YAKEEN NEET 2.0

2026

Circular Motion

PHYSICS | Lecture - 04

By - Saleem Ahmed Sir

Today's Goal

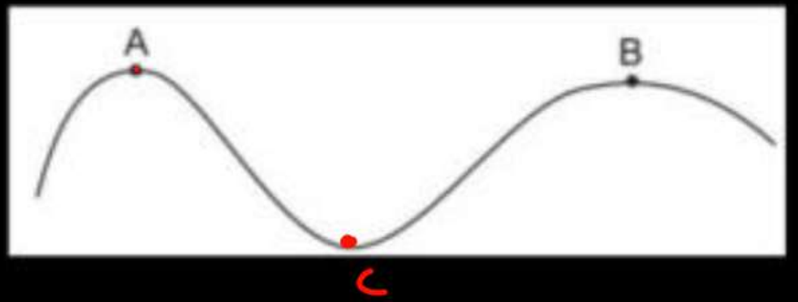
Circular motion

Next class

H/w

3. A car moves at a constant speed on a road as shown in figure (7-Q2). The normal force by the road on the car is N_A and N_B when it is at the points A and B respectively.

(a) $N_A = N_B$ (b) $N_A > N_B$ (c) $N_A < N_B$ (d) insufficient information to decide the relation of N_A and N_B.



Ans : (c)

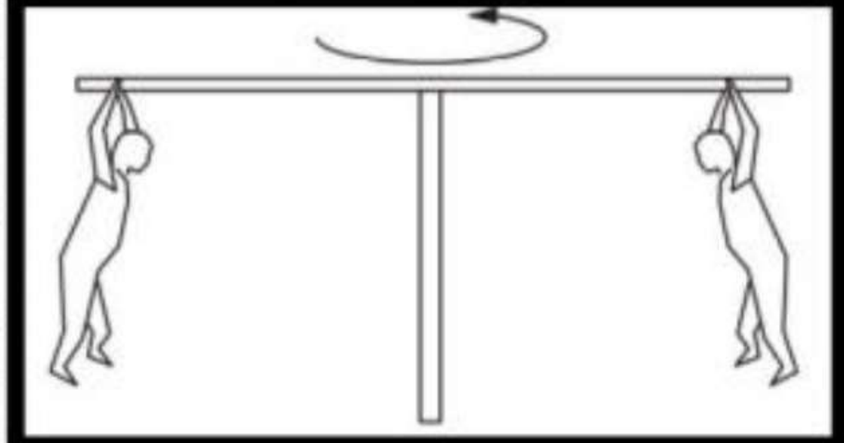
OBJECTIVE I

1. When a particle moves in a circle with a uniform speed
   (a) its velocity and acceleration are both constant
   (b) its velocity is constant but the acceleration changes
   (c) its acceleration is constant but the velocity changes
   (d) its velocity and acceleration both change.

Ans : (d)

HCV Hlw

23. In a children's park a heavy rod is pivoted at the centre and is made to rotate about the pivot so that the rod always remains horizontal. Two kids hold the rod near the ends and thus rotate with the rod (figure 7-E2). Let the mass of each kid be 15 kg, the distance between the points of the rod where the two kids hold it be 3·0 m and suppose that the rod rotates at the rate of 20 revolutions per minute. Find the force of friction exerted by the rod on one of the kids.



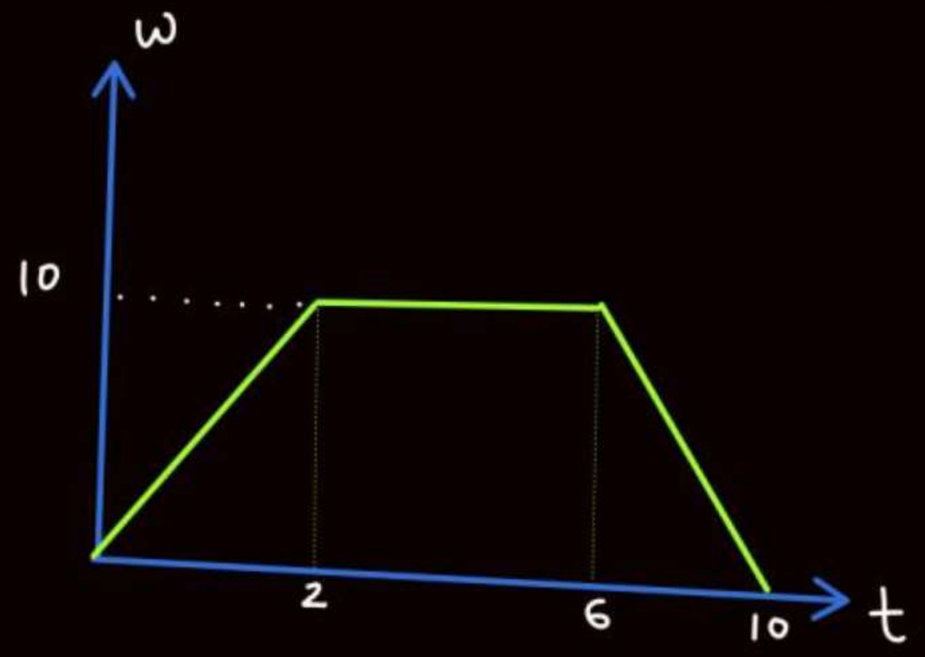
Ans : $(10\ \pi^2\ N)$

18. A turn of radius 20 m is banked for the vehicles going at a speed of 36 km/h. If the coefficient of static friction between the road and the tyre is 0·4, what are the possible speeds of a vehicle so that it neither slips down nor skids up ?

Ans : Between 14.7 km/h and 54 km/hr

Revision

particle start moving in a circular path such that its ω vs relation is given as



find

① α at $t = 1$, $t = 4$, $t = 9$

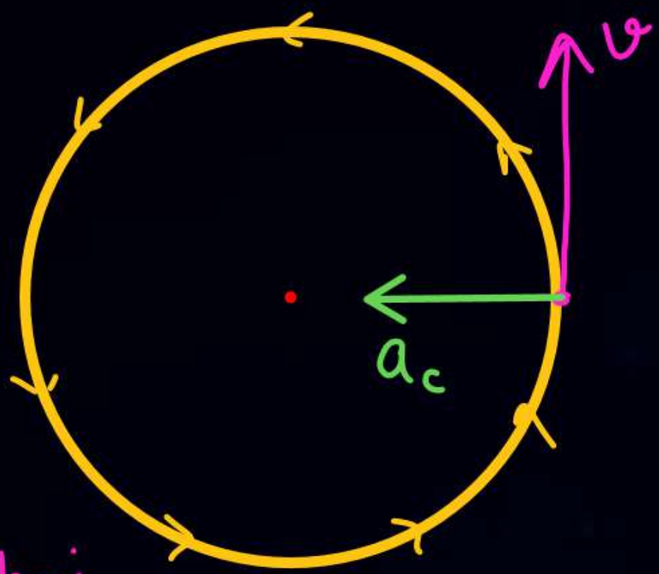
② Total angle rotated by particle.

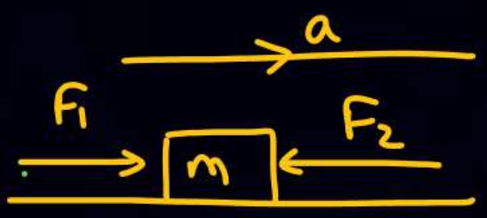
Circular motion

Centripital acc. $a_c = \frac{v^2}{R}$

$F_{net} = ma_c$ = Centripital force

→ Net force towards center.





$\vec{F}_{net} = ma = F_1 - F_2$

Lagne walla force Nahi hai

it is the resultant of all the forces acting towards the center of circle jinhone Milkar a_c Diya.

SKC

Agar particle circular motion kar raha hai...

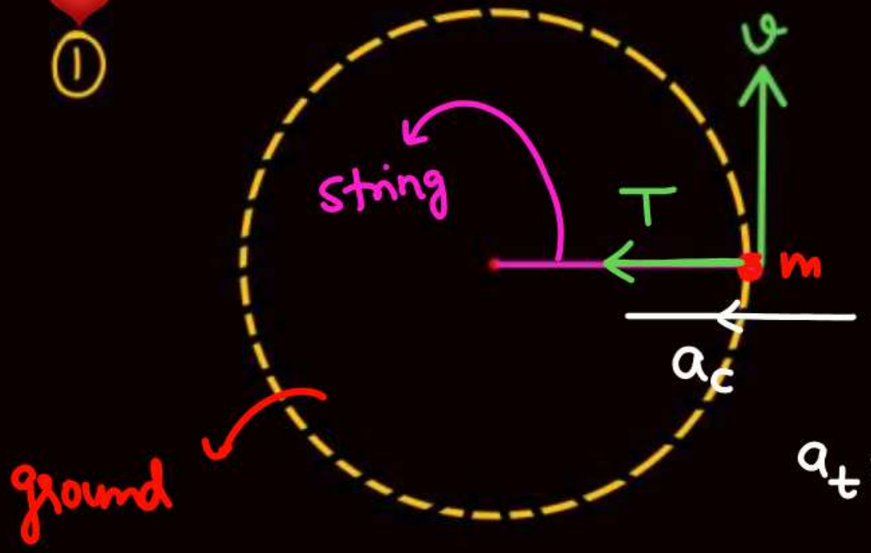
to center ki taraf $a_c = \frac{v^2}{R}$ hoga hi hoga

$(v \neq 0)$

$$a_c = R\omega^2$$

Particle is moving in a circular path with const speed v on a horizontal floor.

①



$a_t = 0$

$\left(\begin{matrix}\text{H}_2\text{ floor} \\ \mu = 0\end{matrix}\right)$

$T = ma_c$

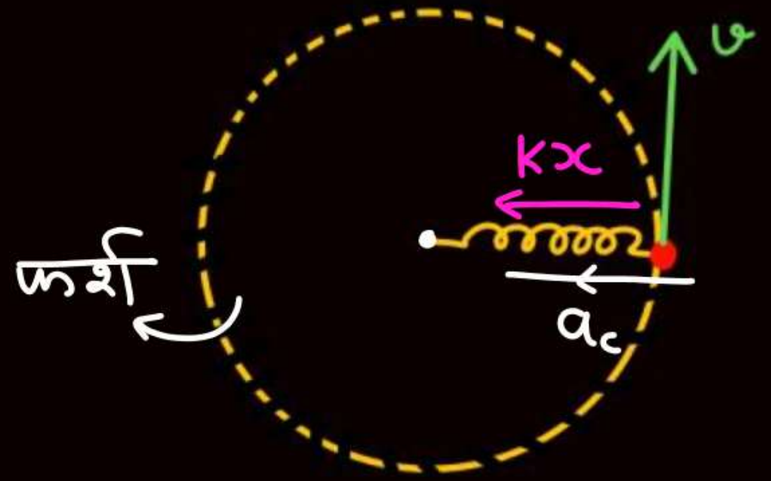
$T = \frac{mv^2}{R}$

$mg \longrightarrow$ Andar

$N \longrightarrow$ Bahar

②

If natural length of spring is l_0 Particle is moving on a circular path with const speed v. Find elongation in spring.

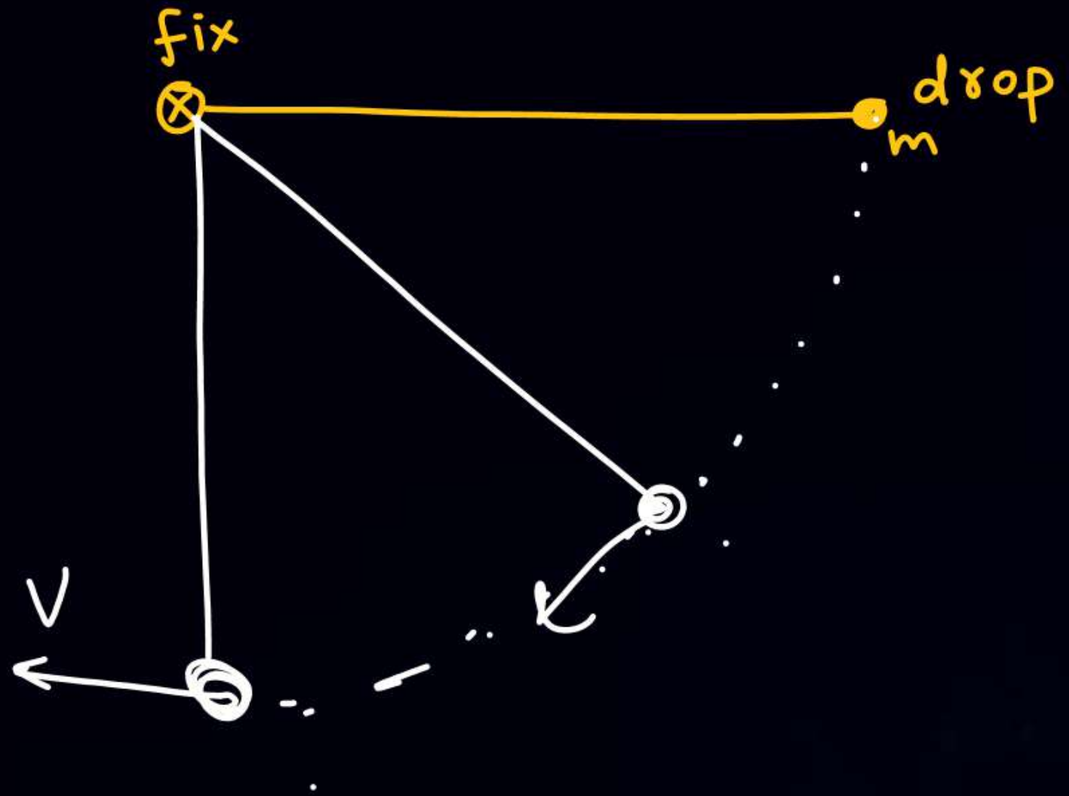


$(N.L = l_0)$

$a_t = 0$

$\left(\begin{matrix}\text{H}_2\text{ floor} \\ \mu = 0\end{matrix}\right)$

$kx = ma_c = \frac{mv^2}{r} = \frac{mv^2}{(l_0 + x)}$

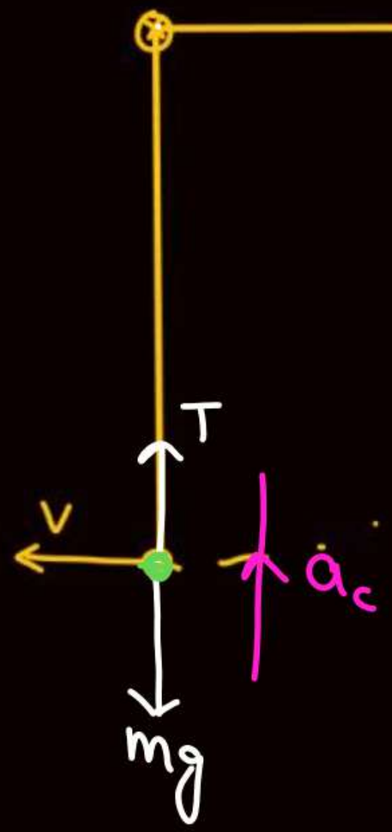

fix
drop
m
V

SKC (Circular motion)

- Center pata karo
- FBD
- Sare forces ko center ki taraf and uske perpendicular tod lo
- Center ki taraf wale force $\Rightarrow$ $F_{net} = ma_c = \frac{mv^2}{R} = mR\omega^2$

Non U.C.M

③

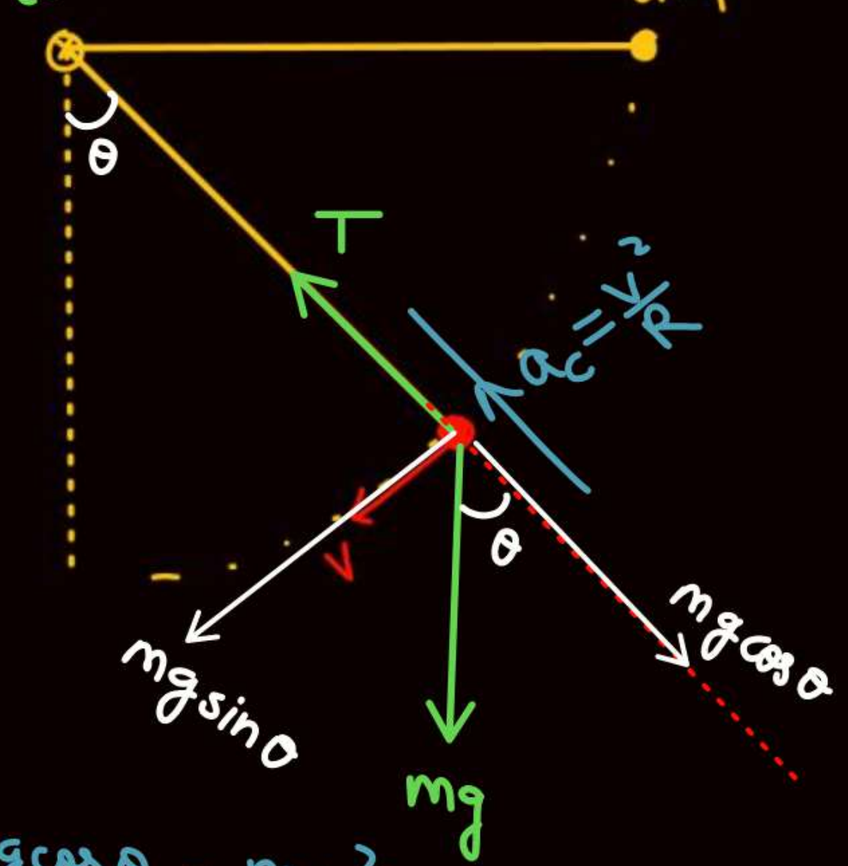


$T - mg = ma_c$

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

$a_t = 0$

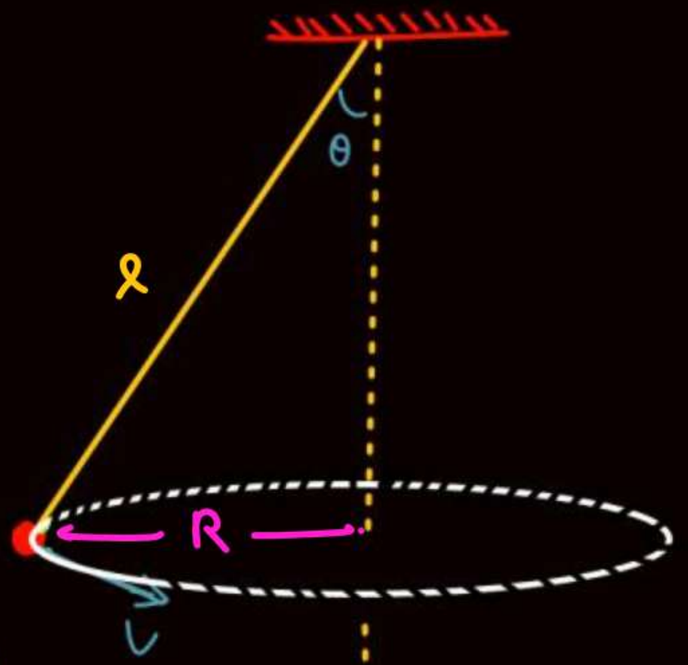
④



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

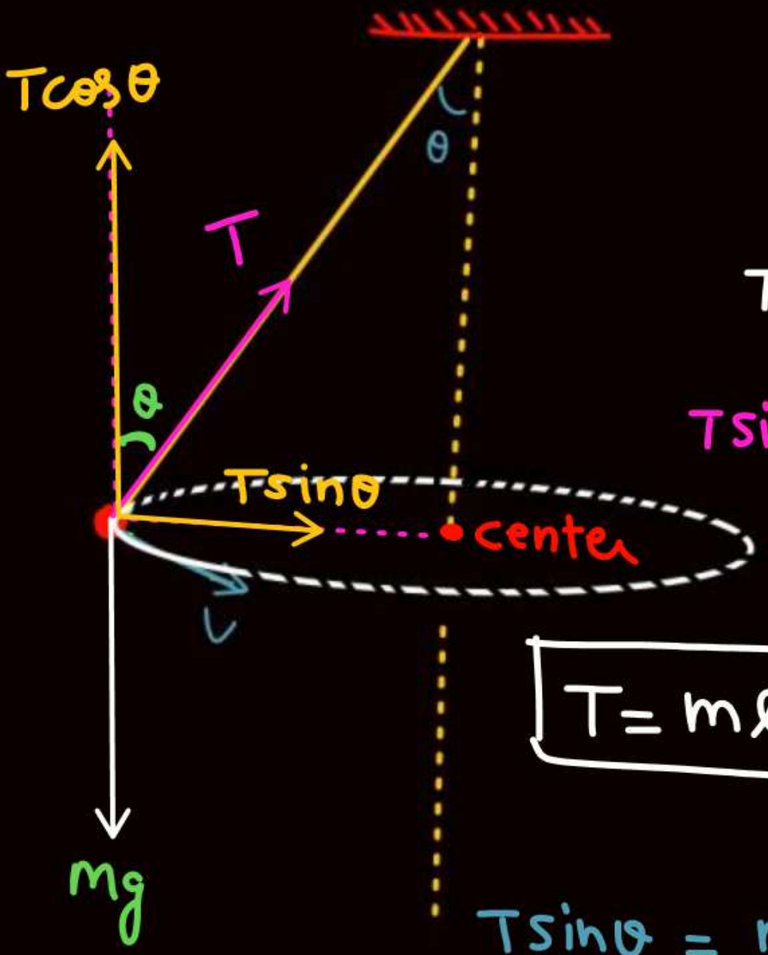
$mg\sin\theta = ma_t$

Conical Pendulum.



(speed const)

$\ell \sin\theta = R$



$T\sin\theta = \frac{mv^2}{R}$

$T\sin\theta = m.R.\omega^2$

$T\sin\theta = m\ell\sin\theta\,\omega^2$

$\boxed{T = m\ell\omega^2}$

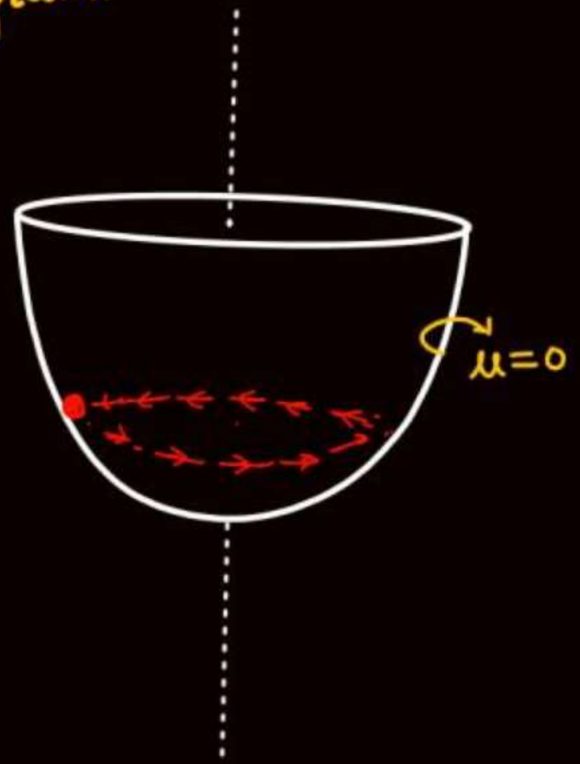
$T\sin\theta = \frac{mv^2}{R}$

$T\cos\theta = mg$

$\tan\theta = v^2/Rg$

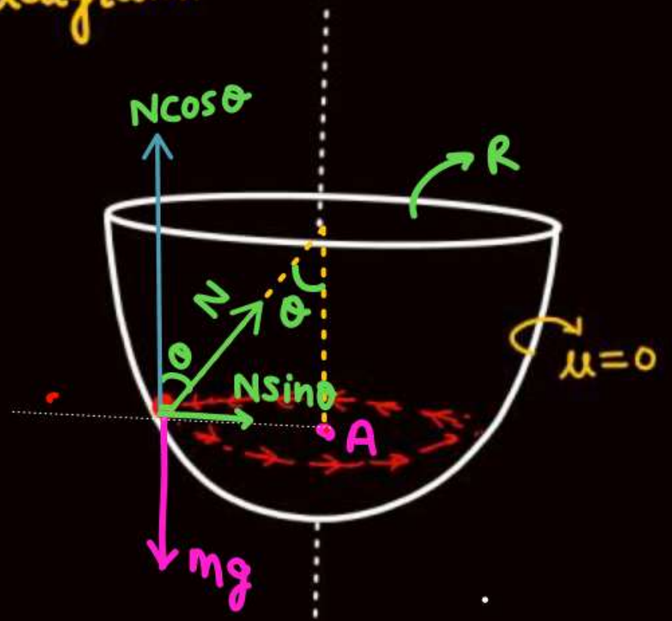
$a_t = 0$

A particle is moving with const speed in a circular path as shown in daigram.



$a_t = 0$

Q ❤️ A particle is moving with const speed in a circular path as shown in daigram.



$N\cos\theta = mg$

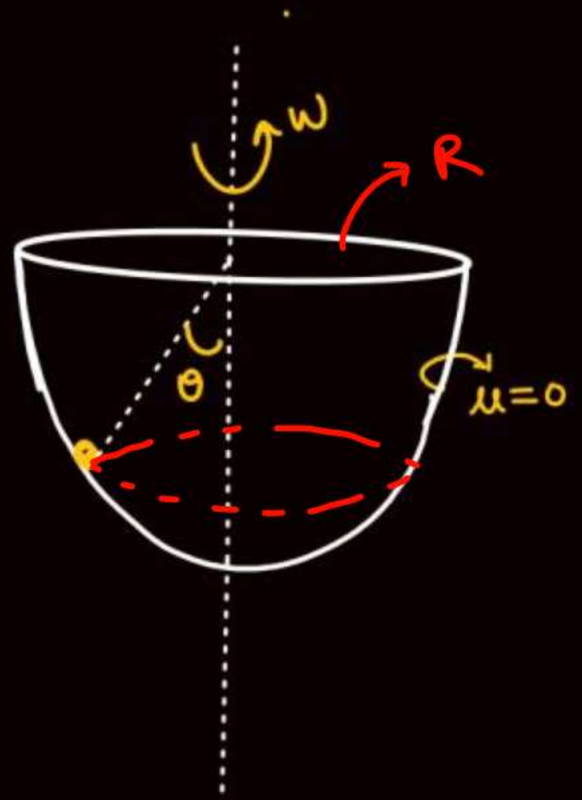
$N\sin\theta = \frac{mv^2}{r} = mr\omega^2$

R ⟶ Radius of gola

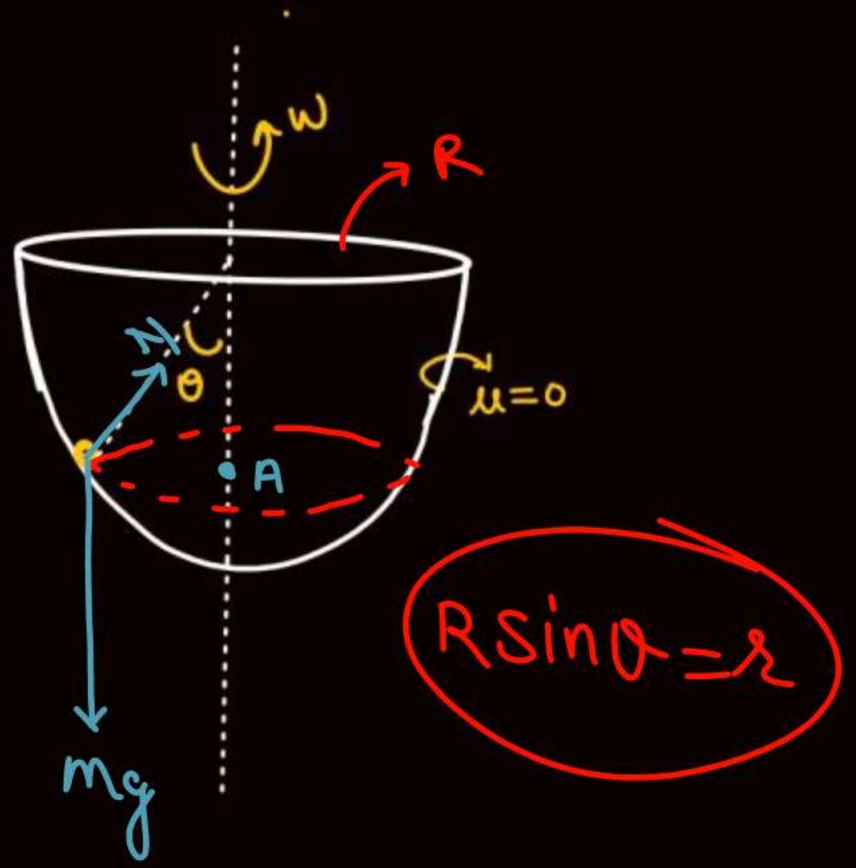
r ⟶ Radius of circle

$R\sin\theta = r$

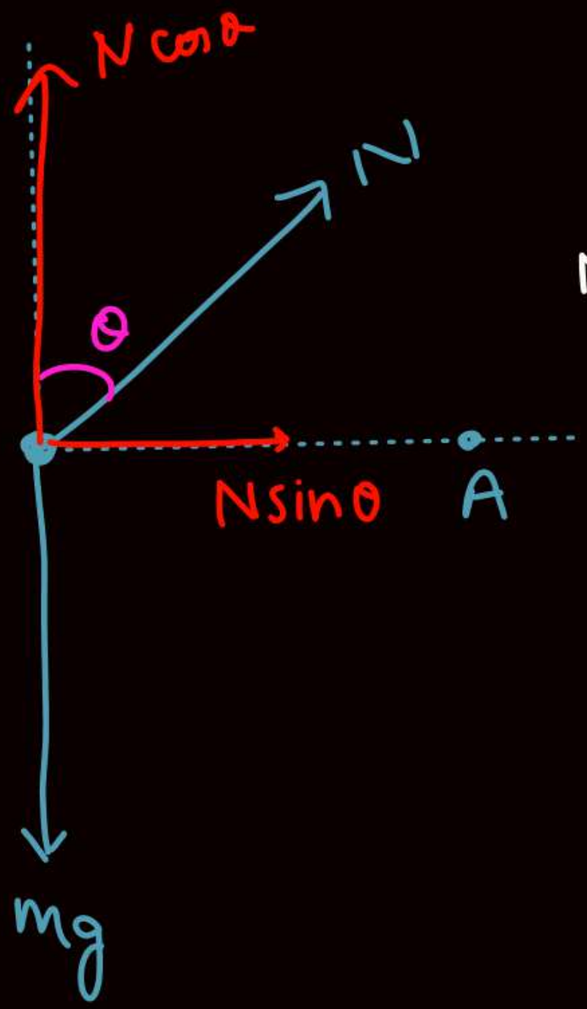
A katora is rotating with const w s.t particle is at rest wrt katora. write the circular motion equation.



A Katora is rotating with const w s.t particle is at rest wrt Katora. write the circular motion equation.



$R\sin\theta = r$



$N\sin\theta = mr\omega^2$

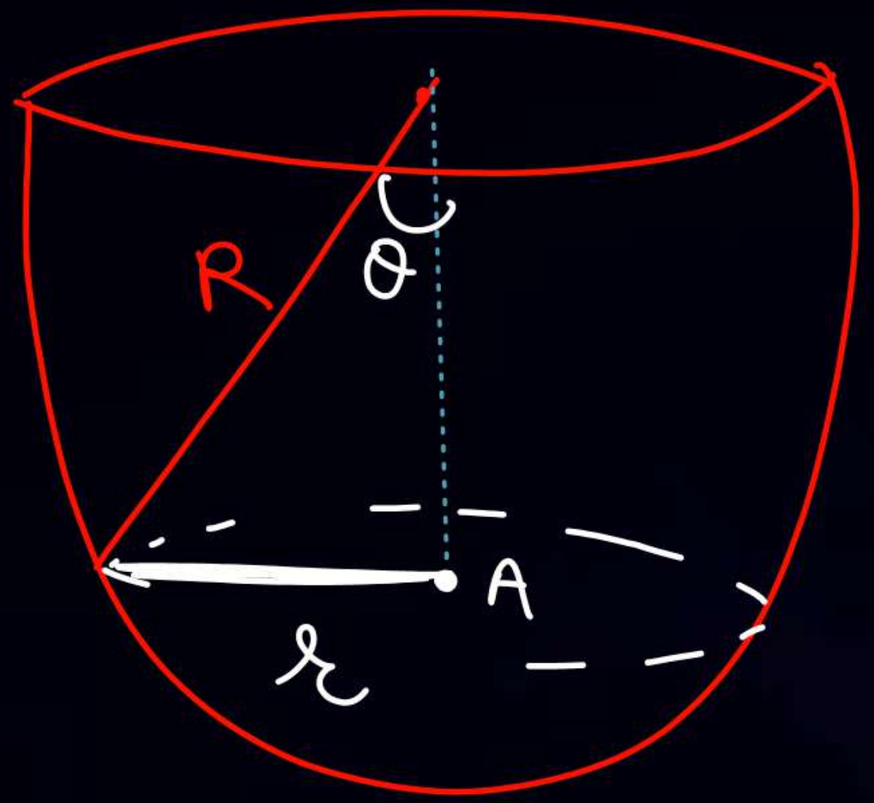
$N\sin\theta = mR\sin\theta\,\omega^2$

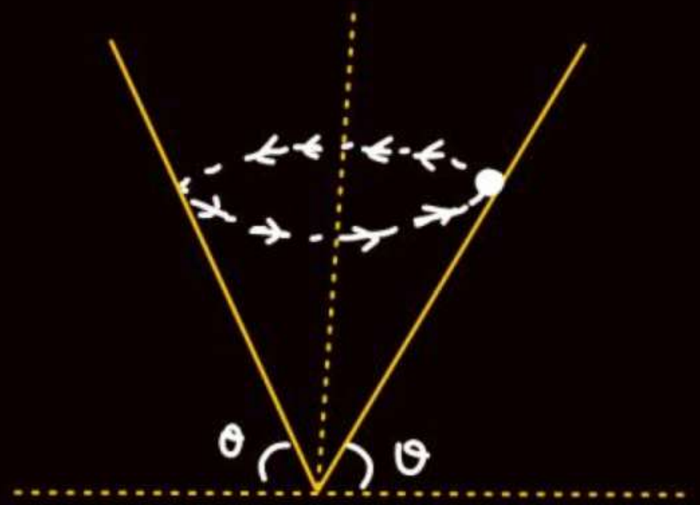
$N = mR\omega^2$

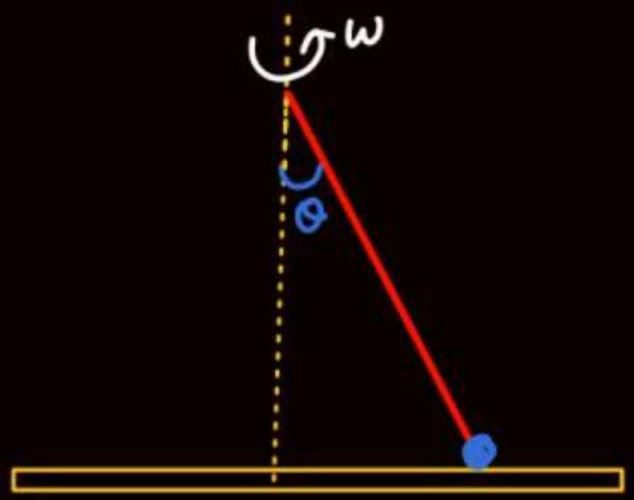
$N\cos\theta = mg$

$$\sin\theta = \frac{r}{R}$$

$$r = R\sin\theta$$

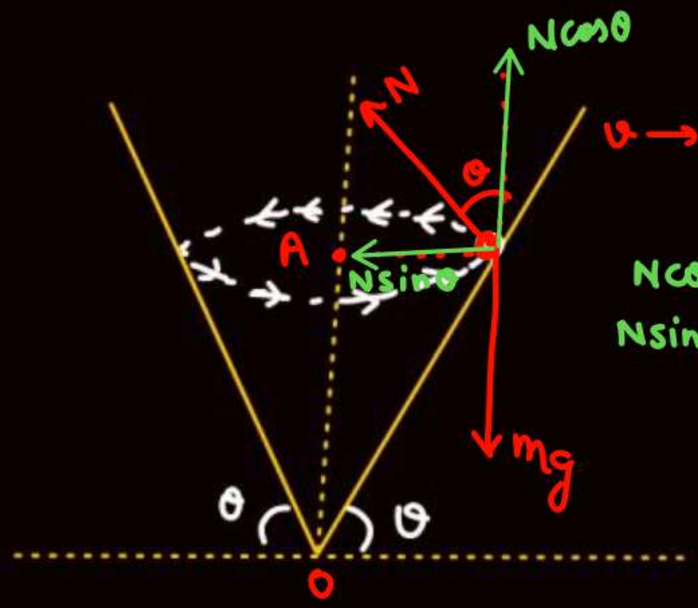






plateform is rotating with const ω and mass is at rest wrt plateform. find ω for which contact loose.

Q

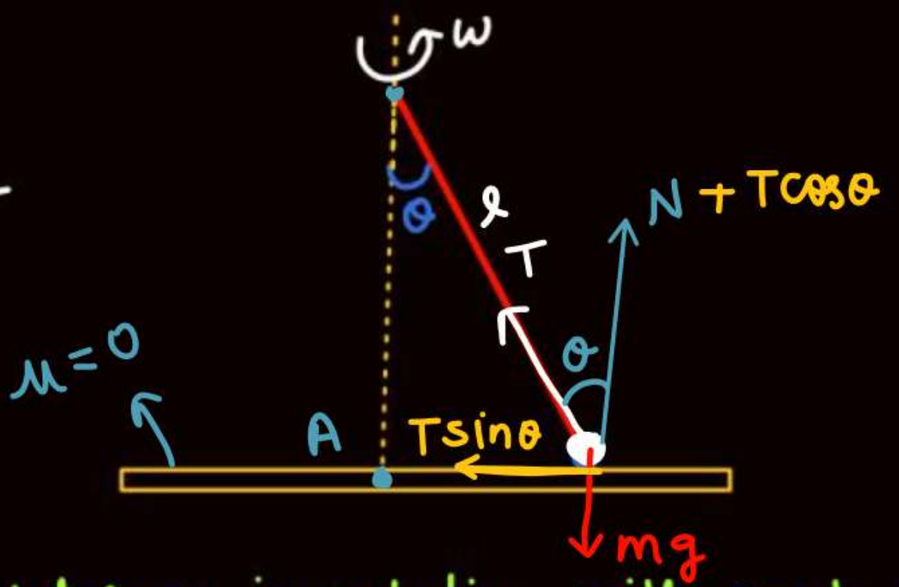


$v \to$ const.

$N\cos\theta = mg$

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

Q



platform is rotating with const ω and mass is at rest wrt platform. find ω for which contact loose.

Sol^n

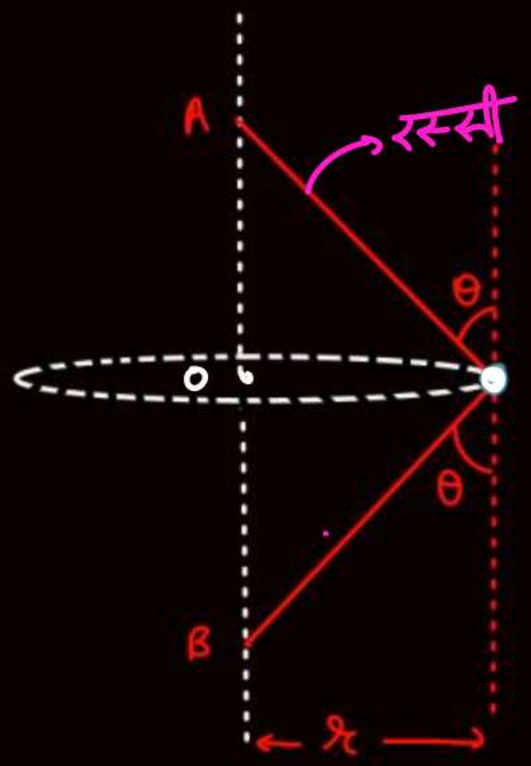
$N + T\cos\theta = mg$

$T\sin\theta = m r \omega^2$

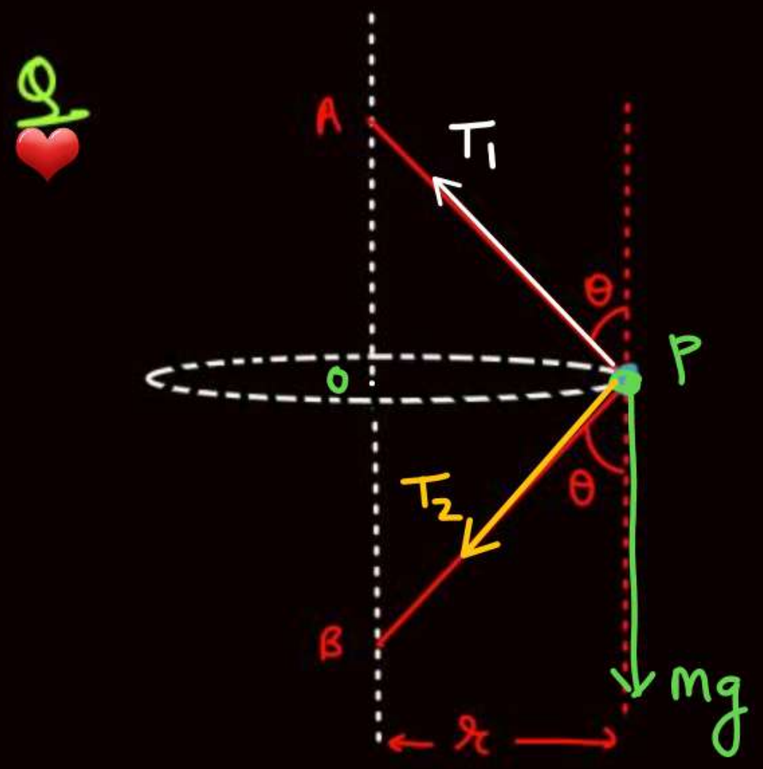
$\tan\theta = \frac{r\omega^2}{g} \Rightarrow \omega = \sqrt{\frac{g\tan\theta}{r}}$

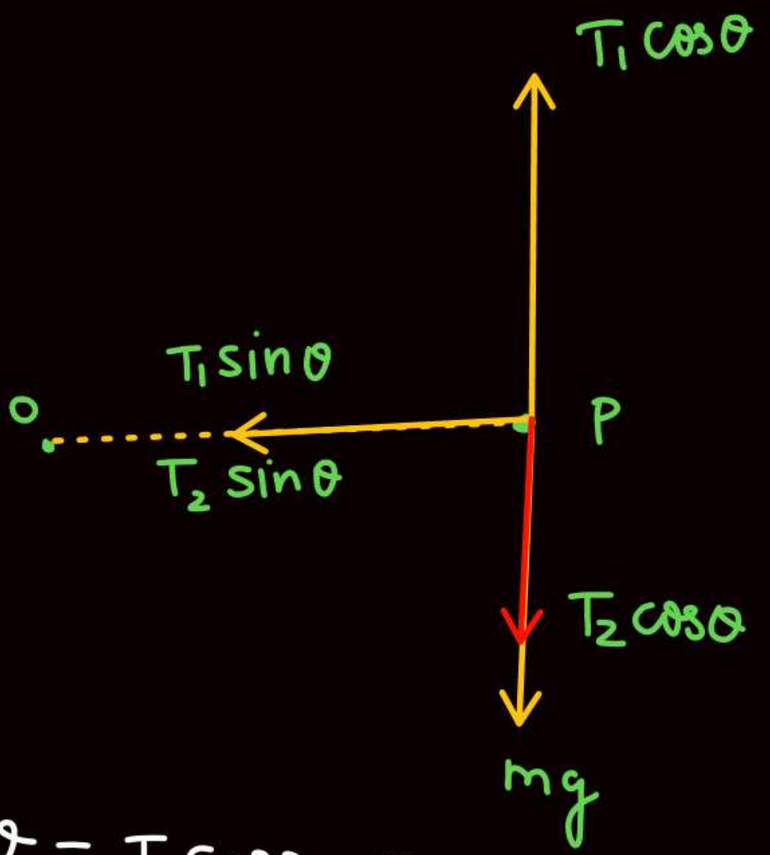
$r = l\sin\theta$

Q



particle is moving with const angular speed ω

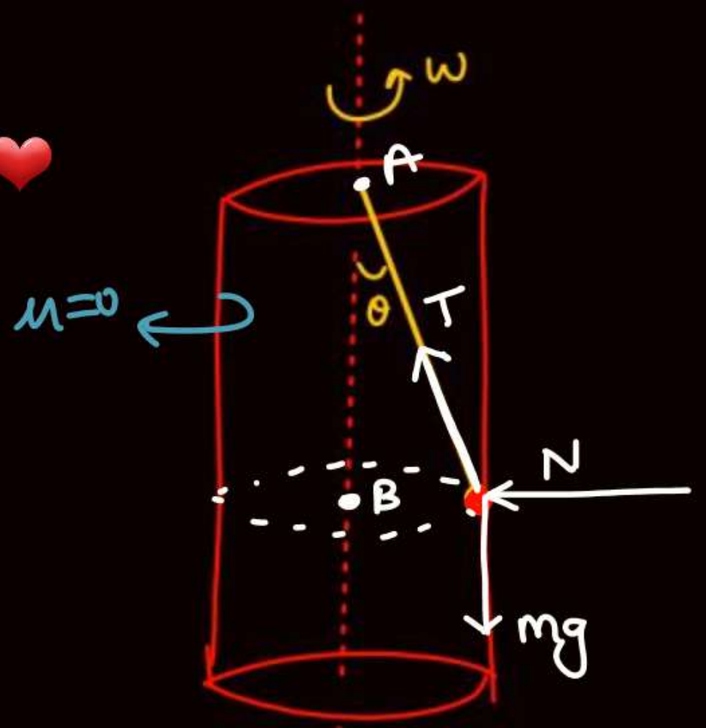




$$T_1\cos\theta = T_2\cos\theta + mg$$

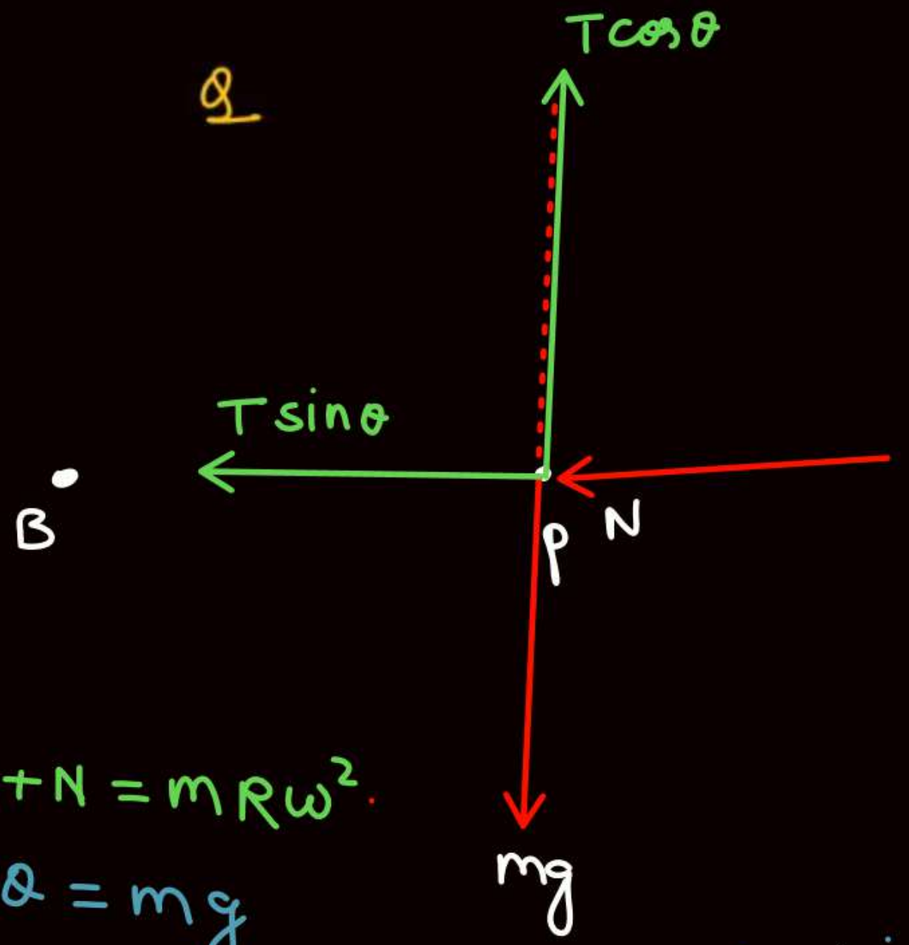
$$T_1\sin\theta + T_2\sin\theta = mr\omega^2$$

Q ❤



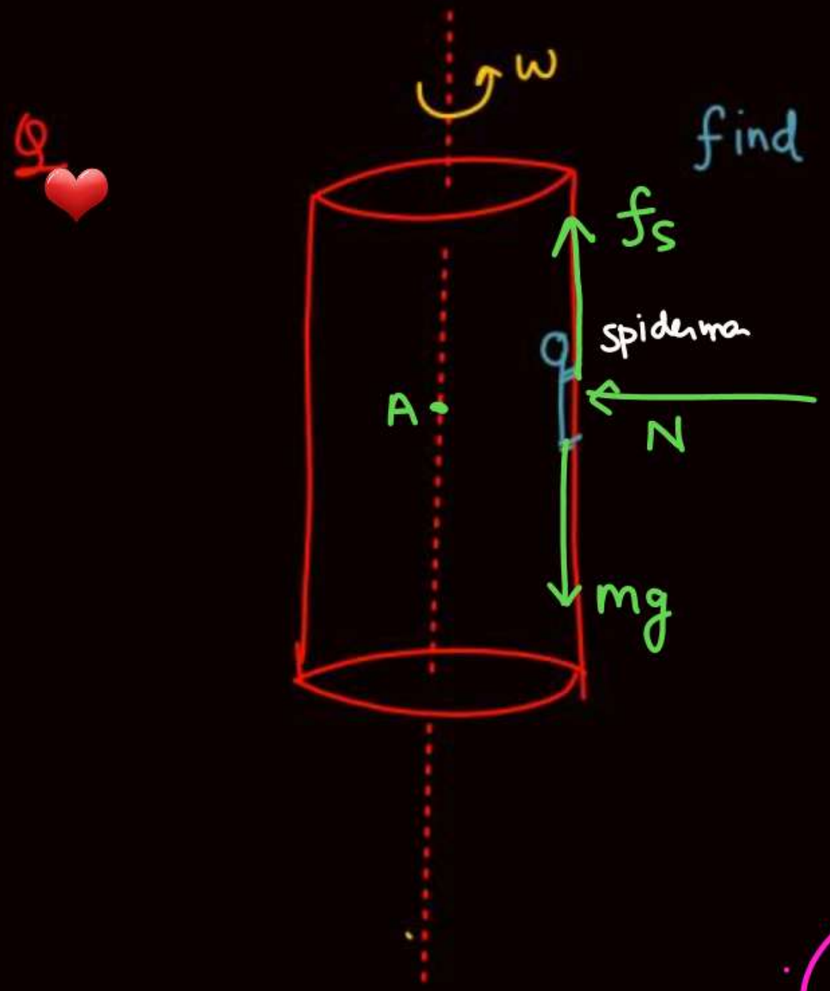
mass is at rest
wrt rotating cylinder.
Write circular motion eqⁿ

Q



$T\sin\theta + N = mR\omega^2$

$T\cos\theta = mg$



find μ_{min} so that spider man remains at rest wrt cylinder.

$$N = mR\omega^2$$

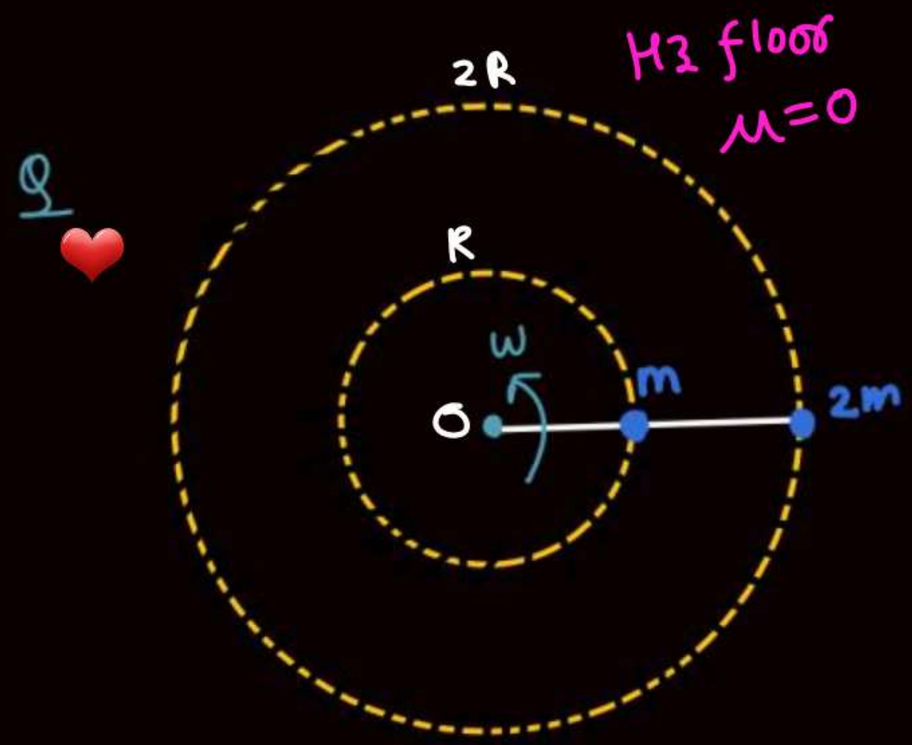
$$f_s = mg$$

$$\mu N = mg$$

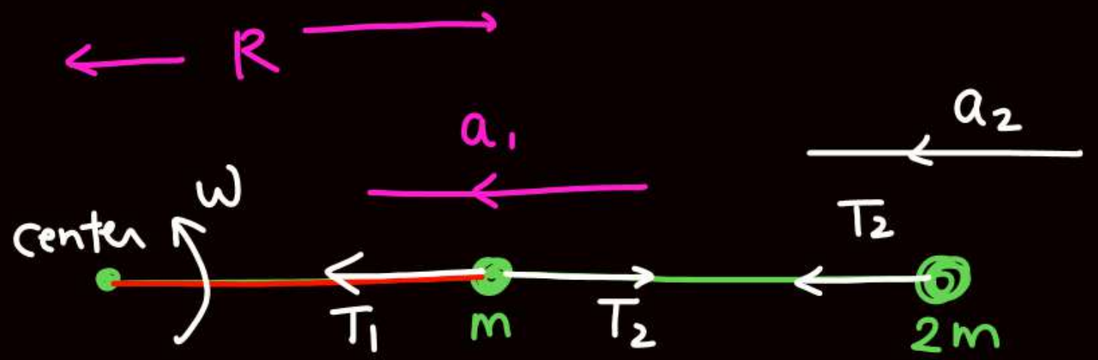
$$\mu mR\omega^2 = mg$$

$$\mu = \frac{g}{R\omega^2}$$

$$(f_s)_{max} \geq mg$$



Find $T_1 : T_2$



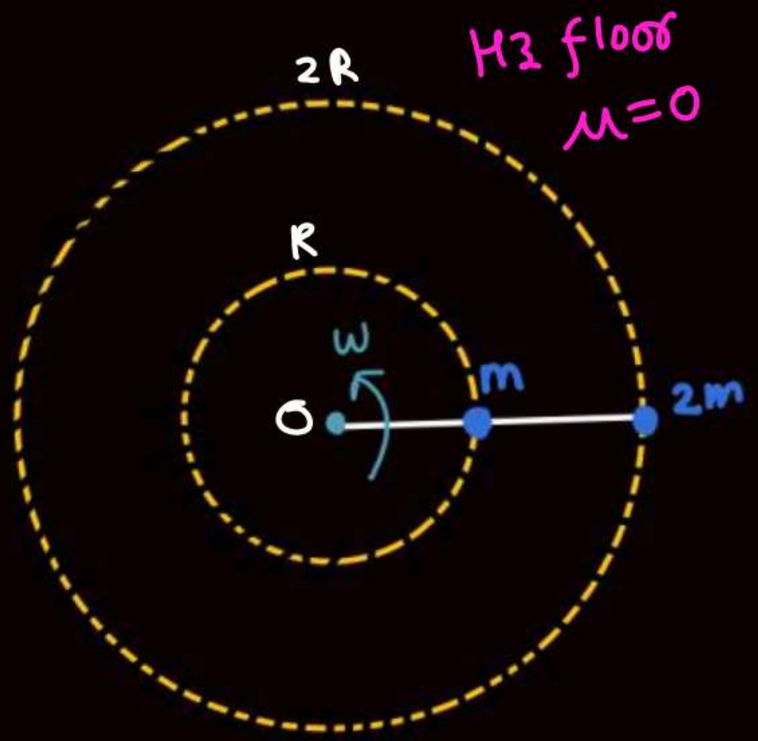
$T_1 - T_2 = mR\omega^2$

$T_2 = 2m(2R)\omega^2$

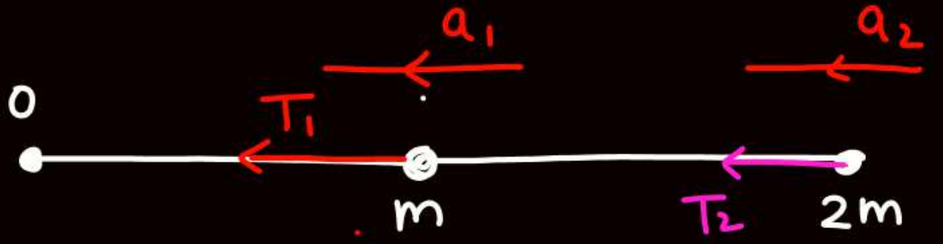
$T_2 = 4mR\omega^2$

put

$T_1 = 5mR\omega^2$



H2 floor
$\mu = 0$



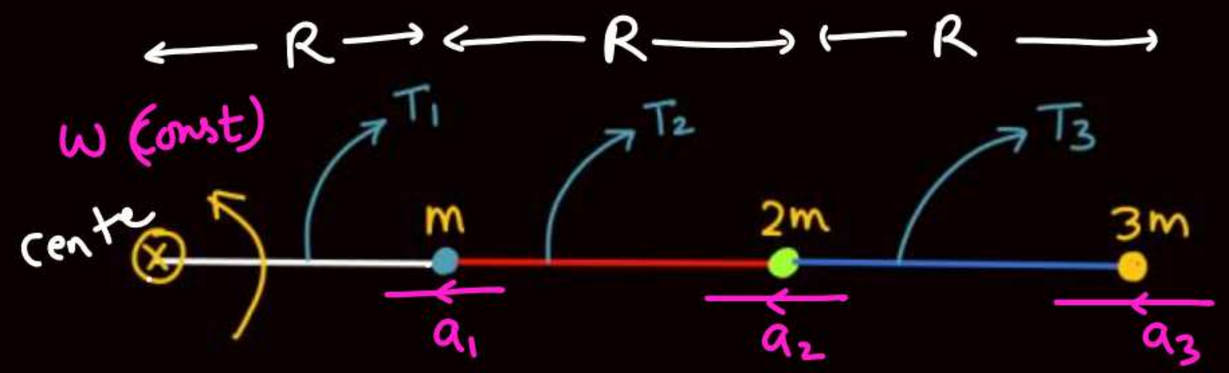
$T_1 = m a_1 + 2m a_2$

$T_1 = m R\omega^2 + 2m \cdot 2R\omega^2$

$T_1 = 5mR\omega^2$

$T_2 = 2m \cdot 2R \cdot \omega^2$

Q



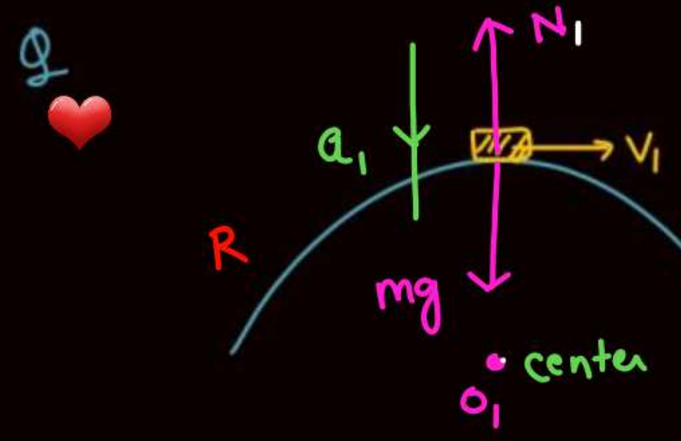
find $T_1 : T_2 : T_3$

$$T_1 = mR\omega^2 + 2m \cdot 2R \cdot \omega^2 + 3m \cdot 3R\omega^2$$

$$T_2 = 2m\ 2R\omega^2 + 3m \cdot 3R\omega^2$$

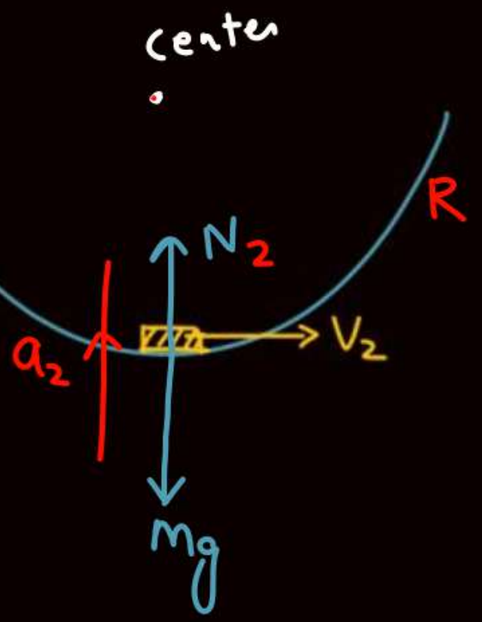
$$T_3 = 3m \cdot 3R \cdot \omega^2$$

write the circular motion eqn



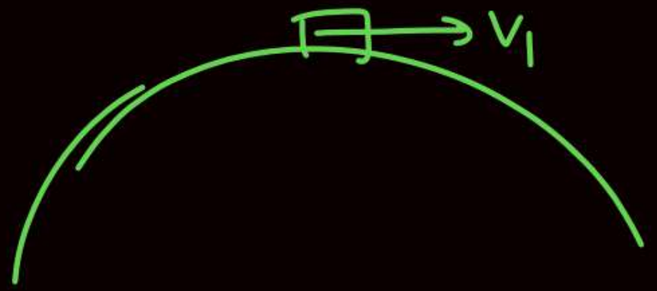
$$mg - N_1 = \frac{mV_1^2}{R}$$

$$N_1 = mg - \frac{mV_1^2}{R}$$

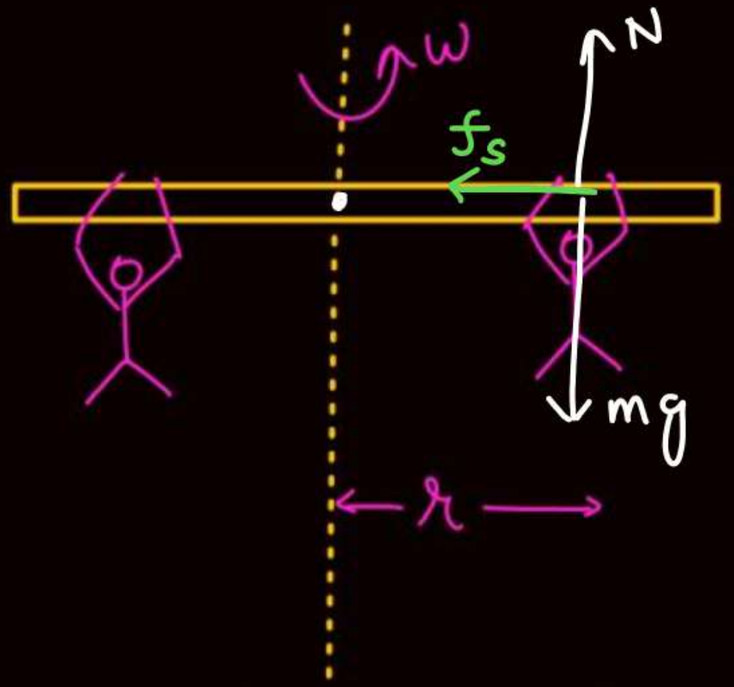


$$N_2 - mg = \frac{mV_2^2}{R}$$

$$N_2 = mg + \frac{mV_2^2}{R}$$



$N_2 > N_1$



$N = mg$

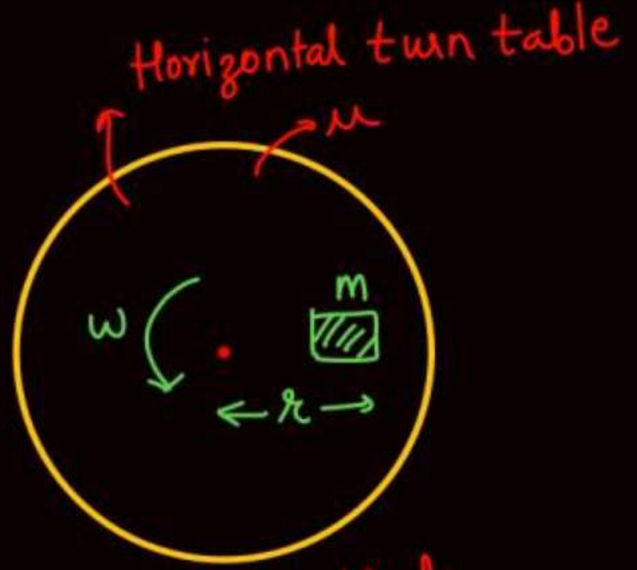
$f_s = m r \omega^2$

$(f_s)_{max} = \mu N = \mu mg = m r \omega^2$

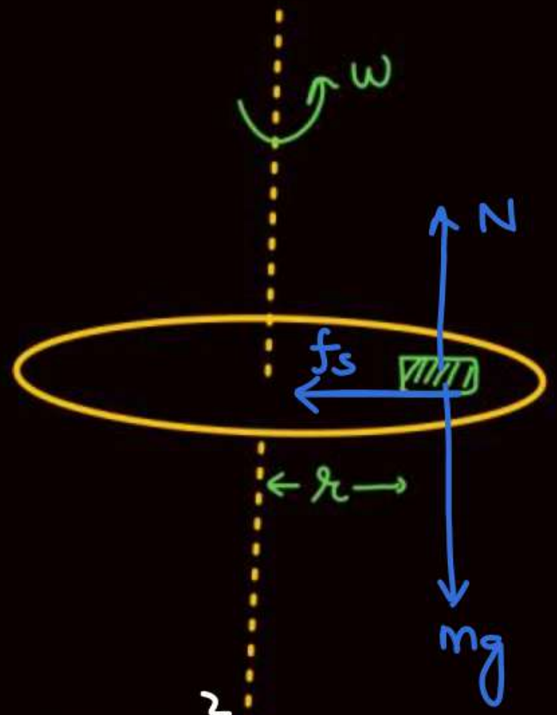
$\mu =$ ✓

find ω min so that man remains at rest wrt rod.

Q ❤️



Find ω_{max} so that mass remains at rest wrt turn table.



$f = m r \omega^2$

Sol:

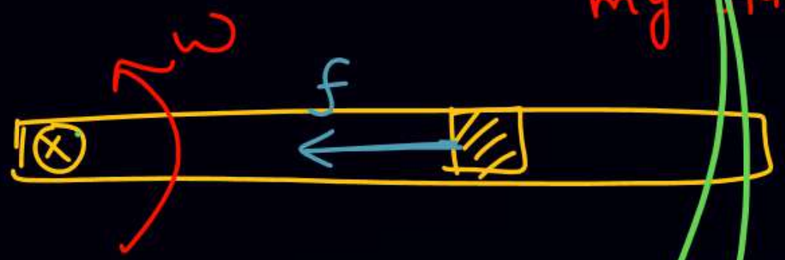
$$(f_s)_{max} = m r \omega^2$$

$$\mu N = \mu m g = m r \omega^2$$

$$\omega = \sqrt{\frac{\mu g}{r}}$$

$\omega_{max} = ?$

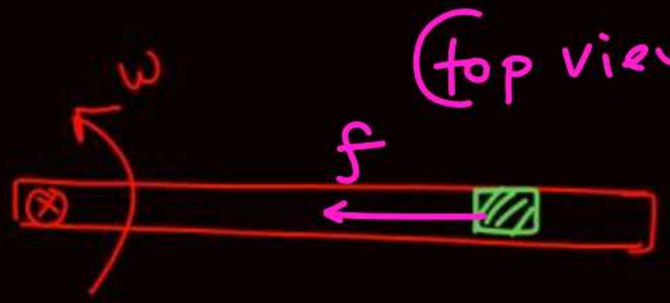
Q



N बाहर
mg अंदर

$f = m r \omega^2$

9



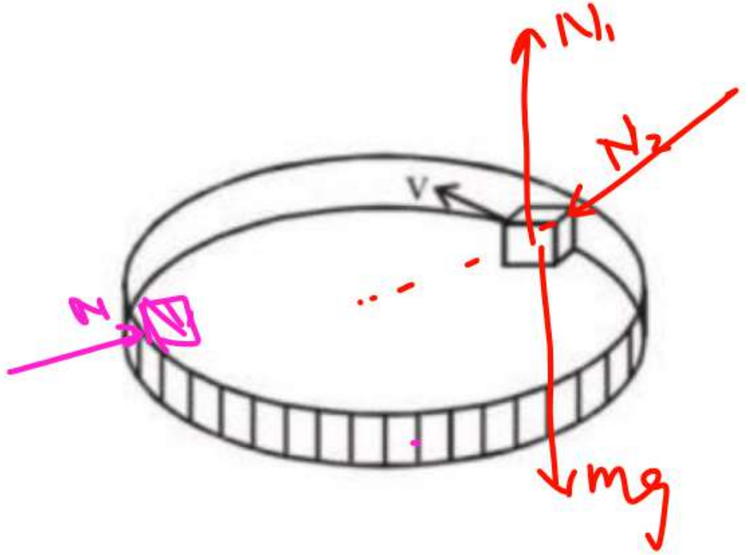
$$f = m r \omega^2 = \mu m g$$

A block of mass m moves with speed v against a smooth, fixed vertical circular groove of radius r kept on smooth horizontal surface.

एक ब्लॉक का द्रव्यमान m है। यह चिकनी क्षैतिज सतह पर रखे त्रिज्या r वाले घर्षणरहित, स्थिर ऊर्ध्वाधर वृत्ताकार खाँचें में v चाल से गति करता है

$N_1 = mg$

$N_2 = \frac{mv^2}{R}$



Find :

(i) normal reaction of the floor on the block.

(ii) normal reaction of the vertical wall on the block.

ज्ञात कीजिए :

(i) ब्लॉक पर फर्श की अभिलम्ब प्रतिक्रिया।

(ii) ब्लॉक पर ऊर्ध्वाधर दीवार की अभिलम्ब प्रतिक्रिया।

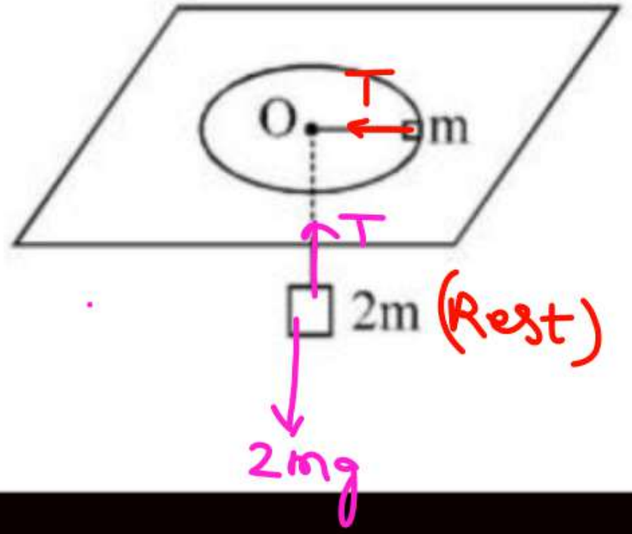
Ans. (i) mg, (ii) $\frac{mv^2}{r}$

A mass m rotating freely in a horizontal circle of radius 1 m on a frictionless smooth table supports a stationary mass 2m, attached to the other end of the string passing through smooth hole O in table, hanging vertically. Find the angular velocity of rotation.

एक घर्षणरहित चिकनी मेज पर एक द्रव्यमान m, 1 m त्रिज्या के क्षैतिज वृत्त में मुक्त रूप से घूर्णन कर रहा है। इस मेज पर एक घर्षणरहित छिद्र O है (चित्र देखें) इसमें से एक रस्सी गुजर रही है। इस रस्सी के एक सिरे पर द्रव्यमान m (जो कि घूर्णन कर रहा है) बंधा हुआ है तथा दूसरे सिरे पर द्रव्यमान 2m (जो कि ऊर्ध्वाधर रूप से लटका हुआ है) जुड़े हैं। घूर्णन का कोणीय वेग ज्ञात कीजिए।

$T = 2mg = m r \omega^2$

$20 = 1 \times \omega^2$



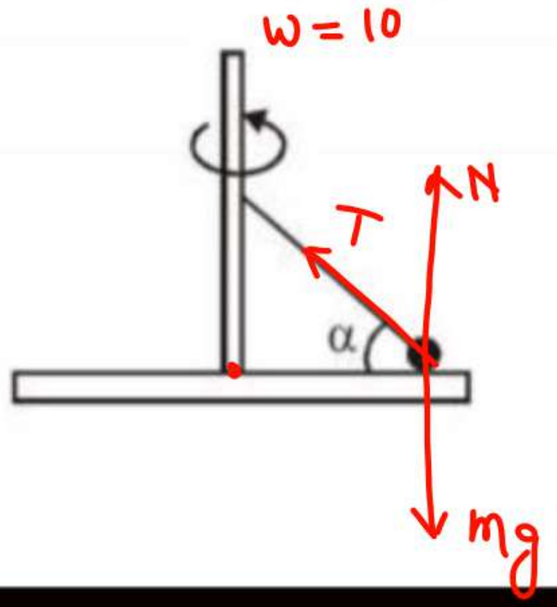
Ans. $\sqrt{2g}$ rad/s

A circular platform rotates around a vertical axis with angular velocity $\omega = 10$ rad/s. On the platform is a ball of mass 1 kg, attached to the long axis of the platform by a thin rod of length 10 cm ($\alpha = 30°$). Find normal force exerted by the ball on the platform (in newton). Friction is absent.

एक वृत्ताकार प्लेटफॉर्म, ऊर्ध्वाधर अक्ष के चारों ओर कोणीय वेग $\omega = 10$ rad/s से घूमता है। प्लेटफॉर्म पर एक 1 kg द्रव्यमान की गेंद रखी है जो 10 cm लम्बी पतली छड़ द्वारा प्लेटफॉर्म की लम्बी अक्ष से जुड़ी हुई है, तथा ($\alpha = 30°$) है। प्लेटफॉर्म पर गेंद द्वारा आरोपित अभिलम्ब बल का मान (न्यूटन में) ज्ञात कीजिए। घर्षण अनुपस्थित है।

$T\cos\alpha = mR\omega^2$

$T\sin\alpha + N = mg$



Ans. 5

Two blocks of mass m_1=10kg and m_2=5kg connected to each other by a massless inextensible string of length 0.3m are placed along a diameter of a turn table. The coefficient of friction between the table and m_1 is 0.5 while there is no friction between m_2 and the table. The table is rotating with an angular velocity of 10rad/sec about a vertical axis passing through its centre. The masses are placed along the diameter of the table on either side of the centre O such that m_1 is at a distance of 0.124 m from O. The masses are observed to be at rest with respect to an observer on the turn table.

(i) Calculate the frictional force on m_1.

(ii) What should be the minimum angular speed of the turn table so that the masses will slip from this position. $f = \mu m g = (m_1 r_1 - m_2 r_2)\omega^2$

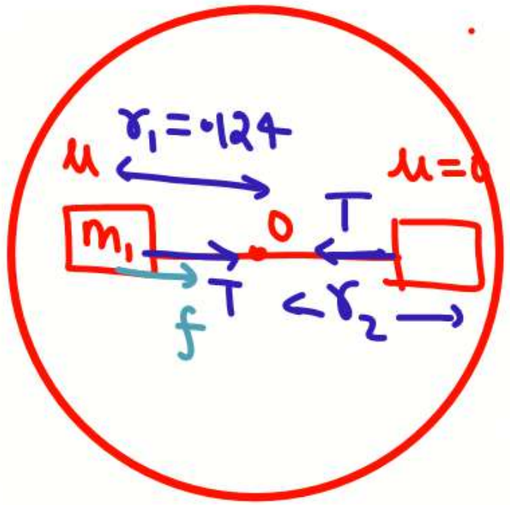
(iii) How should the masses be placed with the string remaining taut, so that there is no frictional force acting on the mass m_1.

new

$T + f = m_1 r_1 \omega^2$

$T = m_2 r_2 \omega^2$

$f = (m_1 r_1 - m_2 r_2)\omega^2$



$m_1 = 10$ Kg
$m_2 = 5$Kg
$\omega = 10$
$r_1 = \cdot 124$
$r_2 = 3 - \cdot 124 =$ ✓
$\mu = \cdot 5$

Ans. (i) 36N, (ii) 11.66rad/sec, (iii) 0.1m, 0.2m

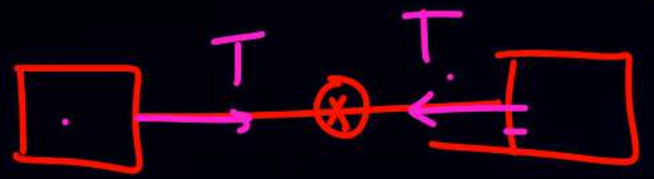
$10r_1 = 5r_2$

$r_2 = 2r_1$

$r_1 + r_2 = 3$

$T = m_1 r_1 \omega^2$

$T = m_2 r_2 \omega^2$



$f = 0$

$m_1 r_1 \omega^2 = m_2 r_2 \omega^2$

$m_1 r_1 = m_2 r_2$

$r_1 + r_2 = 3$

In the shown figure inside a fixed hollow cylinder with vertical axis a pendulum is rotating in a conical path with its axis same as that of the cylinder with uniform angular velocity. Radius of cylinder is 30 cm, length of string is 50 cm and mass of bob is 400 gm. The bob makes contact with the inner frictionless wall of the cylinder while moving :-

(A) The minimum value of angular velocity of the bob so that it does not leave contact is 5 rad/s

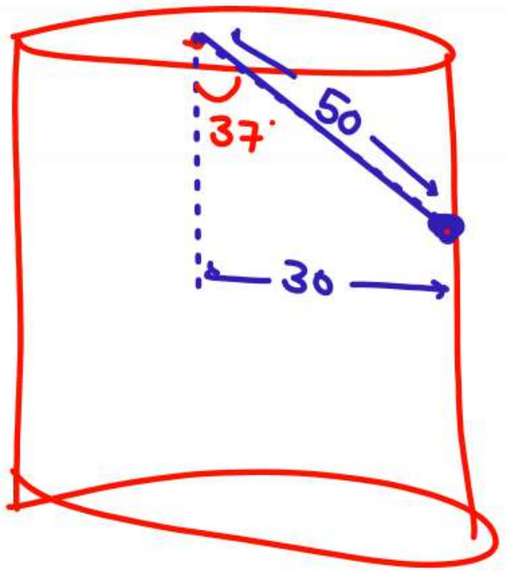
(B) Tension in the string is 5N for all values of angular velocity .

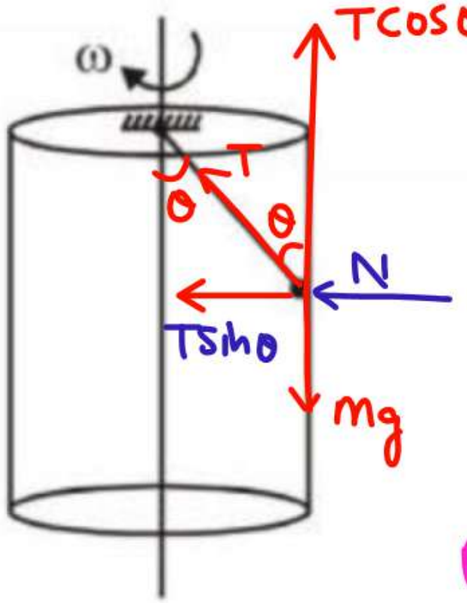
(C) For angular velocity of 10 rad/s the bob pushes the cylinder with a force of 9N

(D) For angular velocity of 10 rad/s, tension in the string is 20N

HW

$\omega = 10$ put





$T\cos\theta = mg$

$T \times \frac{4}{5} = .4 \times 10$

$T = 5$

$T\sin\theta + N = mR\omega^2$

$5 \times \frac{3}{5} + 0 = .4 \times .3\,\omega^2$

$\omega = 5$

प्रदर्शित चित्र में एक स्थिर खोखले बेलन जिसकी अक्ष ऊर्ध्वाधर है, के अंदर एक लोलक एकसमान कोणीय वेग से एक

On a circular turn table rotating about its center horizontally with uniform angular velocity ω rad/s placed two blocks of mass 1 kg and 2 kg, on a diameter symmetrically about center. Their separation is 1m and friction is sufficient to avoid slipping. The spring between them as shown is stretched and applied force of 5N. If f_1 and f_2 are values of friction on 1 kg & 2kg block respectively:-

(A) For $\omega = 2$ rad/s, $f_1 = 3N$ & $f_2 = 1N$

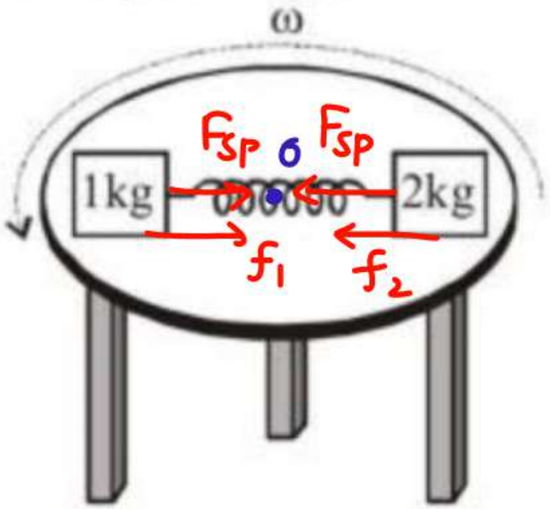
(B) For $\omega = 3$ rad/s, $f_1 = 0.5$ N & $f_2 = 4N$

(C) For $\omega = \sqrt{10}$ rad/s, $f_1 = 0$ & $f_2 = 5N$

(D) For $\omega = \sqrt{10}$ rad/s, $f_1 = 0$ & $f_2 = 0N$

$5 + f_1 = 1 \times \frac{1}{2} \times \omega^2$

$5 + f_2 = 2 \times \frac{1}{2} \times \omega^2$

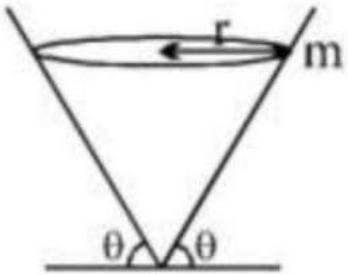


A ball of mass 'm' is rotating in a circle of radius 'r' with speed v inside a smooth cone as shown in figure. Let N be the normal reaction on the ball by the cone, then choose the correct option.

(A) $N = mg\cos\theta$

HW

(B*) $g\sin\theta = \frac{v^2}{r}\cos\theta$



(C*) $N\sin\theta - \frac{mv^2}{r} = 0$

(D) none of these

A particle P of mass m is attached to a vertical axis by two strings AP and BP of length l each. The separation AB=l. P rotates around the axis with an angular velocity ω. The tensions in the two strings are T_1 and T_2

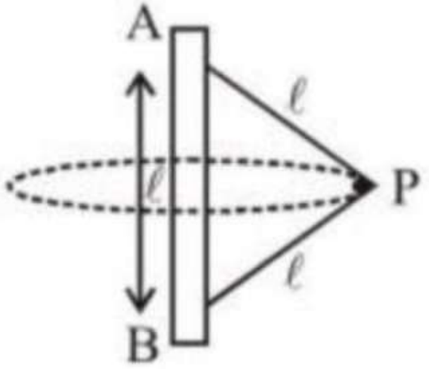
(A) $T_1=T_2$

(B) $T_1+T_2=m\omega^2 l$

(C) $T_1-T_2=2mg$

(D) BP will remain taut only if $\omega \geq \sqrt{\frac{2g}{\ell}}$

Ans



THANK YOU