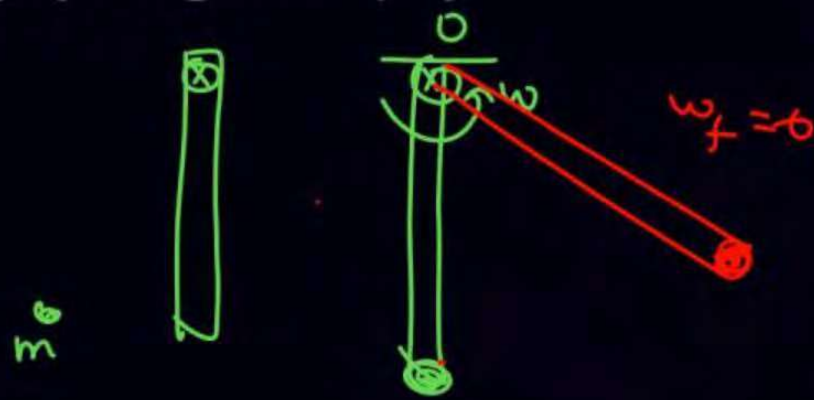
Ans. (3)

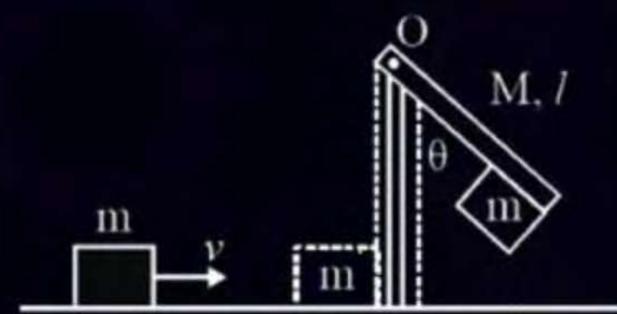
QUESTION

A block of mass m = 1 kg slides with velocity v = 6 m/s on a frictionless horizontal surface and collides with a uniform vertical rod and sticks to it as shown. The rod is pivoted about O and swings as a result of the collision making angle θ before momentarily coming to rest. If the rod has mass M = 2 kg, and length l = 1 m, the value of θ is approximately: (Take $g = 10\ m/s^2$)

[JEE Main 2020]

1. 69°
2. 63°
3. 55°
4. 49°



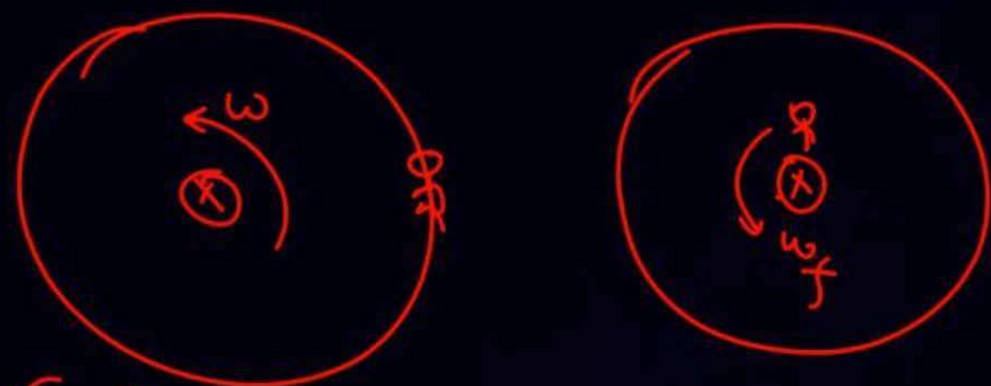


Ans. (2)

QUESTION

A person of 80 kg mass is standing on the rim of a circular platform of mass 200 kg rotating about its axis as 5 revolutions per minute (rpm). The person now starts moving towards the centre of the platform. What will be the rotational speed (in rpm) of the platform when the person reaches its centre ______.

[JEE Main 2020]



$$\left(\frac{mR^2}{2}+mR^2\right)\omega = 0+\frac{mR^2}{2}\omega_f$$

Ans. (9)

QUESTION

Consider two uniform discs of the same thickness and different radii $R_1 = R$ and $R_2 = \alpha R$ made of the same material. If the ratio of their moments of inertia I_1 and I_2, respectively, about their axes is $I_1 : I_2 = 1 : 16$ then the value of a is: **[JEE Main 2020]**

(1) $\sqrt{2}$

(2) 2

(3) 4

(4) $2\sqrt{2}$

$$I_1 = \frac{mR^2}{2} = \frac{\cancel{\rho}\,\cancel{\pi} R^2 t \cdot R^2}{2}$$

$$I_2 = \frac{\cancel{\rho} \times \cancel{\pi} (\alpha R)^2 t \times (\alpha R)^2}{2}$$

$$\frac{I_1}{I_2} = \frac{1}{\alpha^4} = \frac{1}{16}$$

Ans. (2)

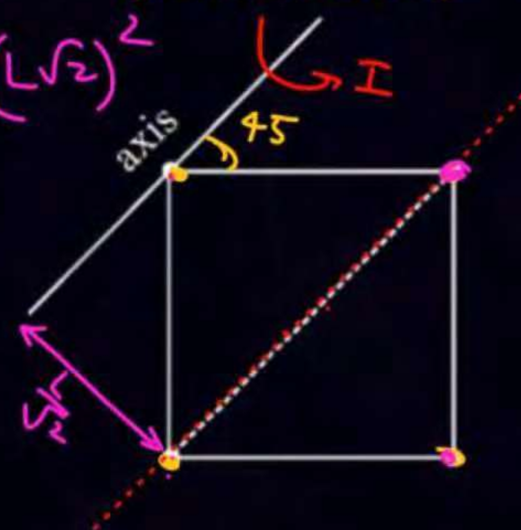
QUESTION

Four point masses, each of mass m, are fixed at the corners of a square of side ℓ. The square is rotating with angular frequency w, about an axis passing through one of the corners of the square and parallel to its diagonal, as shown in the figure. The angular momentum of the square about this axis is: **[JEE Main 2020]**

$= I\omega$

$I = 0 + m\left(\frac{L}{\sqrt{2}}\right)^2 + m\left(\frac{L}{\sqrt{2}}\right)^2 + m(L\sqrt{2})^2$

$I = 3mL^2$



(1) $2m\ell^2 w$

(2) $3m\ell^2 w$

(3) $m\ell^2 w$

(4) $4m\ell^2 w$

Ans. (2)

QUESTION

A cord is wound round the circumference of wheel of radius r. The axis of the wheel is horizontal and the moment of inertia about it is I. A weight mg is attached to the cord at the end. The weight falls from rest. After falling through a distance 'h', the square of angular velocity of wheel will be:

[JEE Main 2021]

(1) $\frac{2mgh}{1+2mr^2}$

(2) $\frac{2mgh}{1+mr^2}$

(3) 2gh

(4) $\frac{2gh}{1+mr^2}$

Ans. (2)

QUESTION

A mass M hangs on a massless rod of length ℓ which rotates at a constant angular frequency. The mass M moves with steady speed in a circular path of constant radius. Assume that the system is in steady circular motion with constant angular velocity ω. The angular momentum of M about point A is L_A which lies in the positive z direction and the angular momentum of M about B is L_B. The correct statement for this system is:

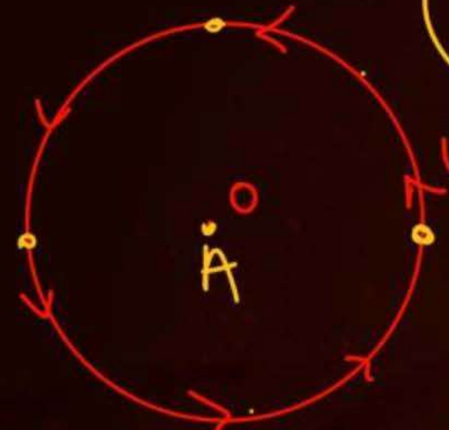
[JEE Mains 2021]

1. L_A and L_B are both constant in magnitude and direction
2. L_B is constant in direction with varying magnitude
3. L_B is constant, both in magnitude and direction
4. L_A is constant, both in magnitude and direction

Ans. (4)

(A)

L_A



$v \rightarrow$ const

$L_O \longrightarrow$ const dir^n, magnitude

$$\vec{L} = \vec{r} \times m\vec{v}$$

QUESTION

The following bodies,

(1) a ring

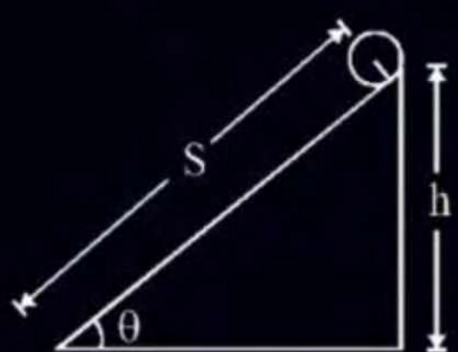
(2) a disc

(3) a solid cylinder

(4) a solid sphere, of same mass 'm' and radius 'R' are allowed to roll down without slipping simultaneously from the top of the inclined plane. The body which will reach first at the bottom of the inclined plane is ____.

[Mark the body as per their respective numbering given in the question]

[JEE Mains 2021]



Ans. (4)

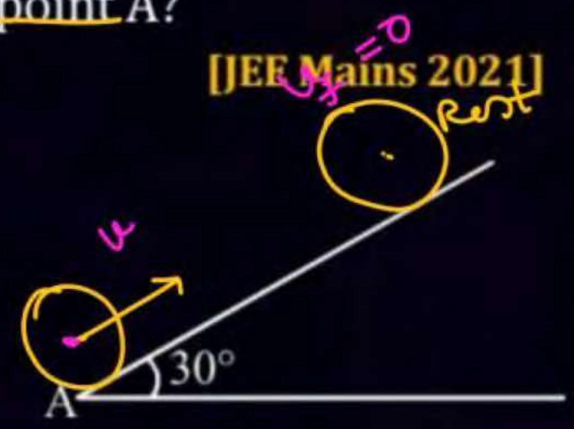
QUESTION

A sphere of mass 2kg and radius 0.5 m is rolling with an initial speed of 1 ms^{-1} goes up an inclined plane which makes an angle of 30° with the horizontal plane, without slipping. How low will the sphere take to return to the starting point A?

[JEE Mains 2021]

$v = u + at$

$0 = 1 - \frac{g\sin\theta}{1+\frac{I}{MR^2}} \cdot t$



(1) 0.60 s

(2) 0.52 s

(3) 0.57 s

(4) 0.80 s

Ans. (3)

QUESTION

A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points. The angular speed of the ring will become: [JEE Mains 2021]

(1) $\omega \frac{M}{M+m}$

(2) $\omega \frac{M+2m}{M}$

(3) $\omega \frac{M}{M+2m}$

(4) $\omega \frac{M-2m}{M+2m}$

Ans. (3)

QUESTION

Two discs of moment of inertia $I_1 = 4\ \text{kg m}^2$ and $I_2 = 2\ \text{kg m}^2$ about their central axes & normal to their planes, rotating with angular speeds 10 rad/s & 4 rad/s respectively are brought into contact face to face with their axe of rotation coincident. The loss in kinetic energy of the system in the process is _____ J [30 Jan. 2024 - Shift 2]

Ans : (24)

QUESTION

A body of mass 'm' is projected with a speed 'u' making an angle of 45° with the ground. The angular momentum of the body about the point of projection, at the highest point is expressed as $\frac{\sqrt{2}mu^3}{Xg}$. The value of 'X' is _____. **[31 Jan. 2024 - Shift 2]**

Ans : (8)

QUESTION

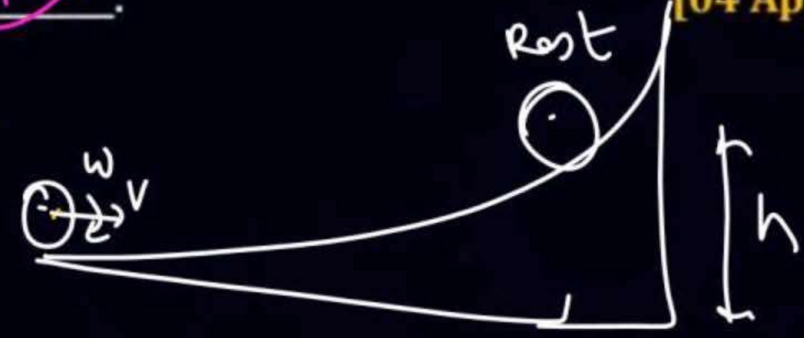
$\frac{2}{5}mR^2$ $\qquad$ mR^2

A solid sphere and a hollow cylinder roll up without slipping on same inclined plane with same initial speed v. The sphere and the cylinder reaches upto maximum heights h_1 and h_2, respectively, above the initial level. The ratio $h_1 : h_2$ is $\frac{n}{10}$. The value of n is __7__. **[04 Apr. 2024 - Shift 1]**

$$\frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{R^2} = mgh$$

$$h = \frac{1}{2}\frac{\cancel{m}v^2}{\cancel{m}g}\left(1+\frac{I}{mR^2}\right)$$

$$\frac{h_1}{h_2} = \frac{1+2/5}{1+1} = \frac{7}{5\times 2} = \frac{7}{10}$$



Ans : (7)

QUESTION

A hollow sphere is rolling on a plane surface about its axis of symmetry. The ratio of rotational kinetic energy to its total kinetic energy is $x/5$. The value of x is ______.

[05 Apr. 2024 - Shift 2]

Ans : (2)

QUESTION

If the radius of earth is reduced to three-fourth of its present value without change in its mass then value of duration of the day of earth will be 13 hours 30 minutes.

[06 Apr. 2024 - Shift 1]

$$I_1 \omega_1 = I_2 \omega_2$$

$$\frac{2}{5} \cancel{mR^2} \omega_i = \frac{2}{5} m \left(\frac{3R}{4}\right)^2 \omega_f$$

$$\omega_f = \frac{16}{9} \omega_i$$

$$T_f = \frac{9}{16} T_i = \frac{9}{\cancel{16}_{2}} \times \cancel{24}^{3} = \frac{27}{2} \text{ hour}$$

Ans : (13)

QUESTION

A thin circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with angular velocity ω. If another disc of same dimensions but of mass M/2 is placed gently on the first disc co-axially, then the new angular velocity of the system is: [08 Apr. 2024 - Shift 2]

$I/2$

$$I\omega + 0 = \left(I + \frac{I}{2}\right)\omega_f$$

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

(2) $\frac{5}{4}\omega$

(3) $\frac{2}{3}\omega$

(4) $\frac{4}{5}\omega$

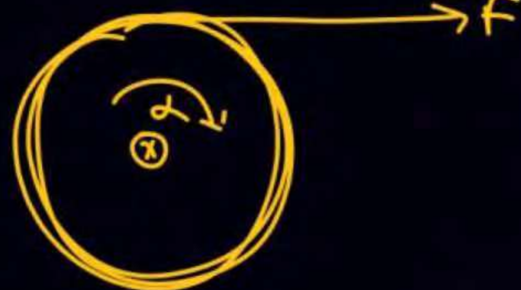
Ans : (3)

QUESTION

A string is wrapped around the rim of a wheel of moment of inertia $0.40\ kgm^2$ and radius 10 cm. The wheel is free to rotate about its axis. Initially the wheel is at rest. The string is now pulled by a force of 40 N. The angular velocity of the wheel after 10 s is x rad/s, where x is ______.

[09 Apr. 2024 - Shift 1]

$$\omega = 0 + \alpha t$$

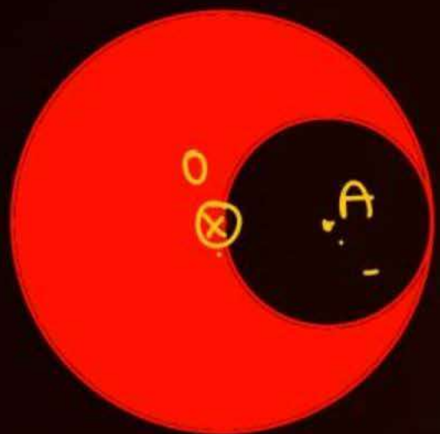


$$FR = I\alpha$$

$$40 \times \frac{1}{10} = \frac{4}{10} \times \alpha$$

$$\alpha = 10$$

Ans : (100)



$$I_0 = \frac{MR^2}{2} - \left[\frac{(M/4)(R/2)^2}{2} + \left(\frac{M}{4}\right)(R/2)^2 \right]$$

15. Consider a body of mass 1.0 kg at rest at the origin at time $t = 0$. A force $\vec{F} = (\alpha t\hat{i} + \beta\hat{j})$ is applied on the body, where $\alpha = 1.0\ Ns^{-1}$ and $\beta = 1.0\ N$. The torque acting on the body about the origin at time $t = 1.0$ s is $\vec{\tau}$. Which of the following statements is (are) true? **[JEE Advanced-2018]**

(A) $|\vec{\tau}| = \frac{1}{3}$ Nm

(B) The torque $\vec{\tau}$ is in the direction of the unit vector $+\hat{k}$

(C) The velocity of the body at $t = 1$ s is $\vec{v} = \frac{1}{2}(\hat{i} + 2\hat{j})\ ms^{-1}$

(D) The magnitude of displacement of the body at $t = 1$ s is $\frac{1}{6}$ m

$\vec{F} = t\hat{i} + \hat{j}$

$\vec{a} = \checkmark$

$v = \checkmark$

$\vec{r} = \checkmark$

1.0 kg द्रव्यमान (mass) की एक वस्तु समय $t = 0$ पर मूलबिंदु (origin) पर विरामावस्था में है। इस वस्तु पर एक बल $\vec{F} = (\alpha t\hat{i} + \beta\hat{j})$ लगाया जाता है, जहाँ $\alpha = 1.0\ Ns^{-1}$ और $\beta = 1.0$ N हैं। समय $t = 1.0$ s पर मूलबिंदु के सापेक्ष वस्तु पर लगने वाला बल आघूर्ण (torque) $\vec{\tau}$ है। निम्नलिखित कथनों में से कौन सा (से) सही है (हैं) ?

(A) $|\vec{\tau}| = \frac{1}{3}$ Nm

(B) बल आघूर्ण $\vec{\tau}$ मात्रक सदिश (unit vector) $+\hat{k}$ की दिशा में है

(C) समय $t = 1$ s पर वस्तु का वेग $\vec{v} = \frac{1}{2}(\hat{i} + 2\hat{j})\ ms^{-1}$ है

(D) समय $t = 1$ s पर वस्तु के विस्थापन का परिमाण $\frac{1}{6}$ m है

Ans. (A,C)

14. The potential energy of a particle of mass m at a distance r from a fixed point O is given by $V(r) = kr^2/2$, where k is a positive constant of appropriate dimensions. This particle is moving in a circular orbit of radius R about the point O. If v is the speed of the particle and L is the magnitude of its angular momentum about O, which of the following statements is (are) true ?

द्रव्यमान (mass) m के एक कण की स्थितिज ऊर्जा (potential energy) $V(r) = kr^2/2$ है, जहाँ r एक नियत बिंदु (fixed point) O से कण की दूरी है और k उचित विमाओं (dimensions) वाला एक धनात्मक नियतांक (positive constant) है। यह कण बिंदु O के सापेक्ष R त्रिज्या वाली एक वृत्तीय कक्षा (circular orbit) में घूम रहा है। यदि v कण की चाल है और L बिंदु O के सापेक्ष इसके कोणीय संवेग (angular momentum) का परिमाण (magnitude) है, तो निम्नलिखित कथनों में से कौन सा (से) सही है (हैं)? **[JEE Advanced-2018]**

(A) $v = \sqrt{\frac{k}{2m}}R$ (B) $v = \sqrt{\frac{k}{m}}R$ (C) $L = \sqrt{mk}R^2$ (D) $L = \sqrt{\frac{mk}{2}}R^2$

Ans. (B,C)

8. The position vector $\vec{r}$ of a particle of mass m is given by the following equation $\vec{r}(t) = \alpha t^3 \hat{i} + \beta t^2 \hat{j}$, where $\alpha = \frac{10}{3} ms^{-3}$, $\beta = 5\ ms^{-2}$ and m = 0.1 kg. At t = 1 s, which of the following statement(s) is(are) true about the particle? **[JEE Advanced-2016]**

(A) The velocity $\vec{v}$ is given by $\vec{v} = (10\hat{i} + 10\hat{j}) ms^{-1}$

(B) The angular momentum $\vec{L}$ with respect to the origin is given by $\vec{L} = -\left(\frac{5}{3}\right)\hat{k}$ Nms

(C) The force $\vec{F}$ is given by $\vec{F} = (\hat{i} + 2\hat{j})N$

(D) The torque $\vec{\tau}$ with respect to the origin is given by $\vec{\tau} = -\left(\frac{20}{3}\right)\hat{k}$ Nm

$\boxed{r = \alpha t^3 \hat{i} + \beta t^2}$

$v = $ ✓

$a = $ ✓

$F = $ ✓

m द्रव्यमान के एक कण का स्थिति–सदिश $\vec{r}$ नीचे समीकरण में दिया गया है :

$\vec{r}(t) = \alpha t^3 \hat{i} + \beta t^2 \hat{j}$

जिसमें $\alpha = \frac{10}{3} ms^{-3}$, $\beta = 5\ ms^{-2}$ एवं m = 0.1 kg है। समय t = 1 s पर, निम्नलिखित में से कौनसा/कोनसे कथन सत्य है/हैं ?

(A) वेग का मान $\vec{v} = (10\hat{i} + 10\hat{j}) ms^{-1}$ है।

(B) मूल बिन्दु के गिर्द कोणीय संवेग का मान $\vec{L} = -\left(\frac{5}{3}\right)\hat{k}$ Nms

(C) बल का मान $\vec{F} = (\hat{i} + 2\hat{j})N$ है।

(D) मूल बिन्दु के गिर्द घूर्णन का मान $\vec{\tau} = -\left(\frac{20}{3}\right)\hat{k}$ Nm है।

Ans. (A, B, D)

13. Two solid cylinders P and Q of same mass and same radius start rolling down a fixed inclined plane from the same height at the same time. Cylinder P has most of its mass concentrated near its surface, while Q has most of its mass concentrated near the axis. Which statement(s) is(are) correct?

(A) Both cylinders P and Q reach the ground at the same time. **[IIT-JEE 2012]**

(B) Cylinder P has larger acceleration than cylinder Q.

(C) Both cylinders reach the ground with same translational kinetic energy.

(D) Cylinder Q reaches the ground with larger angular speed

$a = \frac{g\sin\theta}{1 + I/mR^2}$

समान द्रव्यमान और समान त्रिज्या के दो बेलन P तथा Q एक जड़ आनत तबल पर समान ऊंचाई से एक ही समय लुढ़कना शुरू करते हैं। बेलन P का अधिकतर द्रव्यमान उसकी सतह की ओर केंद्रित है और बेलन Q का अधिकतर द्रव्यमान उसके अक्ष की ओर केंन्द्रित है। तब कौन प्रकथन सही है/हैं ?

$P \Rightarrow I\uparrow,\ a\downarrow,$ slow, $v_f\downarrow,\ \omega_f\downarrow$

(A) दोनों बेलन एक साथ जमीन पर पहुंचेंगे ?

(B) बेलन P का रेखीय त्वरण बेलन Q से ज्यादा है।

(C) दोनों बेलन जमीन पर समान स्थानान्तरण गतिज-ऊर्जा के साथ पहुंचते हैं।

(D) बेलन Q जमीन पर ज्यादा कोणीय गति से पहुंचता है।

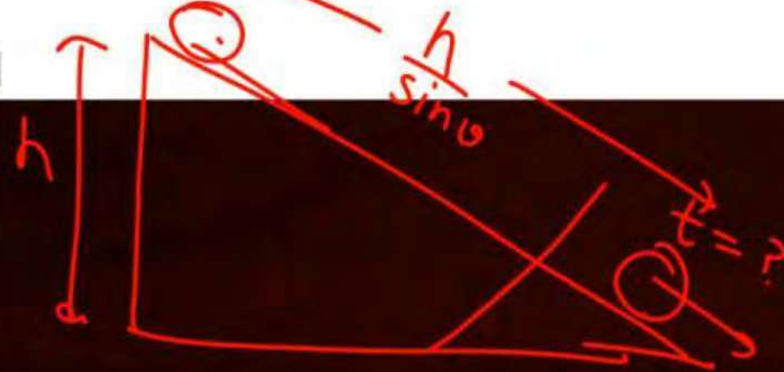
Ans. (D)

31. A ring and a disc are initially at rest, side by side, at the top of an inclined plane which makes an angle 60° with the horizontal. They start to roll without slipping at the same instant of time along the shortest path. If the time difference between their reaching the ground is $(2-\sqrt{3})/\sqrt{10}$s, then the height of the top of the inclined plane, in meters, is _____. Take g = 10 ms^{-2}.

एक वृत्ताकार वलय (ring) और एक वृत्ताकार चकती (disc), एक आनत तल (inclined plane) के शीर्ष पर अगल-बगल (side by side) विरामावस्था में हैं। आनत तल, क्षैतिज तल (horizontal plane) से 60° का कोण बनाता है। दोनों वस्तुएं एक ही पल, न्यूनतम दूरी वाले पथ पर बिना फिसले लोटना (rolling without slipping) आरम्भ करती हैं। यदि दोनों वस्तुओं के क्षैतिज तल पर पहुँचने का समयांतर $(2-\sqrt{3})/\sqrt{10}$s हो, तो आनत तल के शीर्ष की ऊँचाई _____. मीटर है। g = 10 ms^{-2} लें।

[JEE Advanced-2018]

Ans. 0.75 [0.74, 0.76]



$$\frac{h}{\sin\theta} = 0 + \frac{1}{2} a_1 t^2$$

$$t_1 = \sqrt{\frac{2h}{a_1 \sin\theta}}$$

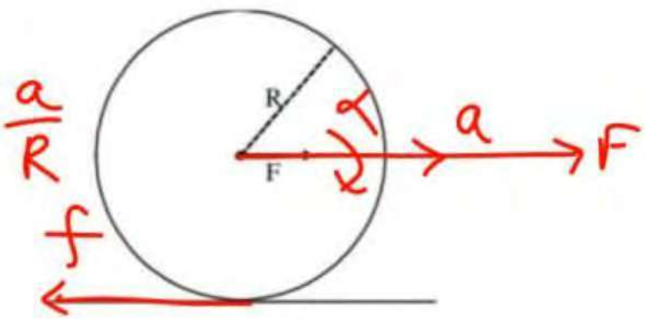
$$t_2 = \sqrt{\frac{2h}{a_2 \sin\theta}}$$

21. A horizontal force F is applied at the center of mass of a cylindrical object of mass m and radius R, perpendicular to its axis as shown in the figure. The coefficient of friction between the object and the ground is μ. The center of mass of the object has an acceleration a. The acceleration due to gravity is g. Given that the object rolls without slipping, which of the following statement(s) is(are) correct? **[JEE Advanced-2021]**

चित्रानुसार, द्रव्यमान m और त्रिज्या R की एक बेलनाकार वस्तु के द्रव्यमान केन्द्र पर उसके अक्ष के लम्बवत् एक क्षैतिज बल F लगाया जाता है। भूमि और वस्तु के बीच का घर्षण गुणांक (coefficient of friction) μ है। वस्तु के द्रव्यमान केन्द्र का त्वरण a है और g गुरूत्वीय त्वरण है। यदि वस्तु बिना फिसले लुढ़कती है, तो निम्न में से कौन सा(से) कथन सत्य है?

$F - f = ma$

$fR = I\alpha = I\frac{a}{R}$



(A) For the same F, the value of a does not depend on whether the cylinder is solid or hollow

(B) For a solid cylinder, the maximum possible value of a is $2\mu g$

(C) The magnitude of the frictional force on the object due to the ground is always μmg

(D) For a thin-walled hollow cylinder, $a = \frac{F}{2m}$

(A) एक ही बल F के लिये, a का मान बेलन के ठोस या खोखले होने पर निर्भर नहीं करता है।

(B) एक ठोस बेलन के लिए, त्वरण a का अधिकतम मान $2\mu g$ है।

(C) भूमि के कारण वस्तु पर घर्षण बल का परिमाण हमेशा μmg होगा।

(D) एक पतली दीवार वाले खोखले बेलन के लिए, $a = \frac{F}{2m}$ है।

Ans. (BD)

SHM

$\vec{F} = -K\vec{x}$

- $T = 2\pi\sqrt{\dfrac{m}{K}}$

- $T = 2\pi\sqrt{\dfrac{m}{K_{eq}}}$

$T = 2\pi\sqrt{\dfrac{\mu}{K}}$ $\quad \mu = \dfrac{m_1 m_2}{m_1 + m_2}$

simple $\Rightarrow$ $T = 2\pi\sqrt{\dfrac{l}{g_{eff}}}$

Compound $T = 2\pi\sqrt{\dfrac{I}{mgd_c}}$

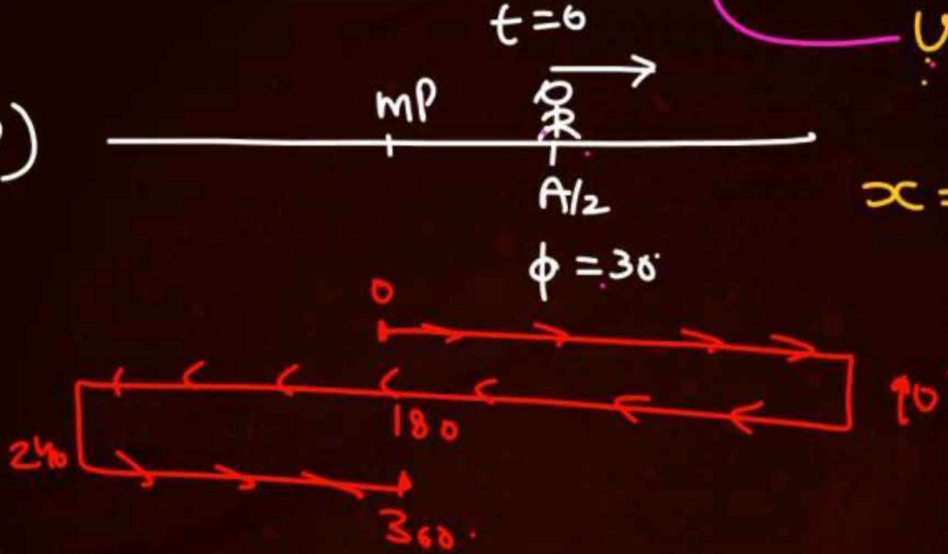
$K = 0$	K_{max}	$(PE)_{max}$
EP	MP	$K = 0$
		EP
$v = 0$	v_{max}	$v = 0$
a_{max}	$a = 0$	a_{max}
$(PE)_{max}$	U_{min}	

$\vec{F} = -K\vec{x}$

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

$v = \frac{dx}{dt}$

$a = \frac{d^2x}{dt^2}$



$V_{min} = 0$

$V_{max} = A\omega$

$v = \omega\sqrt{A^2 - \cancel{x}^2}$

A

$x = \frac{A\sqrt{3}}{2}$, $v = \omega\sqrt{A^2 - \frac{3A^2}{4}}$

$$\vec{F} = -K\vec{x}$$

* $v = \omega\sqrt{A^2 - x^2}$

$$\vec{a} = -\frac{K}{m}\vec{x} = \qquad \omega = \sqrt{\frac{K}{m}}$$

* $a = -x\omega^2$

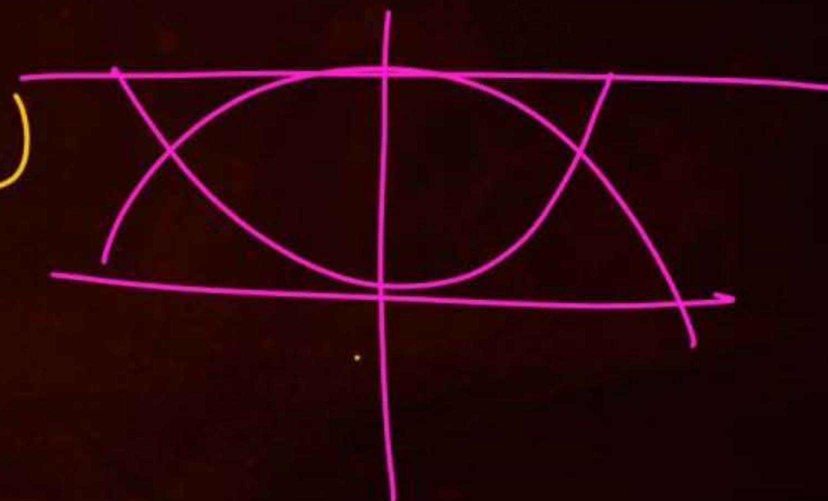
$$K = m\omega^2$$

* $v_{max} = A\omega$, $a_{max} = A\omega^2$

$$KE = \frac{1}{2}m\omega^2(A^2 - x^2) = \frac{1}{2}K(A^2 - x^2)$$

$$PE = \frac{1}{2}Kx^2, \quad U_0 = 0$$

$$\boxed{TE = \frac{1}{2}KA^2 = \text{cons}}$$



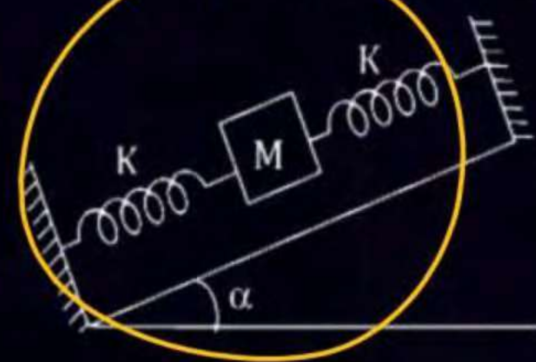
QUESTION

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:

[JEE Mains 2021]

$T = 2\pi\sqrt{\frac{M}{2K}}$

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



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

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

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

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

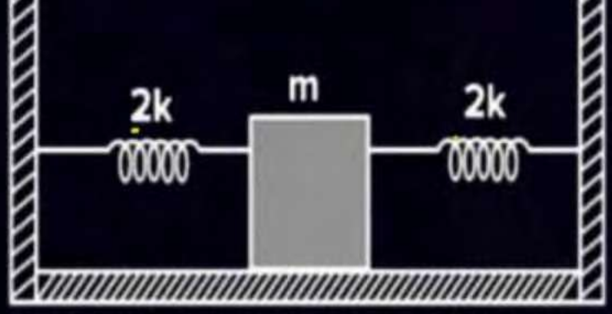
Ans. (2)

QUESTION

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:

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

[JEE Mains 2021]



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

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

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

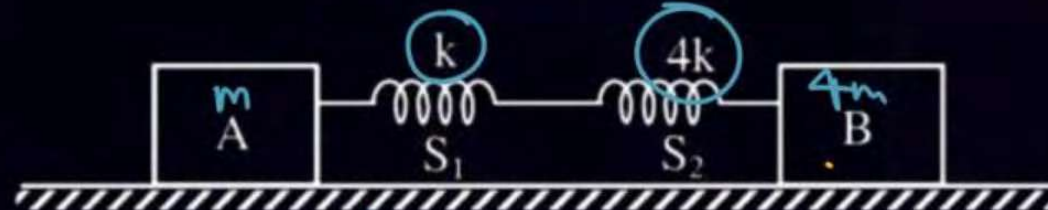
(4) $\pi\sqrt{\frac{m}{k}}$

Ans. (4)

QUESTION

In the reported figure, two bodies A and B of masses 200 g (m) and 800 g (4m) 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 ____10____ rad/s when k = 20 N/m. **[JEE Mains 2021]**

$$\mu = \frac{4m}{5} = \frac{4}{5} \times .2 = \frac{.8}{5}$$



$$K = \frac{4K}{5} = \frac{4 \times 20}{5} = \frac{80}{5}$$

$$\frac{1}{K_{eq}} = \frac{1}{K} + \frac{1}{4K}$$

$$T = 2\pi\sqrt{\frac{\mu}{K_{eq}}} = 2\pi\sqrt{\frac{.8 \times 5}{5 \times 80}} = \frac{2\pi}{10} = T = \frac{2\pi}{\omega}$$

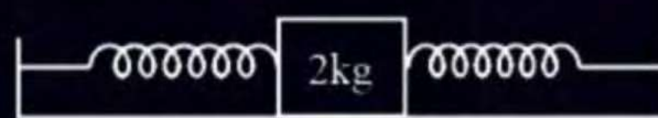
Ans. (10)

QUESTION

A block of mass 2 kg is attached with two identical springs of spring constant 20 N/m 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 January 2023 - Shift 1]

$$T = 2\pi\sqrt{\frac{m}{k_{eq}}}$$



Ans. (5)

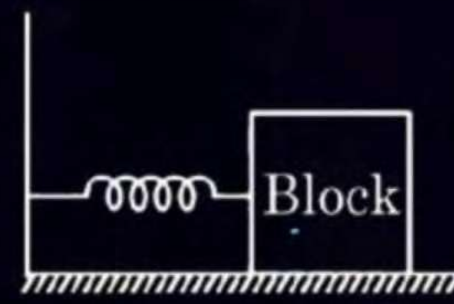
QUESTION

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 January 2023 - Shift 2]

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

$$\frac{\omega_2}{\omega_1} = \sqrt{\frac{m_1}{m_2}}$$



(1) $\sqrt{2}$

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

(3) 2

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

Ans. (2)

QUESTION

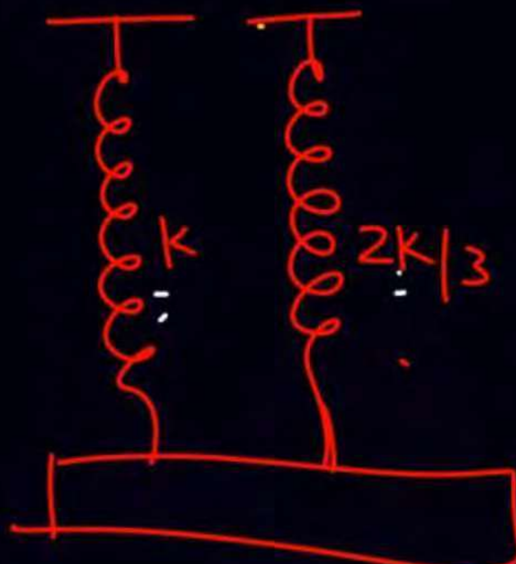
12

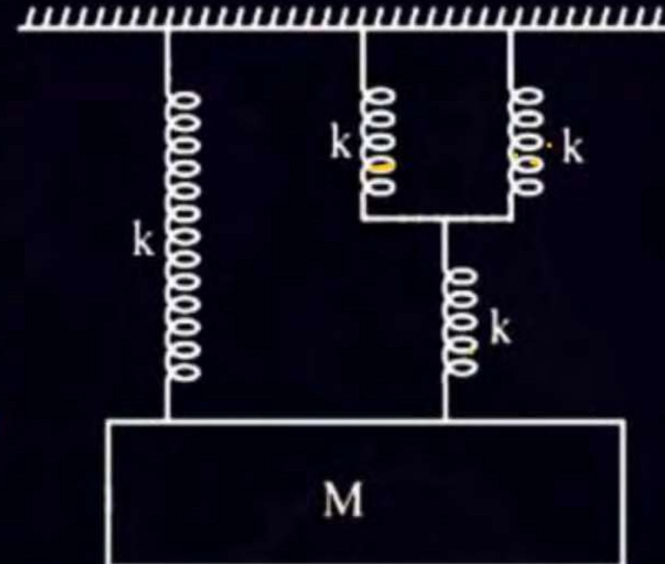
The time period of simple harmonic motion of mass M in the given figure is $\pi\sqrt{\frac{\alpha M}{5K}}$, where the value of α is ______.

[31 Jan. 2024 - Shift 2]

$$T = 2\pi\sqrt{\frac{m}{k + 2k/3}}$$

$$T = \pi\sqrt{\frac{4m \times 3}{5k}}$$



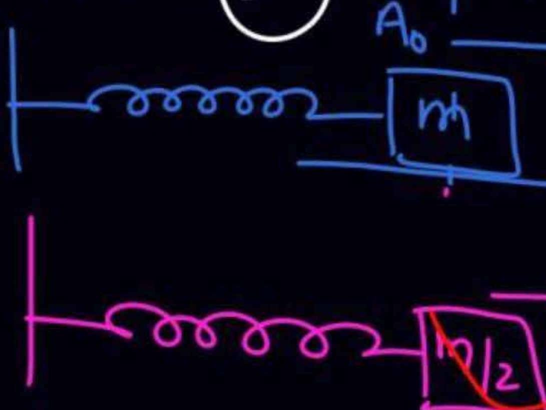


Ans. (12)

QUESTION

Root पर आया। wt

A block of mass m attached to massless spring which 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: **[JEE Mains 2020]**



$v_0 = A_0\omega_0 = A_0\sqrt{\frac{K}{m}}$

$2v_0 = A_{नया}\,\omega_{नया}$

$2A_0\sqrt{\frac{K}{m}} = A_{नया} \times \sqrt{\frac{K}{m/2}}$

$A_{नया} = \frac{2A_0}{\sqrt{2}} = A_0\sqrt{2}$

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

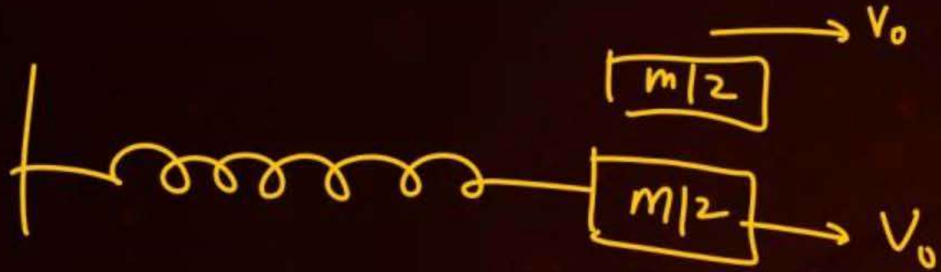
(2) $\sqrt{2}$

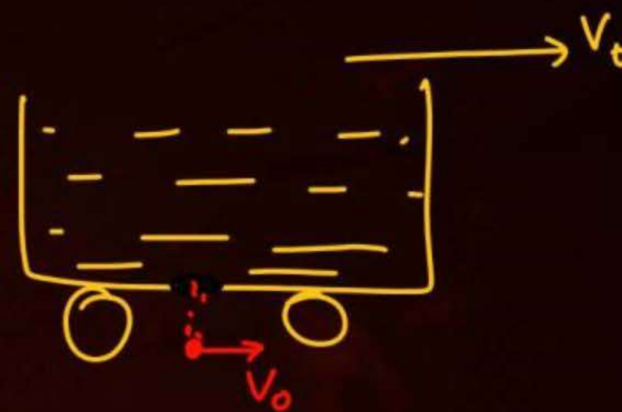
(3) 1

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

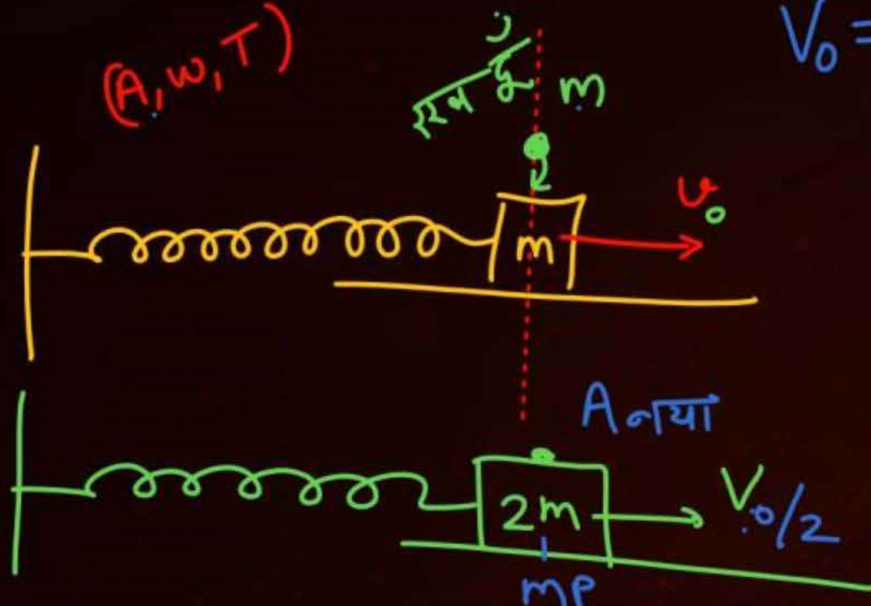
Ans. (~~4~~)


m
V0


V0
m|2
m|2
V0


V0
V0

Q



$$mV_0 + 0 = 2mV_f$$

$$V_f = V_0/2$$

$$V_0 = A_0\omega = A_0\sqrt{K/m}$$

$$T = 2\pi\sqrt{\frac{m}{K}}$$

m → double

T → $\sqrt{2}$ times

$\omega \longrightarrow \frac{\omega}{\sqrt{2}}$ times

$$\frac{V_0}{2} = A_{\text{नया}}\,\omega_{\text{नया}}$$

$$\frac{V_0}{2} = A_{\text{नया}} \times \sqrt{\frac{K}{2m}}$$

$$\frac{A_0}{2}\sqrt{K/m} = A_{\text{नया}}\sqrt{K/2m}$$

QUESTION

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:

[JEE Mains 2020]

1. $\frac{2}{\sqrt{3}}$
2. $\frac{\sqrt{2}}{3}$
3. $\frac{2}{3}$
4. $\frac{3}{\sqrt{2}}$

$$T_1 = 2\pi\sqrt{\frac{I}{mgd_c}} = \cancel{2\pi}\sqrt{\frac{2\cancel{mR^2}}{\cancel{mg}R}}$$

$$T_2 = 2\pi\sqrt{\frac{\frac{mR^2}{2}+mR^2}{mgR}} = \sqrt{\frac{3\cancel{mR^2}}{2\cancel{mgR}}} \times \cancel{2\pi}$$

$$\frac{T_1}{T_2} = \sqrt{\frac{2\times 2}{3}} = \frac{2}{\sqrt{3}}$$

Ans. ~~(2)~~ (1)

QUESTION

$\rightarrow T = 2\ sec$

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.

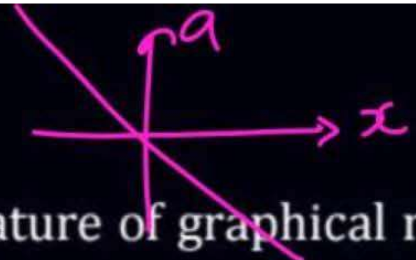
In the light of the above statements, choose the correct answer from the options given below:

[JEE Mains 2021]

1. Both Statement I and Statement II are false.
2. Statement I is false but Statement II is true
3. Statement I is true but Statement II is false
4. Both Statement I and Statement II are true.

Ans. (2)

QUESTION



$a = -\omega^2 x$

When a particle executes SHM, the nature of graphical representation of velocity as of displacement is:

[JEE Mains 2021]

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

(1) circular

$\frac{v^2}{\omega^2} = A^2 - x^2$

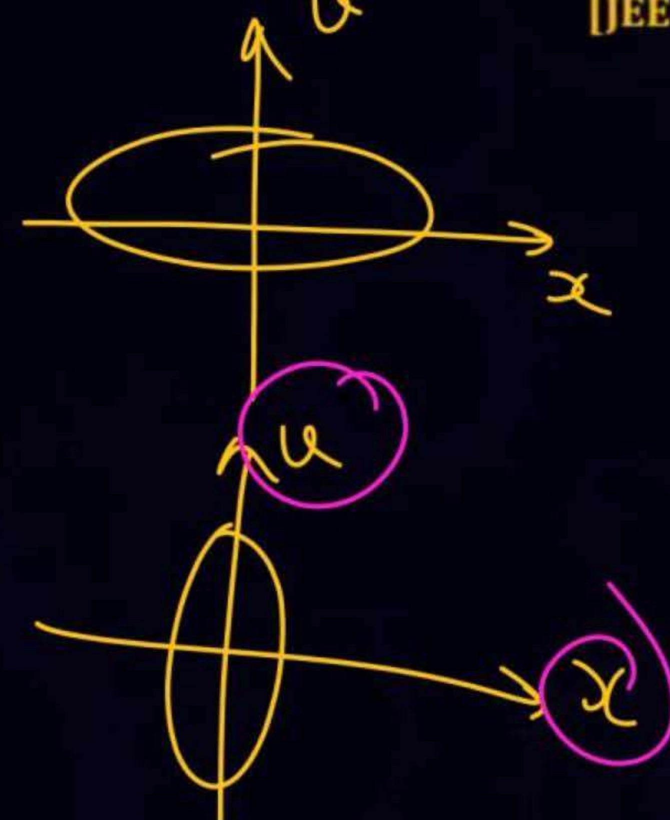
(2) elliptical

$\frac{v^2}{\omega^2} + x^2 = A^2$

(3) parabolic

$\frac{v^2}{A^2\omega^2} + \frac{x^2}{A^2} = 1$

(4) straight line



Ans. (2)

QUESTION

Time period of a simple pendulum is T inside a lift when the lift is stationary. If the lift moves upwards with an acceleration $g/2$, the time period of pendulum will be:

[JEE Mains 2021]

(1) $\sqrt{3}T$

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

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

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

$$T_1 = 2\pi\sqrt{\frac{l}{g}}$$

$$T_2 = 2\pi\sqrt{\frac{l}{g+g/2}}$$

Ans. (4)

QUESTION

A particle executes S.H.M., the graph of velocity as a function of displacement is:

[JEE Mains 2021]

(1) A circle

(2) A parabola

(3) An ellipse

(4) A helix

Ans. (3)

QUESTION

If the time period of a two meter long simple pendulum is 2s, the acceleration due to gravity at the place where pendulum is executing S.H.M. is: **[JEE Mains 2021]**

Ans. (3)

QUESTION

A particle executes S.H.M. with amplitude 'a' and time period V. The displacement of the particle when its speed is half of maximum speed is $\frac{\sqrt{x}a}{2}$. The value of x is ______.

[JEE Mains 2021]

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

$$\frac{A\cancel{\omega}}{2} = \cancel{\omega}\sqrt{A^2 - x^2}$$

Ans. (3)

QUESTION

For what value of displacement the kinetic energy and potential energy of a simple harmonic oscillation become equal?

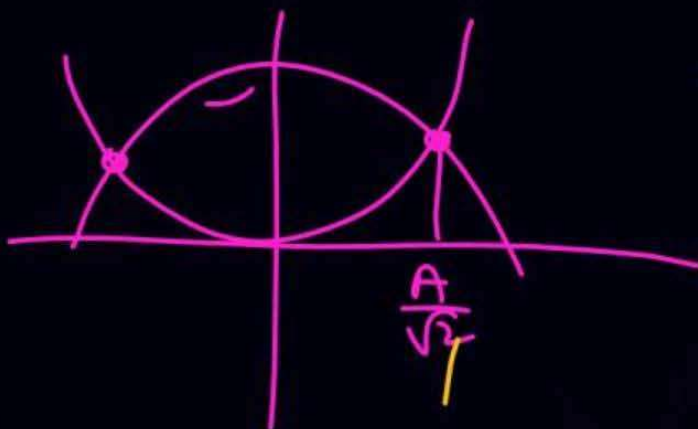
[JEE Mains 2021]

(1) $x = 0$

(2) $x = \pm A$

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

(4) $x = \frac{A}{2}$



$$\frac{1}{2}k(A^2 - x^2) = \frac{1}{2}kx^2$$

$$x = \pm A/\sqrt{2}$$

Ans. (3)

QUESTION

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:

[JEE Mains 2021]

(1) $y = a$

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

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

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

$E = \frac{1}{2}KA^2$

$KE = \frac{3E}{4} = \frac{1}{2}K(A^2 - x^2)$

$\frac{3}{4} \cdot \cancel{\frac{1}{2}}\cancel{K}A^2 = \cancel{\frac{1}{2}}\cancel{K}(A^2 - x^2)$

Ans. (4)

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: **[JEE Mains 2021]**

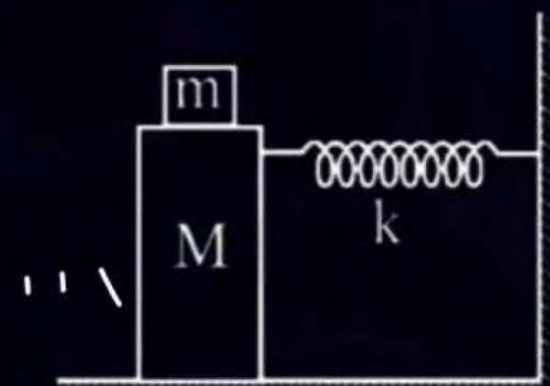
(1) $A\sqrt{\frac{M-m}{M}}$

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

(2) $A\sqrt{\frac{M}{M+m}}$

(3) $A\sqrt{\frac{M+m}{M}}$

(4) $A\sqrt{\frac{M}{M-m}}$



Ans. (2)

QUESTION

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

The function of time representing a simple harmonic motion with a period of $\frac{\pi}{\omega}$ is:

[JEE Mains 2021]

1. $\boxed{\sin(\omega t) + \cos(\omega t)} = \sqrt{2}\sin(\omega t + 45^\circ)$

2. $\cos(\omega t) + \cos(2\omega t) + \cos(3\omega t)$

3. $\sin 2(\omega t) = \sin(2\omega t)$ $\quad T = \frac{2\pi}{2\omega} = \pi/\omega$

4. $3\cos\left(\frac{\pi}{4} - 2\omega t\right)$

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

S.H.M. $\quad A = \sqrt{A_1^2 + A_2^2}$

3, 4

Ans. (4)