

PRAYAS

JEE 2025

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Lecture - 01

Physics

Oscillations

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Topics *to be covered*

1

Toppling

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2

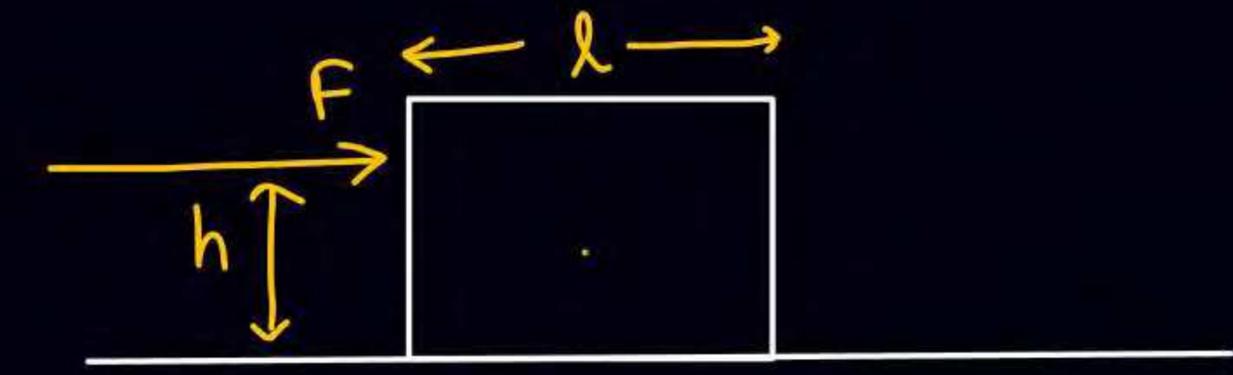
SHM (oscillation) (1 hour 15 min)

3

4



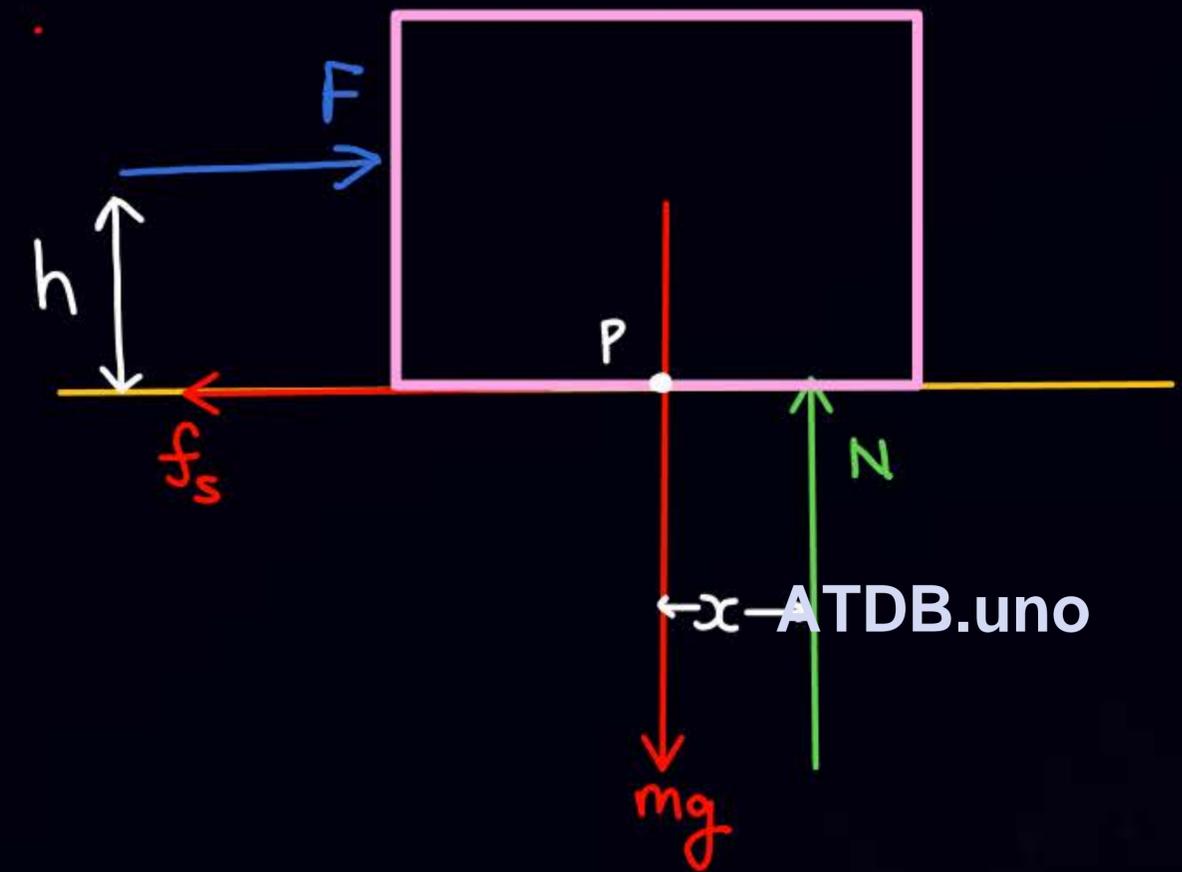
Toppling



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Assume friction is sufficient for avoid slipping



$$F = f_s$$

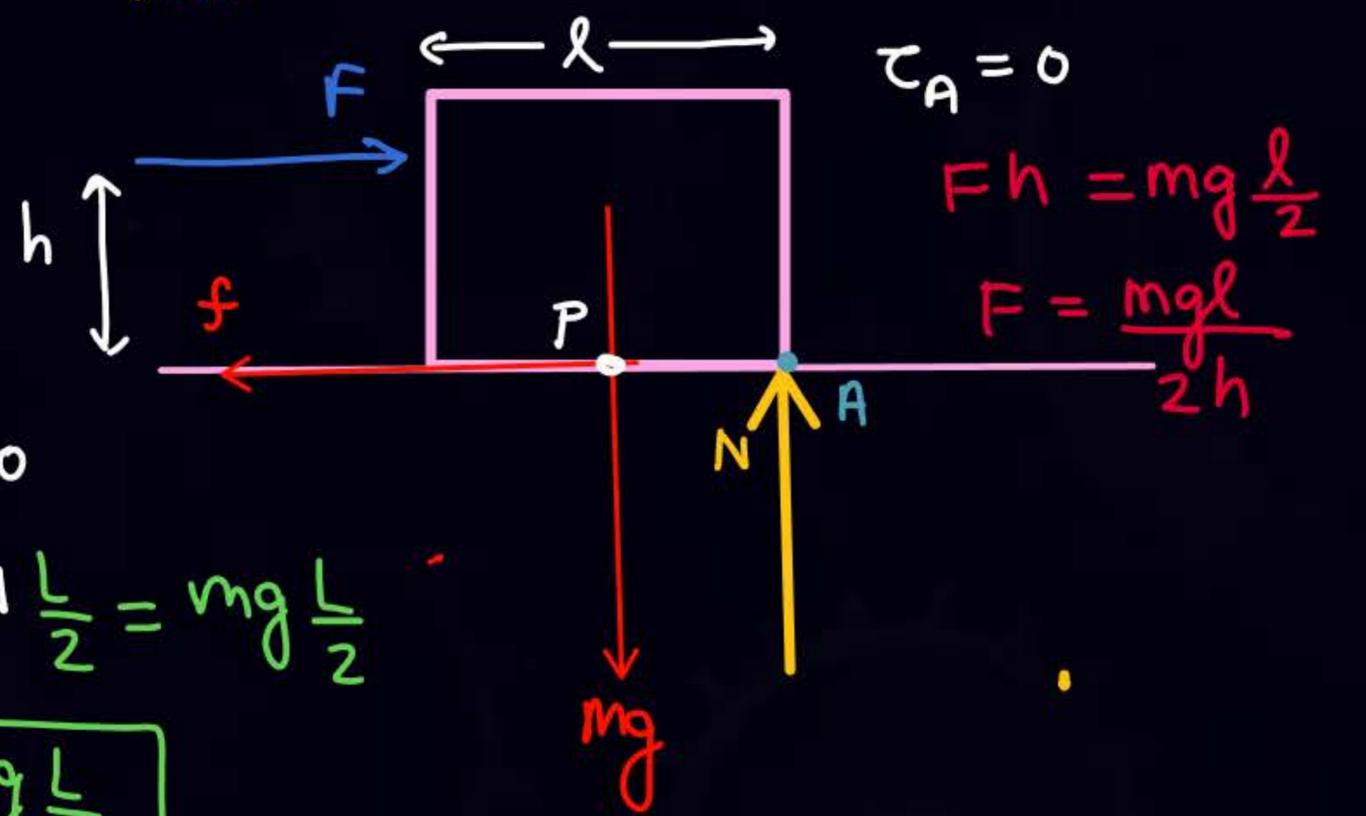
$$N = mg$$

$$Fh = Nx = mgx$$

$$Fh = mgx$$

If $F \uparrow \Rightarrow x \uparrow$

when Normal reaches at extreme point



$$\tau_A = 0$$

$$Fh = mg \frac{l}{2}$$

$$F = \frac{mgl}{2h}$$

$$\tau_P = 0$$

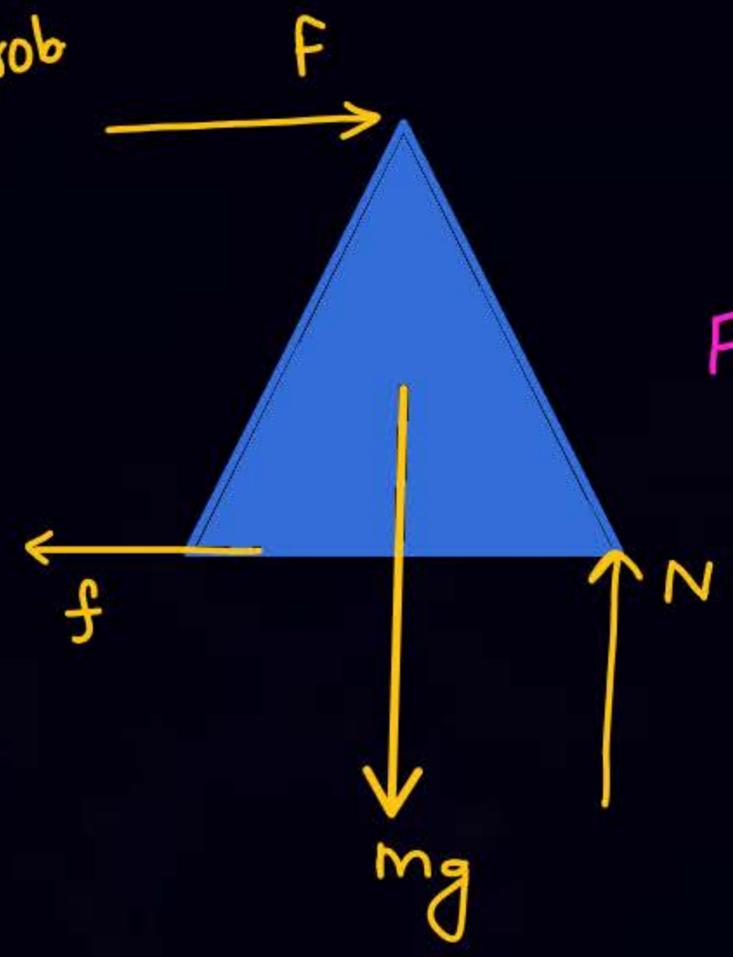
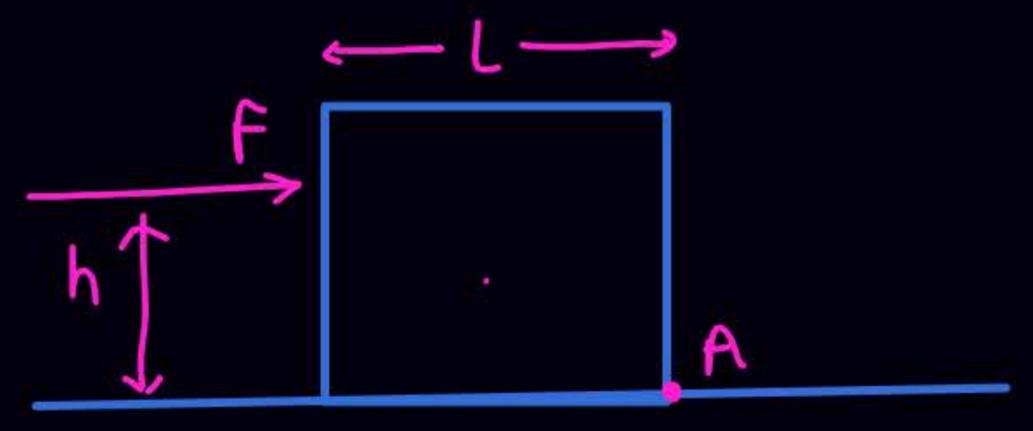
$$Fh = N \frac{l}{2} = mg \frac{l}{2}$$

$$F = mg \frac{l}{2h}$$



Repeat the last Q prob

Q

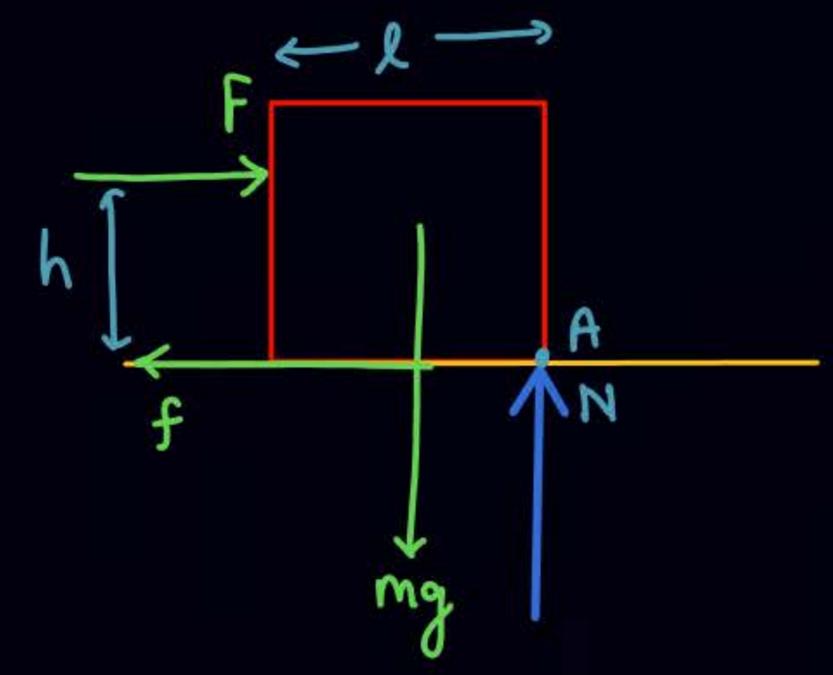


$$Fh = mg \frac{l}{2}$$

friction is sufficient to avoid slipping
 find F_{min} so that body topple about A

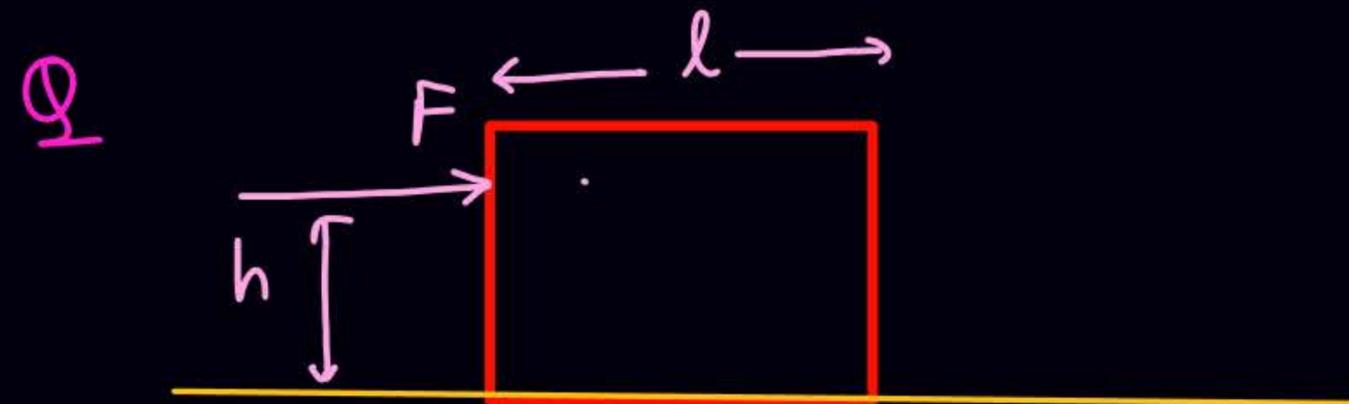
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Solⁿ



$$F \cdot h = mg \frac{l}{2}$$

$$F = \frac{mg l}{2h} = \text{Ans}$$



$$F_{\text{min to topple}} = \frac{mgl}{2h}$$

$$F_{\text{min to slide}} = \mu_s mg$$

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① $(F_{\text{min}})_{\text{slide}} > (F_{\text{min}})_{\text{to topple}}$

If we increase force F gradually

Body topple first

$$\mu_s mg > \frac{mgl}{2h}$$

$$\mu_s > \frac{l}{2h} \equiv \text{Body topple 1st}$$

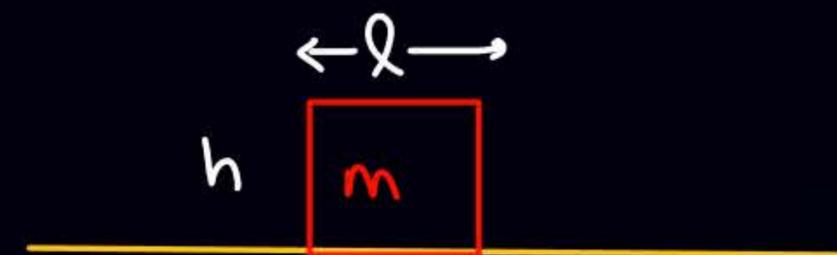
② $(F_{\text{min}})_{\text{slide}} < (F_{\text{min}})_{\text{to topple}}$

$$\mu_s < \frac{l}{2h} \equiv (\text{Body slide 1st})$$

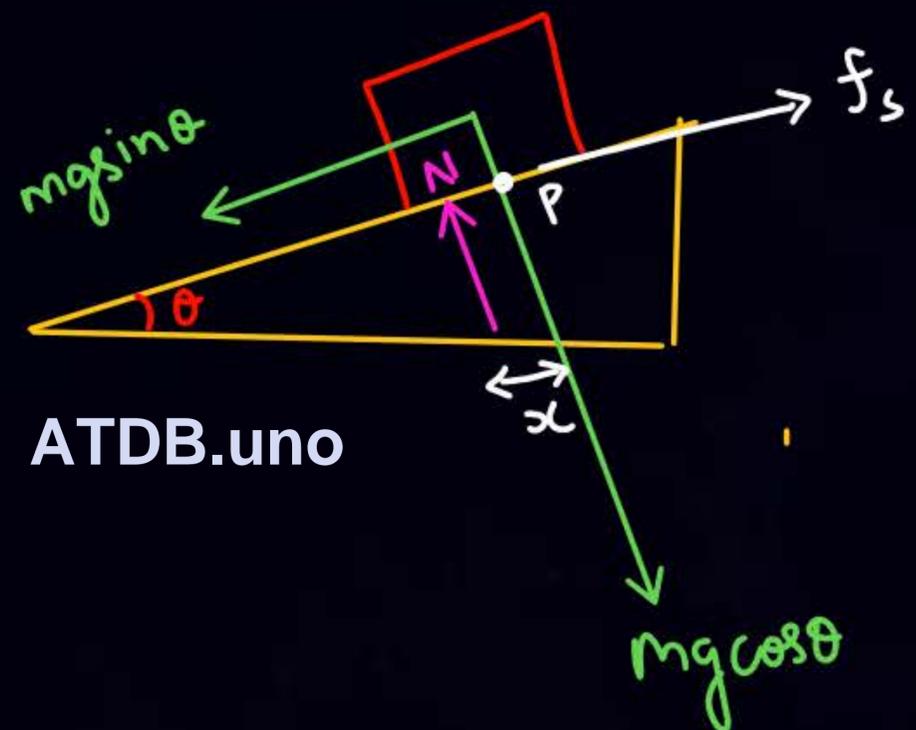




Toppling on Inclined



≡



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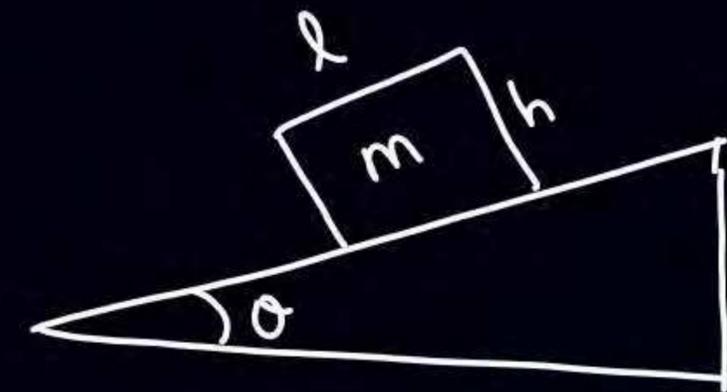
$$N = mg \cos \theta$$

$$mg \sin \theta \frac{h}{2} = N x$$

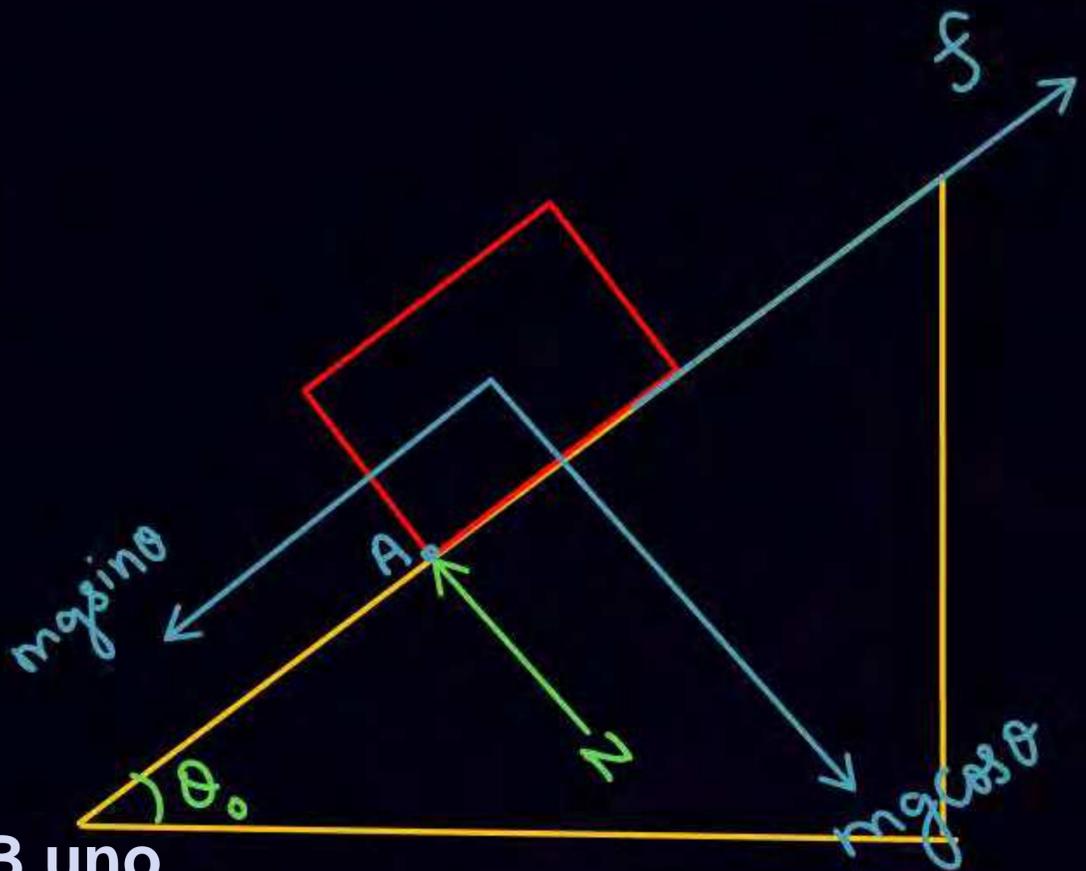
If we increase θ

$$\theta \uparrow \Rightarrow x \uparrow$$

If friction is sufficient to avoid slipping
find θ_{\min} so that body topple



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$$\tau_A = 0, \quad mg \sin \theta_0 \cdot \frac{h}{2} = mg \cos \theta_0 \cdot \frac{l}{2}$$

$$\tan \theta_0 = \frac{l}{h}$$

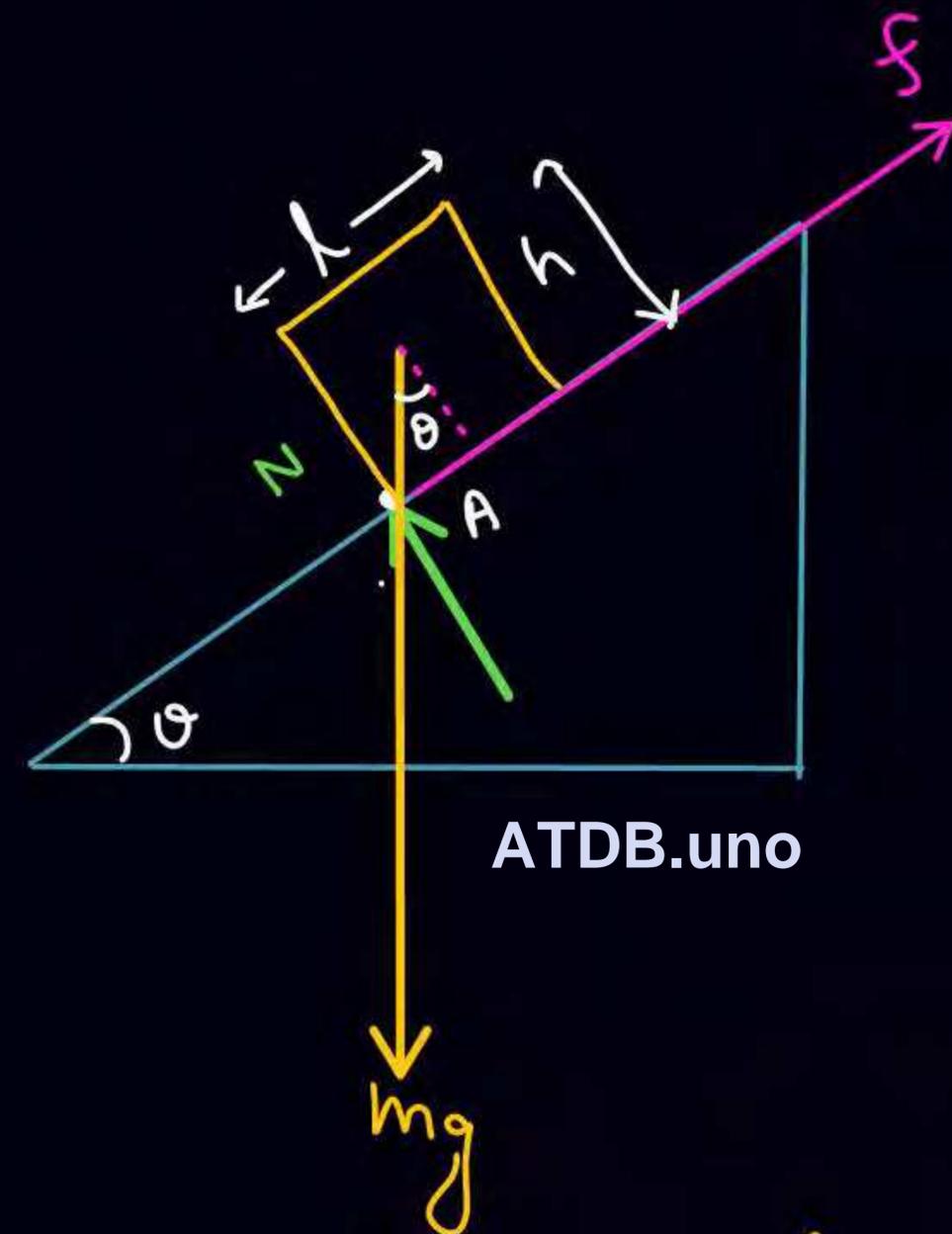
θ_{\min} to topple

$$= \theta_0 = \tan^{-1} \left(\frac{l}{h} \right)$$





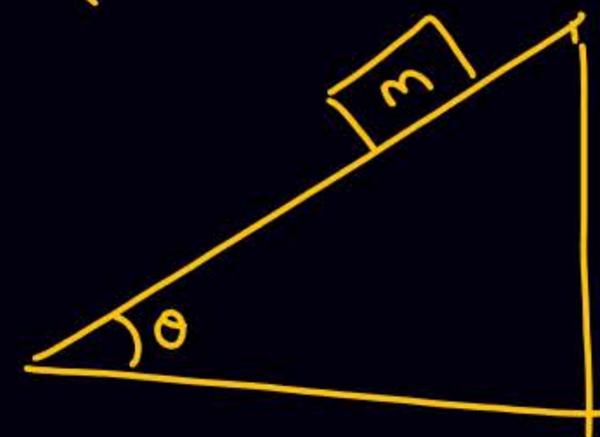
$$\tau_A = 0$$



$$\tan \theta = \frac{l/2}{h/2} = \frac{l}{h}$$



Angle of repose/sliding
(NLM)



$$\tan \theta_{\text{sliding min}} = \mu_s$$

$$(\theta_{\text{min}})_{\text{topple}} = \tan^{-1}\left(\frac{l}{h}\right)$$

$$(\theta_{\text{min}})_{\text{slide}} = \tan^{-1}(\mu_s)$$

Let we increase θ gradually from 0.

① $(\theta_{\text{min}})_{\text{topple}} > (\theta_{\text{min}})_{\text{slide}} \Rightarrow$ Body slide 1st

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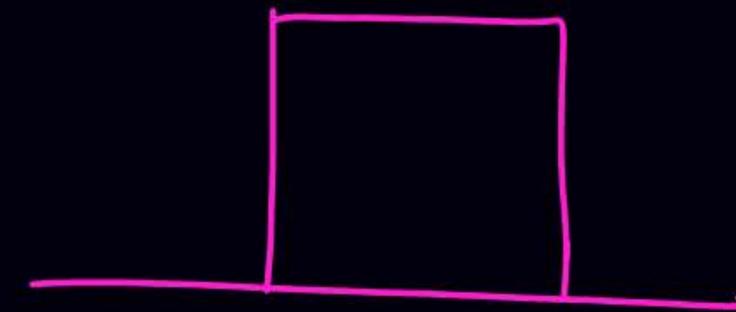
$$(\tan \theta)_{\text{topple}} > (\tan \theta)_{\text{slide}}$$

$$\frac{l}{h} > \mu_s$$

② $(\theta_{\text{min}})_{\text{topple}} < (\theta_{\text{min}})_{\text{slide}} \Rightarrow$ Body topple 1st

$$\frac{l}{h} < \mu_s$$

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2009



$$l = 10 \text{ cm}$$

$$b = 10 \text{ cm}$$

$$h = 15 \text{ cm}$$

$$\mu = \sqrt{3}$$

$$\theta_{\text{slider}} = 60$$

If value of θ is increase gradually
from $\theta = 0$

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- ① At $\theta = 30$, block will slide down
 - ② Block will remain at rest on the plane up to θ & then it will topple

$$\tan \theta_{\text{topple}} = \frac{l}{h} = \frac{10}{15} = \frac{2}{3} = 0.66$$

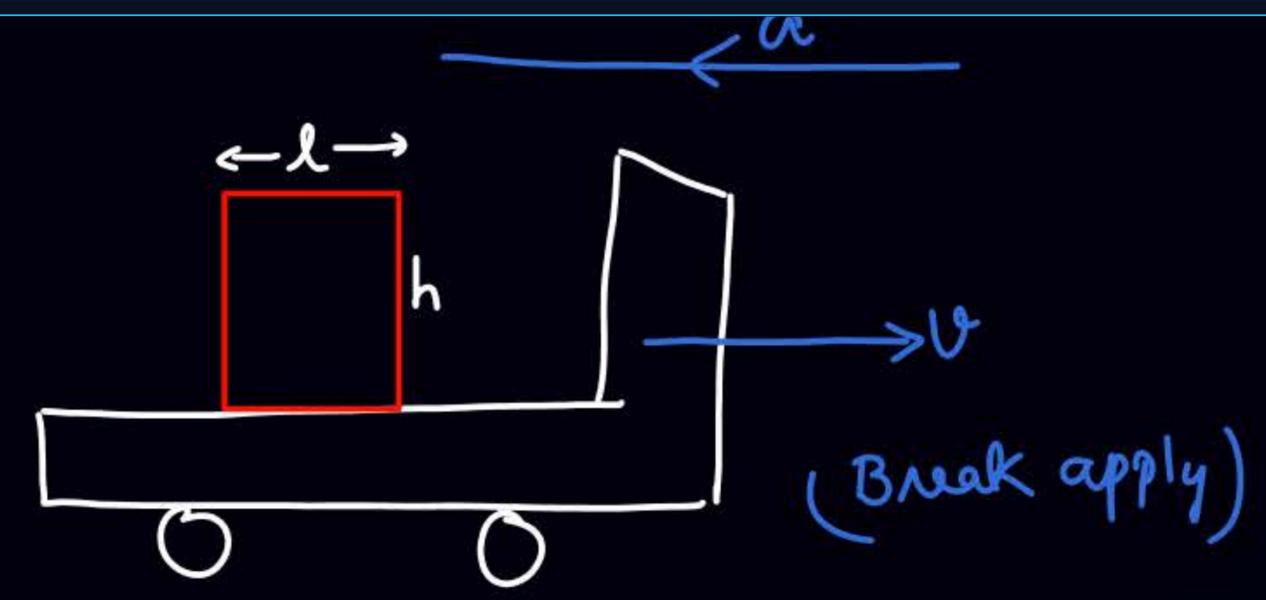
$$\tan \theta_{\text{slide}} = \mu_s = 1.73$$



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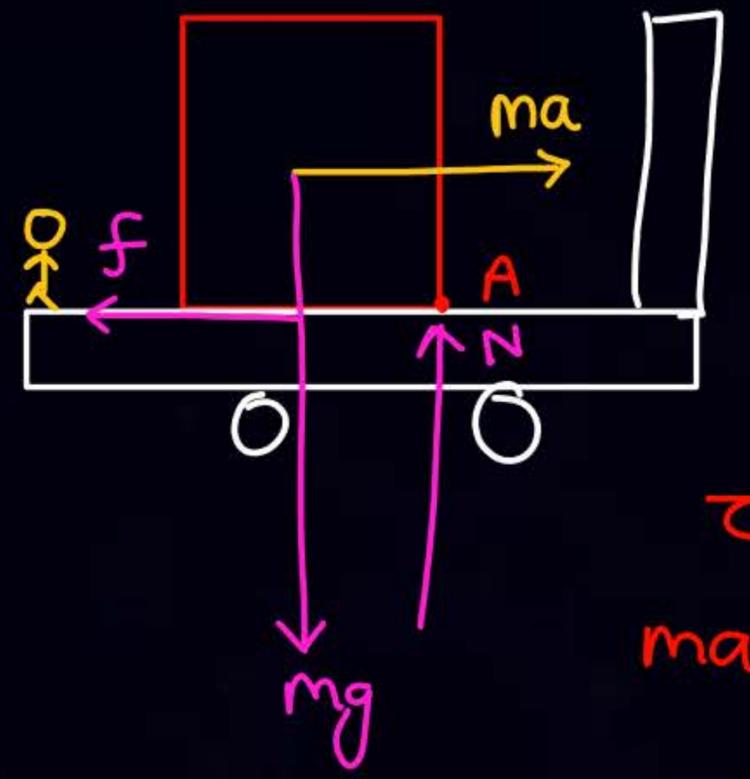
Q



Solⁿ

If friction is sufficient to avoid slipping.
 find a_{max} so that body does not topple.
 find a_{min} so that body topple

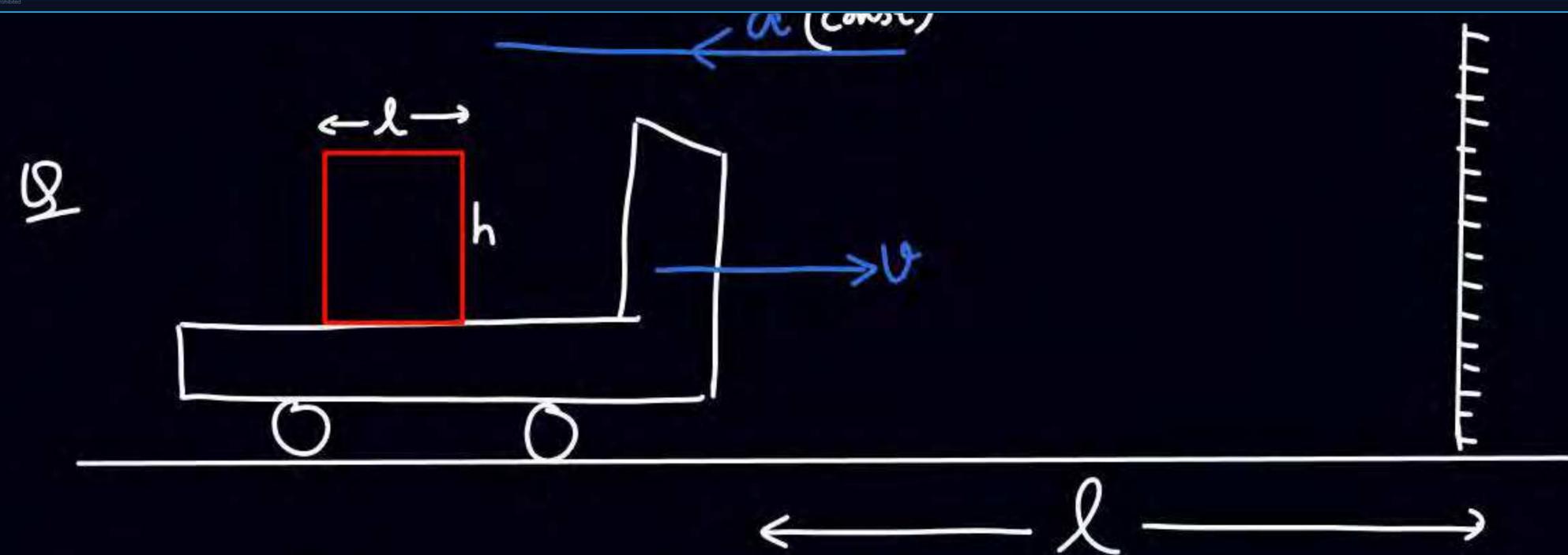
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$$\tau_A = 0$$

$$ma \frac{h}{2} = mg \frac{l}{2}$$

$$a = \frac{gl}{h}$$



find l min so that, body does not topple & truck does not collide with wall

$$mg \frac{l}{2} = ma \cdot \frac{h}{2}$$

$$a = \frac{gl}{h}$$

$$0^2 = v^2 - 2al$$

$$l = \frac{v^2}{2a} = \checkmark$$



Rot. 17 (पाठ में com KPP ए)

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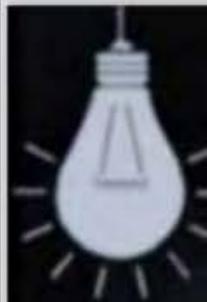


SHM (oscillation) (Undamped)

- periodic motion
 - oscillatory motion
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SHM = ?



Periodic motion \rightarrow Any motion which repeats itself after regular interval of time.

The const interval of time after which the motion is repeated is called time period.

Ex \rightarrow Spring balance system, motion of earth around sun
Uniform circular motion, pendulum

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Oscillatory motion

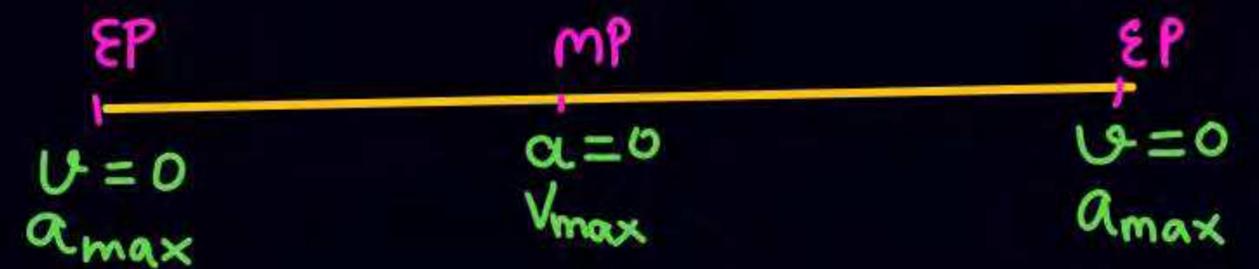
- motion is oscillatory if it moves to & fro about a fixed point after regular interval of time
- * Fixed point about which body oscillates is called mean position or equilibrium position. (m.p.)

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$$\vec{F}_{\text{net}} = -k\vec{x}$$



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$$x = f(t)$$



SHM →

It a special kind of oscillatory motion in which net force on particle at any time (any wTTE) is proportional to negative of displacement from mean position

$$\vec{F}_{\text{net}} \propto -\vec{x}$$

$$\vec{F}_{\text{net}} = -k \vec{x}$$

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net ext force

displ. of particle from mean position (m.p.)

$$\text{At m.p.} \Rightarrow \vec{F}_{\text{net}} = 0$$

SHM \forall const

$$\vec{F}_{\text{net}} \propto -\vec{x}$$

$$\vec{a}_{\text{net}} \propto -\vec{x}$$

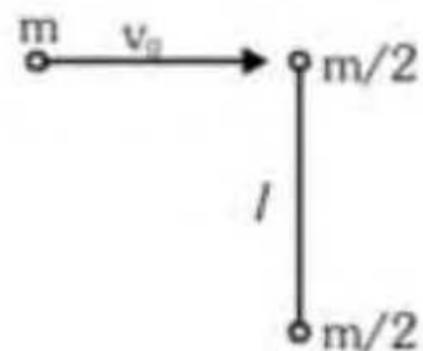
$$\vec{a}_{\text{net}} = -\frac{k}{m} \vec{x}$$

A uniform disc of radius R and mass M , spinning with angular velocity ω_0 is carefully lowered onto the rough horizontal surface with coefficient of friction μ . Find the time when the disc comes at rest.

$$\text{Ans} \rightarrow \frac{3\omega_0 R}{4\mu g}$$

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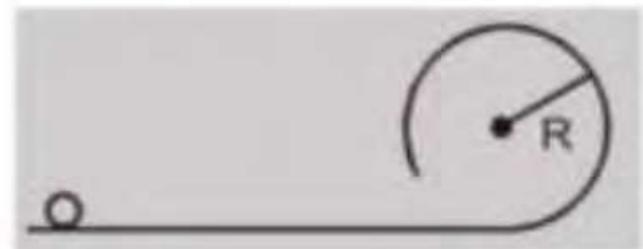
A ball of mass m is moving with velocity v_0 experiences a head-on elastic collision with one of the spheres of a stationary rigid dumbbell as shown in Fig. The mass of each sphere equals $m/2$, and the distance between them is ℓ . Disregarding the size of the spheres, find the proper angular momentum \vec{M} of the dumbbell after the collision, i.e. the angular momentum in the reference frame moving translationally and fixed to the dumbbell's centre of inertia.



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Ans. $\vec{M} = \frac{1}{3} \ell m v_0$

Figure shows a rough track, a portion of which is in the form of a cylinder of radius R . What minimum linear speed should a sphere of radius r be set rolling on the horizontal part so that it completely goes round the circle on the cylindrical part ?



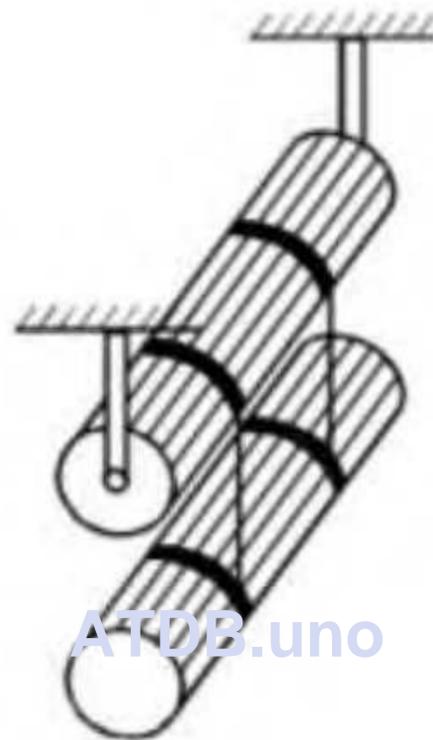
Ans. $\sqrt{\frac{27}{7}g(R-r)}$

A uniform ball of radius r rolls without slipping down from the top of a sphere of radius R . Find the angular velocity of the ball at the moment it breaks off the sphere. The initial velocity of the ball is negligible.

$$\text{Ans. } \omega = \sqrt{10g(R+r)/17r^2}$$

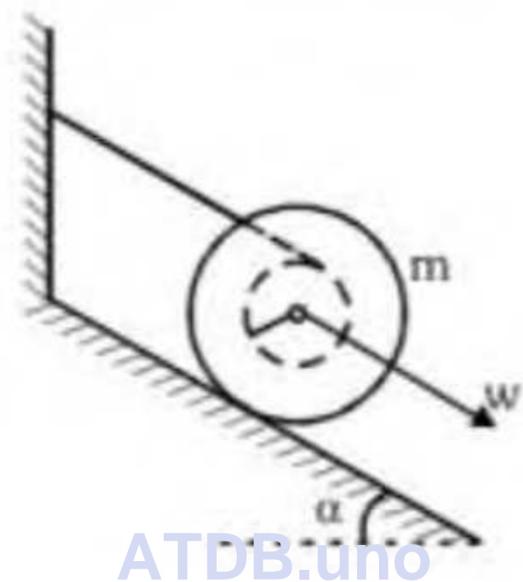
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The arrangement shown in Fig. consists of two identical uniform cylinders, each of mass m , on which two light threads are wound symmetrically. Find the tension of each thread in the process of motion. The friction in the axle of the upper cylinder is assumed to be absent.



Ans. $T = \frac{1}{10} mg$

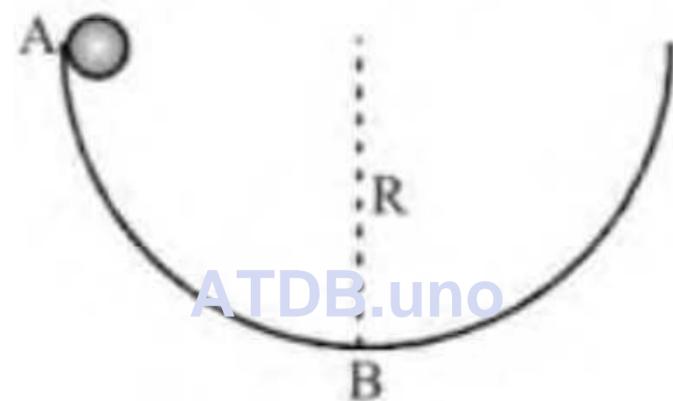
A spool with a thread wound on it is placed on an inclined smooth plane set at an angle $\alpha = 30^\circ$ to the horizontal. The free end of the thread is attached to the wall as shown in Fig. The mass of the spool is $m = 200 \text{ g}$, its moment of inertia relative to its own axis $I = 0.45 \text{ g} \cdot \text{m}^2$, the radius of the wound thread layer $r = 3.0 \text{ cm}$. Find the acceleration of the spool axis.



Ans. $w = g \sin \alpha / (1 + I/mr^2) = 1.42 \text{ m/s}^2$

A small sphere A of mass m and radius r rolls without slipping inside a large fixed hemispherical bowl of radius R ($\gg r$) as shown in figure. If the sphere starts from rest at the top point of the hemisphere find the normal force exerted by the small sphere on the hemisphere when it is at the bottom B of the hemisphere.

एक छोटे गोले A का द्रव्यमान m व त्रिज्या r है। यह चित्रानुसार R ($\gg r$) त्रिज्या वाले एक बड़े स्थिर अर्द्धगोलाकार प्याले के अन्दर बिना फिसले लुढ़कता है। जब गोला, प्याले के उच्चतम बिन्दु से विरामावस्था से गति प्रारम्भ कर इस प्याले के पैंदे B पर पहुंचता है तो उस क्षण छोटे गोले द्वारा, प्याले पर लगाया गया अभिलम्ब बल होगा :-



(A) $\frac{10}{7} mg$

(B) $\frac{17}{7} mg$

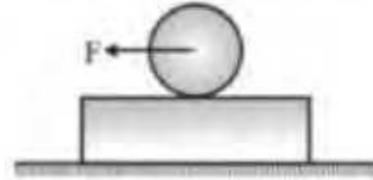
(C) $\frac{5}{7} mg$

(D) $\frac{7}{5} mg$

Ans. (B)

A disc of mass m and radius R is placed over a plank of same mass m . There is sufficient friction between disc and plank to prevent slipping. A force F is applied at the centre of the disc. Friction is absent between plank and ground.

m द्रव्यमान एवं R त्रिज्या वाली चकती समान द्रव्यमान वाले एक तख्ते पर रखी हुई है। चकती एवं तख्ते के बीच फिसलन को रोकने के लिये पर्याप्त घर्षण है। चकती के केन्द्र पर एक बल F लगाया जाता है।



Acceleration of the plank is :-

तख्ते का त्वरण है :-

(A) $\frac{F}{2m}$

(B) $\frac{3F}{4m}$

(C) $\frac{F}{4m}$

(D) $\frac{3F}{2m}$

Ans. (C)

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Force of friction between the disc and the plank is :-

चकती एवं तख्ते के बीच घर्षण बल है :-

(A) $\frac{F}{2}$

(B) $\frac{F}{4}$

(C) $\frac{F}{3}$

(D) $\frac{2F}{3}$



A ring of radius R is rolling purely on the outer surface of a pipe of radius $4R$. At some instant, the center of the ring has a constant speed $= v$. Then ,

त्रिज्या R वाली एक वलय त्रिज्या $4R$ वाले पाईप की बाह्य सतह पर शुद्ध रूप से लुढ़क रही है। किसी क्षण वलय के केन्द्र की नियत चाल v है। तब पाईप की सतह के सम्पर्क में स्थित वलय के बिन्दु का त्वरण होगा:-

- (A) The acceleration of the point on the ring which is in contact with the surface of the pipe is $4v^2/5R$
- (B) The acceleration of the point on the ring which is in contact with the surface of the pipe is $3v^2/5R$
- (C) The acceleration of the point on the ring which is farthest from the center of the pipe, at the given moment is $6v^2/5R$
- (D) The acceleration of the point on the ring which is farthest from the center of the pipe, at the given moment is $3v^2/5R$

Ans. (A, C)

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A straight rod of length L is released on a frictionless horizontal floor in a vertical position. As it falls + slips, the distance of a point on the rod from the lower end, which follows a quarter circular locus is :-

एक L लम्बाई की सीधी छड़ को घर्षणरहित क्षैतिज फर्श पर ऊर्ध्वाधर स्थिति में विरामावस्था से छोड़ा जाता है। यह फिसलती तथा गिरती है। इसके निचले सिरे से छड़ पर स्थित उस बिन्दु की दूरी ज्ञात कीजिये जो कि एक चौथाई वृत्त में गति करता है।

(A) $L/2$

(B) $L/4$

(C) $L/8$

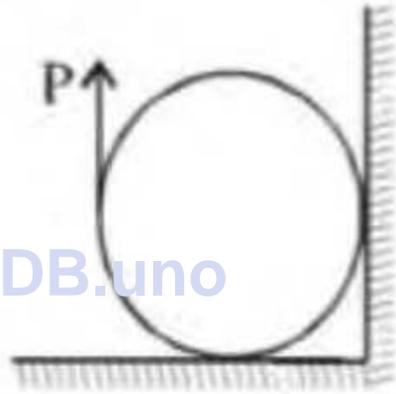
(D) None

Ans. (B)

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Figure shows a vertical force applied tangentially to a uniform cylinder of weight F_g . The coefficient of static friction between the cylinder and both surfaces is 0.500. In terms of F_g , find the maximum force P that can be applied that does not cause the cylinder to rotate.

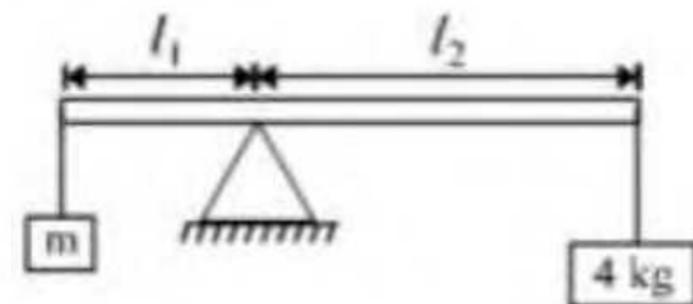
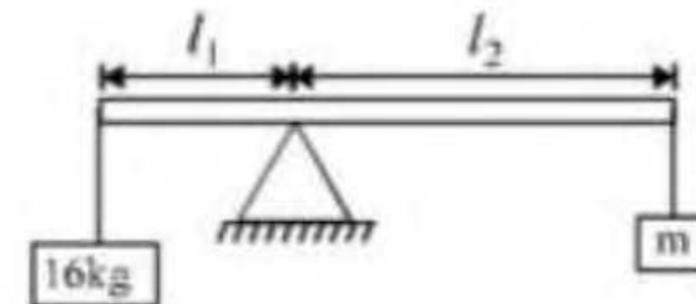
चित्र में F_g भार वाले समरूप बेलन पर एक ऊर्ध्वाधर बल स्पर्शरिखीय रूप से लगता हुआ दिखाया गया है। बेलन तथा इसकी संपर्क सतहों के मध्य स्थैतिक घर्षण गुणांक का मान 0.500 है। F_g के पदों में अधिकतम बल P का मान क्या होना चाहिये ताकि जिसे लगाये जाने पर बेलन घूर्णन नहीं करे?



Ans. $(3/8) F_g$

In an experiment with a massless beam balance an unknown mass m is balanced by two known masses of 16 kg and 4 kg as shown in figure. Find the value of the unknown mass m .

चित्रानुसार द्रव्यमानहीन छड़ संतुलन के एक प्रयोग में 16 kg तथा 4 kg के दो ज्ञात द्रव्यमानों द्वारा एक अज्ञात द्रव्यमान m को संतुलित किया जाता है। अज्ञात द्रव्यमान m का मान ज्ञात कीजिए।



Ans. 8 kg

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A 3.0 kg bobbin consists of a central cylinder of radius 5.0 cm and two end plates each of radius 6.0 cm. It is placed on a slotted incline, where friction is sufficient to prevent sliding. A block of mass 4.5 kg is suspended from a cord wound around the bobbin and passing through the slot under the incline. If the bobbin is in static equilibrium, what is the angle of tilt of the incline?

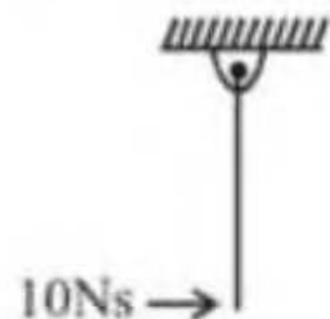
एक 3 kg की फिरकी में 5 cm त्रिज्या का एक केन्द्रीय बेलन तथा 6 cm त्रिज्या वाली दो प्लेटें हैं। इसे नत-तल के एक भाग पर रखा गया है, जहाँ फिसलन को रोकने के लिए पर्याप्त घर्षण है। एक 4.5 kg द्रव्यमान के ब्लॉक को फिरकी पर लिपट रही रस्सी पर लटकाया गया है जो कि नत-तल के छिद्र से होकर गुजर रही है। यदि फिरकी स्थैतिक साम्यावस्था में है तो नत-तल का झुकाव कोण क्या है?



Ans. 30°

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

एक पतली समरूप सीधी छड़ का द्रव्यमान 2 kg व लम्बाई 1 m है। यह विरामावस्था में है तथा अपने ऊपरी सिरे के सापेक्ष घूर्णन के लिये स्वतंत्र है। इसकी लम्बाई के लम्बवत् इसके निचले सिरे को चित्रानुसार 10 N-s का एक आवेगीय धक्का दिया जाता है। टक्कर के तुरन्त पश्चात् छड़ की गतिज ऊर्जा की गणना कीजिए।

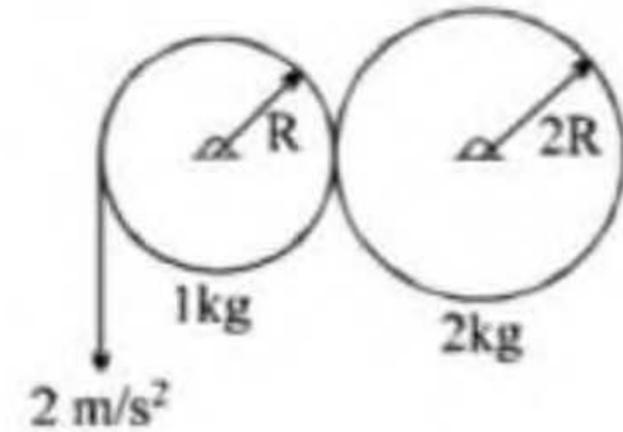


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Ans. 75 J

Two discs A and B touch each other as shown in figure. A rope tightly wound on A is pulled down at 2 m/s^2 . Find the friction force between A and B if slipping is absent

दो चकतियां A व B चित्रानुसार एक दूसरे को स्पर्श करती हैं। A पर एक रस्सी कस कर बंधी हुई है। इसे 2 m/s^2 से नीचे खींचा जाता है। यदि यहां फिसलन नहीं होती हो तो A व B के मध्य लगने वाले घर्षण बल का मान ज्ञात कीजिए।



Ans. 2N

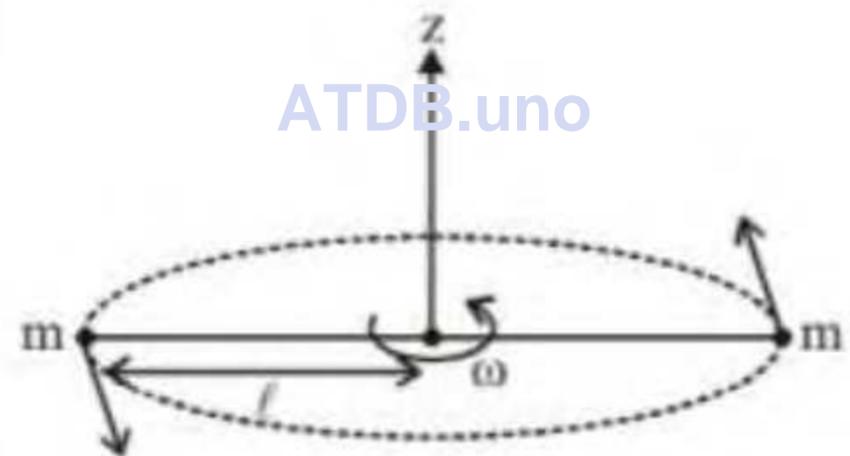
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A dumbbell consists of two identical particles of mass m connected by a rigid light rod of length $2l$. The dumbbell is set spinning with angular speed ω_0 on a surface with a small friction coefficient μ_k . If

dumbbell stops in time $t = \frac{K\omega_0 l}{2\mu g}$ where K is a constant, then find the value of K .

प्रत्येक m द्रव्यमान वाले दो एक जैसे कणों को $2l$ लम्बाई वाली एक दृढ़ हल्की छड़ द्वारा जोड़कर एक डम्बल बनाया जाता है। इस डम्बल को कोणीय चाल ω_0 से अल्प घर्षण गुणांक μ_k वाली सतह पर चक्रण कराया जाता है। यदि डम्बल समय

$t = \frac{K\omega_0 l}{2\mu g}$ पर रुक जाता है, जहाँ K एक नियतांक है, तो K का मान ज्ञात कीजिए।



Ans. 2

A solid sphere of mass m and radius R is placed on a smooth horizontal surface. A sudden blow is given horizontally to the sphere at a height $h = 4R/5$ above the centre line. If I is the impulse of the blow then find

- (a) the minimum time after which the highest point B will touch the ground
 (b) the displacement of the centre of mass during this interval.

द्रव्यमान m व त्रिज्या R का एक ठोस गोला, एक चिकनी क्षैतिज सतह पर रखा हुआ है। गोले को इसकी केन्द्र रेखा से $h = 4R/5$ ऊंचाई पर एक क्षैतिज धक्का दिया जाता है। यदि इस धक्के का आवेग I हो तो ज्ञात कीजिए।

- (a) वह न्यूनतम समय जिसके पश्चात् इसका उच्चतम बिन्दु B धरातल को स्पर्श करेगा।
 (b) इस समयान्तराल में द्रव्यमान केन्द्र का विस्थापन।

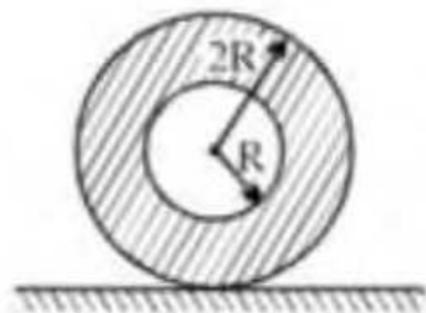
Ans. (a) $t = \frac{\pi R m}{2I}$; (b) $s = \frac{\pi R}{2}$

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A hollow cylinder with inner radius R , outer radius $2R$ and mass M is rolling with speed v of its axis.

Its kinetic energy is :-

एक M द्रव्यमान के खोखले बेलन की आंतरिक त्रिज्या R व बाहरी त्रिज्या $2R$ है। यह v चाल से लुढ़क रहा है। इसकी गतिज ऊर्जा ज्ञात कीजिए।

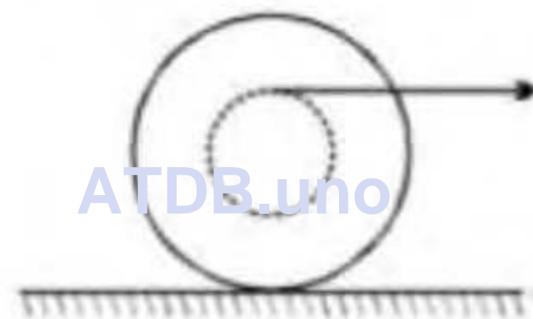


Ans. $\frac{13}{16} Mv^2$

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A spool of inner radius R and outer radius $3R$ has a moment of inertia $= MR^2$ about an axis passing through its geometric centre, where M is the mass of the spool. A thread wound on the inner surface of the spool is pulled horizontally with a constant force $= Mg$. Find the acceleration of the point on the thread which is being pulled assuming that the spool rolls purely on the floor.

एक छिद्रयुक्त चकती की आंतरिक त्रिज्या R व बाह्य त्रिज्या $3R$ है तथा इसके ज्यामितीय केन्द्र से होकर गुजरने वाली अक्ष के सापेक्ष इसका जड़त्व आघूर्ण MR^2 है, जहाँ M चकती का द्रव्यमान है। इस चकती की आंतरिक सतह से बंधे हुए धागे को नियत बल Mg से क्षैतिज रूप से खिंचा जाता है। यह मानते हुए कि चकती फर्श पर शुद्ध लौटनी गति करती है इस धागे पर स्थित उस बिन्दु का त्वरण ज्ञात कीजिये जिसे खिंचा गया था।



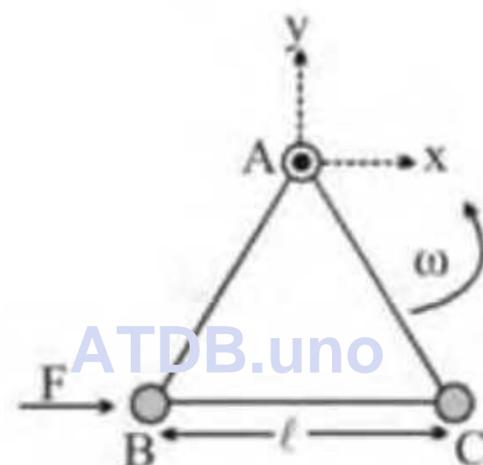
Ans. 16 m/s^2

to form a rigid, equilateral triangular body of side ℓ . This body is placed on a horizontal frictionless table (x-y plane) and is hinged to it at the point A, so that it can move without friction about the vertical axis through A (see figure). The body is set into rotational motion on the table about A with a constant angular velocity ω .

(a) Find the magnitude of the horizontal force exerted by the hinge on the body.

(b) At time T, when the side BC is parallel to the x-axis, a force F is applied on B along BC (as shown). Obtain the x-component and the y-component of the force exerted by the hinge on the body, immediately after time T.

[IIT-JEE' 2001]



तीन कण A, B व C प्रत्येक के द्रव्यमान m है। तीनों द्रव्यमानों को एक दूसरे से तीन द्रव्यमानहीन दृढ़ छड़ों के द्वारा जोड़ा जाता है ताकि ℓ लम्बाई का एक दृढ़ समबाहु त्रिभुजीय पिण्ड बन जाये। अब इस पिण्ड को एक क्षैतिज घर्षणहीन टेबल (x-y तल) पर रखकर बिन्दु A से कीलकित कर दिया जाता है ताकि यह बिन्दु A से जाने वाली उर्ध्व अक्ष के परितः बिना घर्षण के गति कर सके (देखें चित्र)। पिण्ड को टेबल पर A के परितः नियत कोणीय वेग ω से घूर्णन गति कराई जाती है।

(a) पिण्ड पर कीलक द्वारा लगाये गये क्षैतिज बल का परिमाण ज्ञात कीजिए।

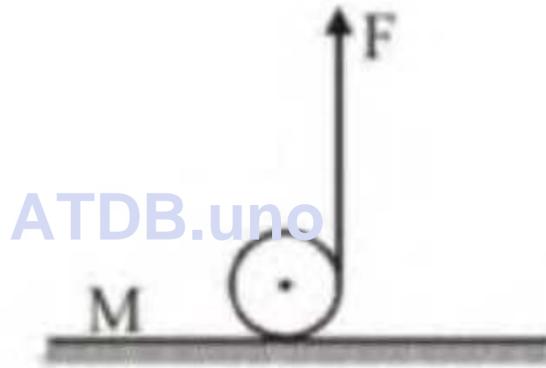
(b) T समय पर, जब भुजा BC, x अक्ष के समांतर है तो एक बल F, B पर BC के अनुदिश लगाया जाता है। (चित्र में दिखाये अनुसार) T समय के तुरन्त पश्चात् पिण्ड पर कीलक द्वारा लगाये गये बल के x व y घटक ज्ञात कीजिए।

Ans. (a) $\sqrt{3} m\omega^2$ (b) $(F_{\text{net}})_x = -\frac{F}{4}$, $(F_{\text{net}})_y = \sqrt{3} m\omega^2$



The free end of the string wound on the surface of a solid cylinder of mass M & radius r is pulled up by a force F as shown. If there is sufficient friction between cylinder & floor so that the cylinder is able to roll without slipping, find the maximum angular acceleration that the cylinder can have (without cylinder leaving contact with surface).

किसी M द्रव्यमान व r त्रिज्या के ठोस बेलन की सतह पर लिपटी रस्सी के मुक्त सिरे को बल F द्वारा चित्रानुसार ऊपर की ओर खिंचा जाता है। यदि बेलन व फर्श के मध्य इतना घर्षण विद्यमान हो कि बेलन बिना फिसले लुढ़क सकता हो तथा बेलन सतह से सम्पर्क नहीं छोड़ता हो तो बेलन का अधिकतम कोणीय त्वरण कितना हो सकता है?



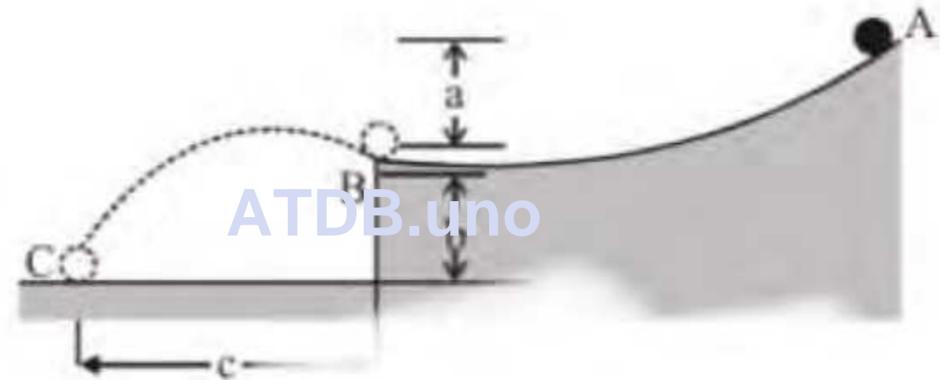
Ans. $\alpha_{\max} = \frac{2g}{3r}$

A small sphere of mass m and radius r is released from rest at A and rolls without sliding on the curved surface to point B where it leaves the surface with a horizontal velocity. Knowing that $a = 1.5$ m & $b = 1.2$ m, determine;

- the speed of the sphere as it strikes the ground at C .
- the corresponding distance c .

एक m द्रव्यमान व r त्रिज्या के छोटे गोले को बिन्दु A से विरामावस्था से छोड़ा जाता है तथा यह एक वक्रिय सतह पर लुढ़कता हुआ बिन्दु B तक जाता है जहाँ यह सतह को एक क्षैतिज वेग के साथ छोड़ देता है। यहाँ $a = 1.5$ m व $b = 1.2$ m है तो ज्ञात कीजिये :

- धरातल पर बिन्दु C पर टकराते समय गोले की चाल।
- संगत दूरी c



Ans. (a) 6.68 m/s (b) 2.27 m

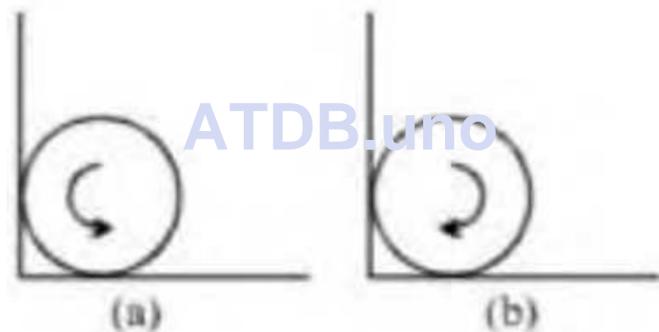
A sphere is placed rotating with its centre initially at rest in a corner as shown in figure (a) & (b).

Coefficient of friction between all surfaces and the sphere is $1/3$. Find the ratio of the frictional force $\frac{f_a}{f_b}$

by ground in situations (a) & (b).

चित्र (a) तथा (b) में प्रदर्शित कोनों में गोले का केन्द्र प्रारम्भ में विरामावस्था में है तथा गोला घूम रहा है। सभी सतहों तथा गोले

के मध्य घर्षण गुणांक $1/3$ है। (a) तथा (b) स्थितियों में जमीन द्वारा घर्षण बल $\frac{f_a}{f_b}$ का अनुपात होगा-



(A) 1

(B) $\frac{9}{10}$

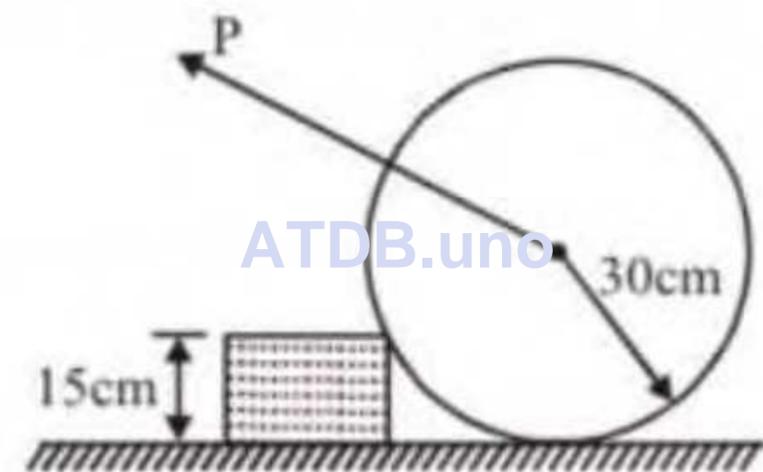
(C) $\frac{10}{9}$

(D) none

Ans. (B)

In the given figure a uniform wheel of radius 30cm rests against a rigid rectangular block 15cm high. The wheel weighs 1000 N. The minimum pull P through the center which will turn the wheel over the block is :-

प्रदर्शित चित्र में 30cm त्रिज्या वाला एक समरूप पहिया 15cm ऊँचे एक दृढ़ आयताकार ब्लॉक के सहारे रखा हुआ है। पहिये का भार 1000 N है। इसके केन्द्र पर कितना न्यूनतम बल P लगाकर खिंचा जाए ताकि पहिया इस ब्लॉक को पार कर जाए :-



(A) $500\sqrt{3}$ N

(B) $1000\sqrt{3}$ N

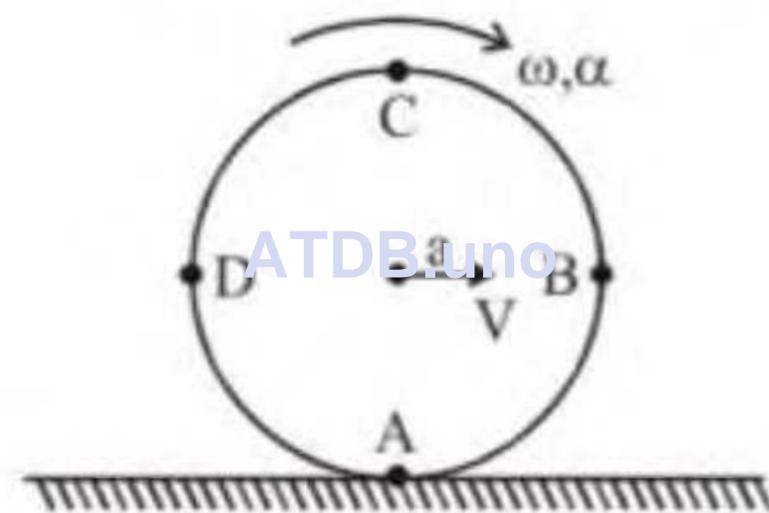
(C) 1000 N

(D) $400\sqrt{3}$ N

Ans. (A)

A circular disc of radius R rolls without slipping on a rough horizontal surface. At the instant shown its linear velocity is V , linear acceleration a , angular velocity ω and angular acceleration α . Four points A, B, C and D lie on its circumference such that the diameter AC is vertical & BD horizontal then choose the **CORRECT** option(s).

त्रिज्या R वाली एक वृत्ताकार चकती खुरदरी क्षैतिज सतह पर बिना फिसले लुढ़कती है। इस क्षण इसका रेखीय वेग V , रेखीय त्वरण a , कोणीय वेग ω तथा कोणीय त्वरण α है। इसकी परिधी पर चार बिन्दु A, B, C तथा D इस प्रकार स्थित है कि व्यास AC ऊर्ध्वाधर तथा BD क्षैतिज है। सही कथन/कथनों को चुनिये:-



$$(A) V_B = \sqrt{V^2 + (R\omega)^2}$$

$$(B) V_C = V + R\omega$$

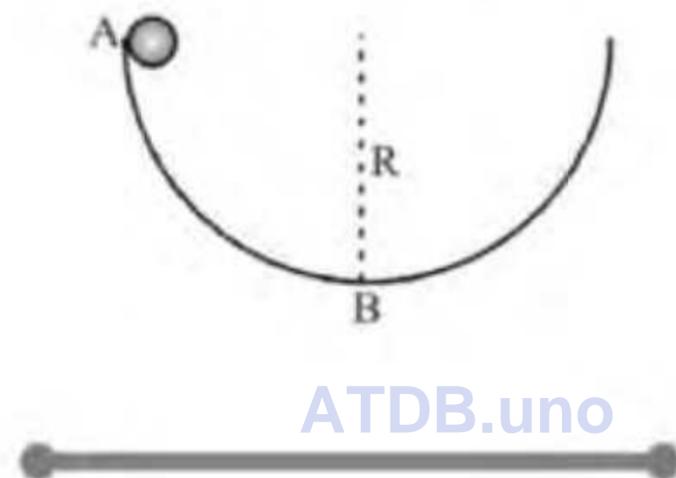
$$(C) a_A = \sqrt{(a - R\alpha)^2 + (\omega^2 R)^2}$$

$$(D) a_D = \sqrt{(a + \omega^2 R)^2 + (R\alpha)^2}$$

Ans. (A,B,C,D)

1. A small sphere A of mass m and radius r rolls without slipping inside a large fixed hemispherical bowl of radius R ($\gg r$) as shown in figure. If the sphere starts from rest at the top point of the hemisphere find the normal force exerted by the small sphere on the hemisphere when it is at the bottom B of the hemisphere.

एक छोटे गोले A का द्रव्यमान m व त्रिज्या r है। यह चित्रानुसार R ($\gg r$) त्रिज्या वाले एक बड़े स्थिर अर्द्धगोलाकार प्याले के अन्दर बिना फिसले लुढ़कता है। जब गोला, प्याले के उच्चतम बिन्दु से विरामावस्था से गति प्रारम्भ कर इस प्याले के पैंदे B पर पहुंचता है तो उस क्षण छोटे गोले द्वारा, प्याले पर लगाया गया अभिलम्ब बल होगा :-



(A) $\frac{10}{7} mg$

(B) $\frac{17}{7} mg$

(C) $\frac{5}{7} mg$

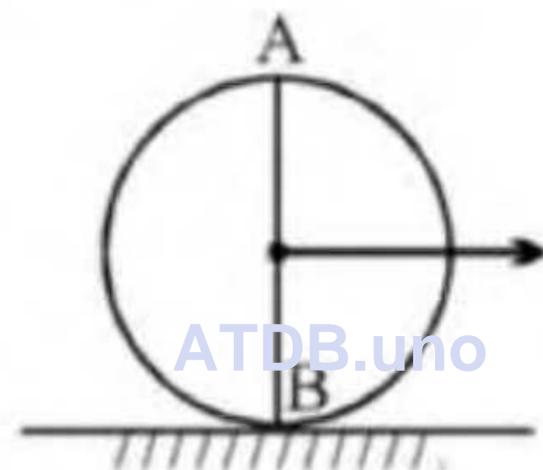
(D) $\frac{7}{5} mg$

Ans. (B)



A uniform disc is rolling on a horizontal surface. At a certain instant B is the point of contact and A is at height $2R$ from ground, where R is radius of disc.

- (A) The magnitude of the angular momentum of the disc about B is thrice that about A.
- (B) The angular momentum of the disc about A is anticlockwise.
- (C) The angular momentum of the disc about B is clockwise
- (D) The angular momentum of the disc about A is equal to that about B.



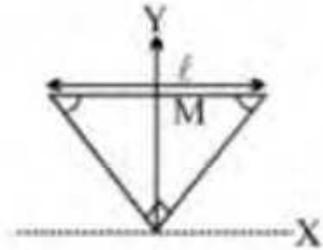
एक समरूप चकती एक क्षैतिज सतह पर लुढ़क रही है। किसी निश्चित क्षण पर, B सम्पर्क बिन्दु है तथा A जमीन से $2R$ ऊँचाई पर है जहाँ R चकती की त्रिज्या है तो

- (A) B के सापेक्ष चकती के कोणीय संवेग का परिमाण, A की अपेक्षा तिगुना है
- (B) A के सापेक्ष चकती का कोणीय संवेग वामावर्त दिशा में है
- (C) B के सापेक्ष चकती का कोणीय संवेग दक्षिणावर्त दिशा में है
- (D) A के सापेक्ष चकती का कोणीय संवेग B के बराबर है

Ans. (A,B,C)

The apex lies at the origin and the base is parallel to X-axis

चित्र में M द्रव्यमान तथा L आधार लम्बाई वाली एक समद्विबाहु त्रिभुजाकार प्लेट को दर्शाया गया है। इसका शीर्ष कोण 90° है। शीर्ष मूलबिन्दु पर है तथा आधार, X-अक्ष के समान्तर है।



The moment of inertia of the plate about the z-axis is :-
z-अक्ष के सापेक्ष प्लेट का जड़त्व आघूर्ण है

- (A) $\frac{ML^2}{12}$ (B) $\frac{ML^2}{24}$ (C) $\frac{ML^2}{6}$ (D) none of these

Ans. (C)

The moment of inertia of the plate about the x-axis is :-
x-अक्ष के सापेक्ष प्लेट का जड़त्व आघूर्ण है

- (A) $\frac{ML^2}{8}$ (B) $\frac{ML^2}{32}$ (C) $\frac{ML^2}{24}$ (D) $\frac{ML^2}{6}$

Ans. (A)

The moment of inertia of the plate about its base parallel to the x-axis is :-
x-अक्ष के समान्तर इसके आधार के सापेक्ष प्लेट का जड़त्व आघूर्ण है

- (A) $\frac{ML^2}{18}$ (B) $\frac{ML^2}{36}$ (C) $\frac{ML^2}{24}$ (D) none of these

Ans. (C)

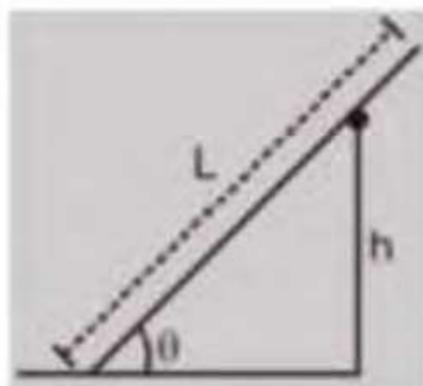
The moment of inertia of the plate about the y-axis is :-
y-अक्ष के सापेक्ष प्लेट का जड़त्व आघूर्ण है

- (A) $\frac{ML^2}{6}$ (B) $\frac{ML^2}{8}$ (C) $\frac{ML^2}{24}$ (D) none of these

Ans. (C)



A uniform rod of length L rests against a smooth roller as shown in figure. Find the friction coefficient between the ground and the lower end if the minimum angle that the rod can make with the horizontal is θ .



(A)
$$\frac{L \cos^2 \theta \sin \theta}{2h - L \cos^2 \theta \sin \theta}$$

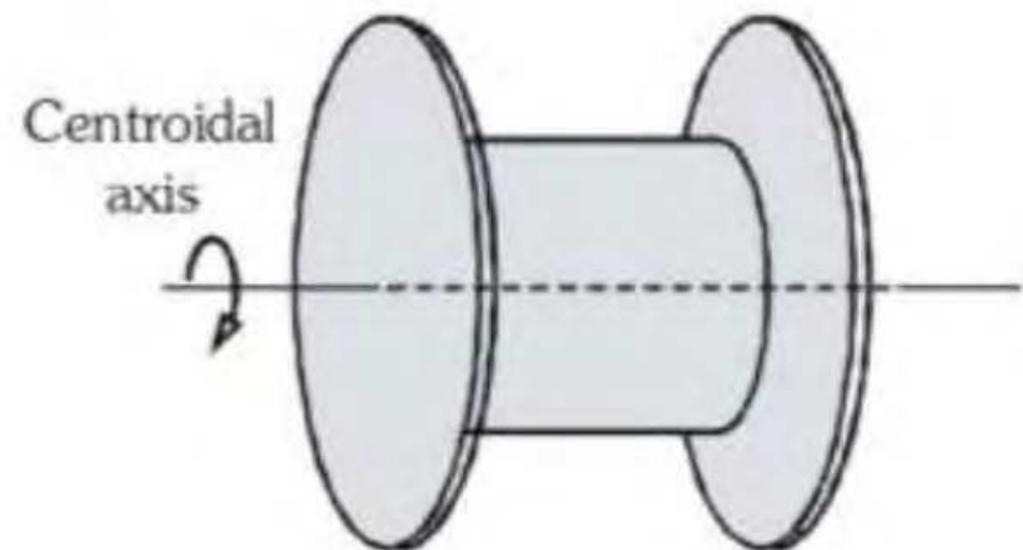
(C)
$$\frac{2L \cos \theta \sin^2 \theta}{2h - L \cos^2 \theta \sin \theta}$$

(B)
$$\frac{L \cos \theta \sin \theta}{2h - L \cos^2 \theta \sin \theta}$$

(D)
$$\frac{L \cos \theta \sin^2 \theta}{2h - L \cos^2 \theta \sin \theta}$$

Ans. (D)

Find moment of inertia about centroidal axis of a bobbin, which is constructed by joining coaxially two identical discs each of mass m and radius $2r$ to a cylinder of mass m and radius r as shown in the figure.



(A) $\frac{9}{2}mr^2$

(B) $\frac{5}{2}mr^2$

(C) $\frac{3}{2}mr^2$

(D) $\frac{7}{2}mr^2$

Ans. (A)

Find moment of inertia of a solid hemisphere of mass M shown in figure, about an axis AA' passing through its centre of mass.

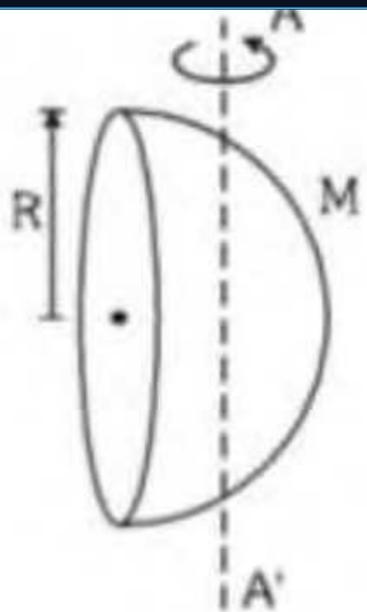
(A) $\frac{19}{320}MR^2$

(B) $\frac{21}{320}MR^2$

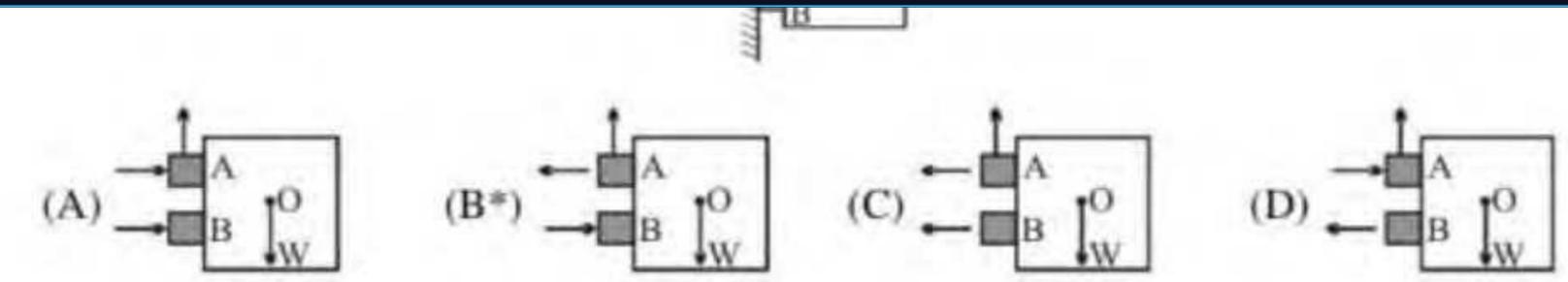
(C) $\frac{83}{320}MR^2$

(D) $\frac{1}{20}MR^2$

Ans. (C)



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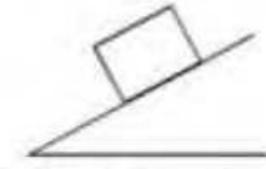


Ans. (B)

Sol. Forces will be such that door will be in rotational as well as translational equilibrium

A homogeneous cubical brick lies motionless on a rough inclined surface. The half which applies greater pressure on the plane is :

- (A) left half
- (B) right half
- (C) both applies equal pressure
- (D) the answer depend upon coefficient



एक समरूप घनाकार ईंट, खुरदरे नततल पर गिराई न अथवा गिरती है। इस ईंट का कौनसा आधा भाग तल पर लगायेगा ?

- (A) बाँया आधा भाग
- (B) दाँया आधा भाग
- (C) दोनों बराबर दाब लगाते हैं।
- (D) यह घर्षण गुणांक पर निर्भर करता है।

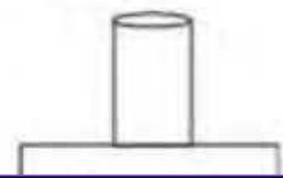
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Ans. (A)

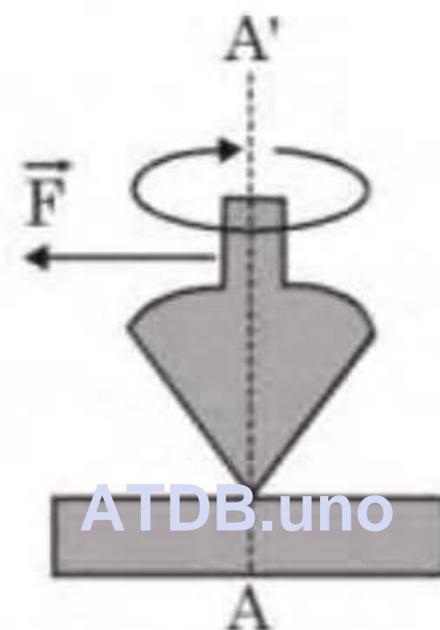
Sol. To balance torque due to friction, normal force will be more in left half of the block

A uniform 2 kg cylinder rests on a laboratory cart as shown. The coefficient of static friction between the cylinder and the cart is 0.5. If the cylinder is 4 cm in diameter and 10 cm in height, which of the following is closest to the maximum acceleration of the cart such that cylinder neither slips nor tips over?

एक 2 kg द्रव्यमान का समरूप बेलन एक गाड़ी पर चित्रानुसार रखा हुआ है। बेलन तथा गाड़ी के मध्य स्थैतिक घर्षण का मान 0.5 है। यदि बेलन का व्यास 4 cm व ऊँचाई 10 cm हो तो बेलन ना तो पलटे ना ही फिसले इसके लिये गाड़ी का अधिकतम त्वरण निम्न में से लगभग किसके बराबर होगा ?



to rotate about the stationary axis AA^1 . A string wrapped around a peg along the axis of the top is pulled in such a manner as to maintain a constant tension of 5.57N . If the string does not slip while it is unwound from the peg, what is the angular speed of the top after 80.0cm of string has been pulled off the peg.



(A) 30 rad/s

(B) 142 rad/s

(C) 149 rad/s

(D) 120 rad/s

Ans. (C)

Sol. Work done by force

$$W = FS = 5.57 \times 0.8$$

$$W = 4.456\text{ J}$$

$$W = \frac{1}{2}I\omega^2$$

$$\therefore \omega = 149\text{ rad/sec}$$

An equilateral triangle ABC formed from a uniform wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO. Then the beads are released from rest simultaneously and allowed to slide down, one along AB and the other along AC as shown. Neglecting frictional effects, the quantities that are conserved as the beads slide down, are

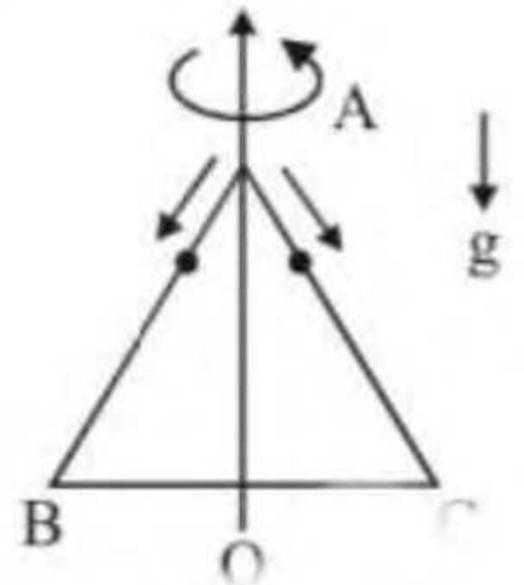
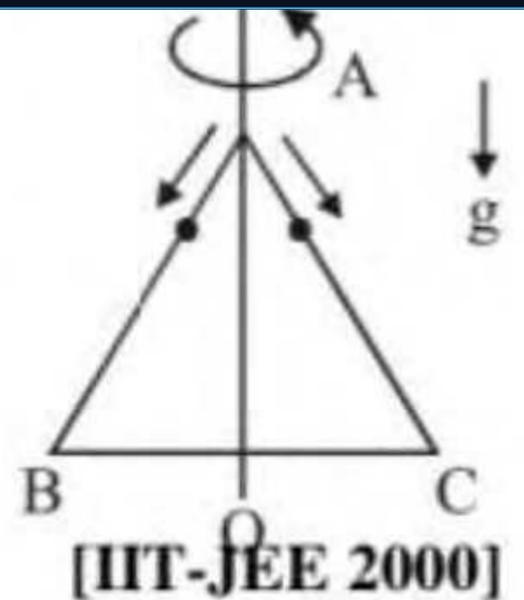
- (A) Angular velocity and total energy (kinetic and potential)
- (B) Total angular momentum and total energy
- (C) Angular velocity and moment of inertia about the axis of rotation.
- (D) Total angular momentum and moment of inertia about the axis of rotation.

एक समबाहु त्रिभुज ABC एक समान तार से बना हुआ है। जिस पर दो छोटे एक समान मनके प्रारम्भ में A पर स्थित हैं। त्रिभुज को उर्ध्व अक्ष AO के परितः घूर्णन करवाया जाता है। जिससे मनके एक साथ विरामावस्था से मुक्त होते हैं और एक मनका AB के अनुदिश एवं दूसरा AC के अनुदिश फिसलना शुरू होते हैं। घर्षण प्रभावों को नगण्य मानते हुए जब मनके फिसलने लगते हैं तो कौनसी राशियाँ संरक्षित रहती हैं

- (A) कोणीय वेग और कुल ऊर्जा (गतिज और स्थितिज ऊर्जा)
- (B) कुल कोणीय संवेग और कुल ऊर्जा
- (C) घूर्णन अक्ष के सापेक्ष कोणीय वेग और जड़त्व आघूर्ण
- (D) घूर्णन अक्ष के सापेक्ष कुल कोणीय संवेग और जड़त्व आघूर्ण

Ans. (B)

Sol. Angular momentum remains conserved as net external torque = 0



elastic. About which of the points will the angular momentum of disc be conserved.

(A) only the Point of collision

(B) Any point on the normal to the wall drawn from the point of collision.

(C) The angular momentum is not conserved about any point.

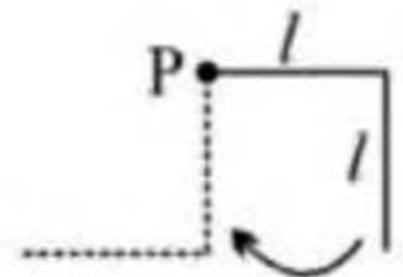
(D) The angular momentum is conserved about all the points in space

Ans. (B)

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An L shaped thin uniform rod of total length $2l$ is free to rotate in a vertical plane about a horizontal axis at P as shown in the figure. The bar is released from rest. Neglect air and contact friction. The angular velocity at the instant it has rotated through 90° and reached the dotted position shown is

एक L आकृति तथा कुल लम्बाई $2l$ वाली समरूप पतली छड़ चित्रानुसार ऊर्ध्वाधर तल में क्षैतिज अक्ष के सापेक्ष बिन्दु P पर घूर्णन करने के लिये स्वतंत्र है। छड़ को विरामावस्था से छोड़ा जाता है। वायु तथा संपर्कघर्षण को नगण्य मानिये। जब यह छड़ 90° कोण पर घूमकर दर्शाये गई बिन्दुकित् स्थिति तक पहुंचती है, उस क्षण छड़ का कोणीय वेग होगा



(A) zero

(B*) $\sqrt{\frac{6g}{5l}}$

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

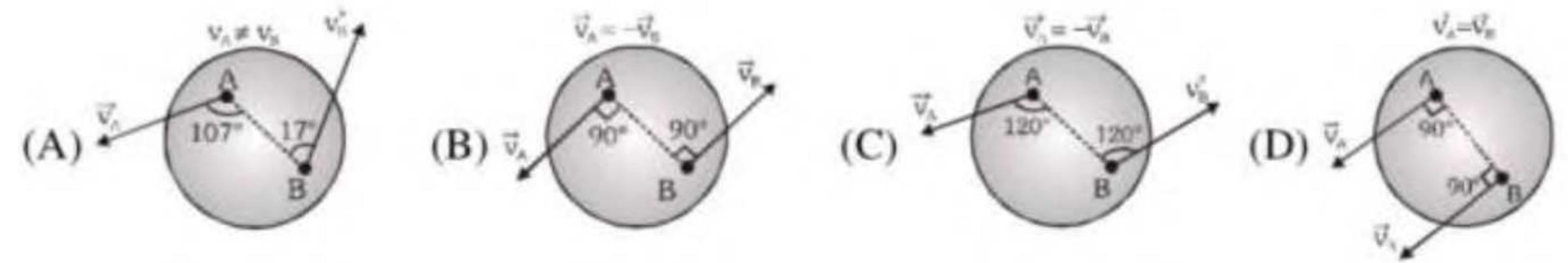
(D) none

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Ans. (B)

A lamina rigid body is confined to move in its own plane. At some instant velocities of any two points on the body are shown in following figures. Which one of the following physical situation cannot be possible?

एक झिल्लीनुमा दृढ़ वस्तु इसके स्वयं के तल में ही गति करती है। किसी क्षण वस्तु पर किन्हीं दो बिन्दुओं के वेगों को चित्र में दर्शाया गया है। निम्न में से कौनसी भौतिक स्थिति संभव नहीं हो सकती है ?

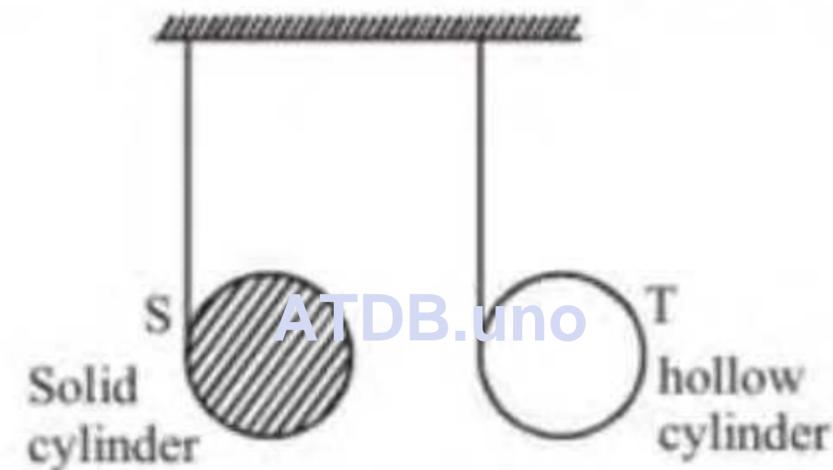


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Ans. (C)

A solid cylinder S and a hollow cylinder T of same mass and same outer radius have a thin thread wound over them. One end of each thread is fixed to the same ceiling. They are initially held at rest with their axis horizontal and parallel to each other, at same height above ground. If the cylinders are released simultaneously with strings taut then the correct statement is :

- (A) S will reach ground earlier than T
- (B) T will reach ground earlier than S
- (C) Both will reach ground together
- (D) For small height S will reach earlier and for large height T will reach earlier.

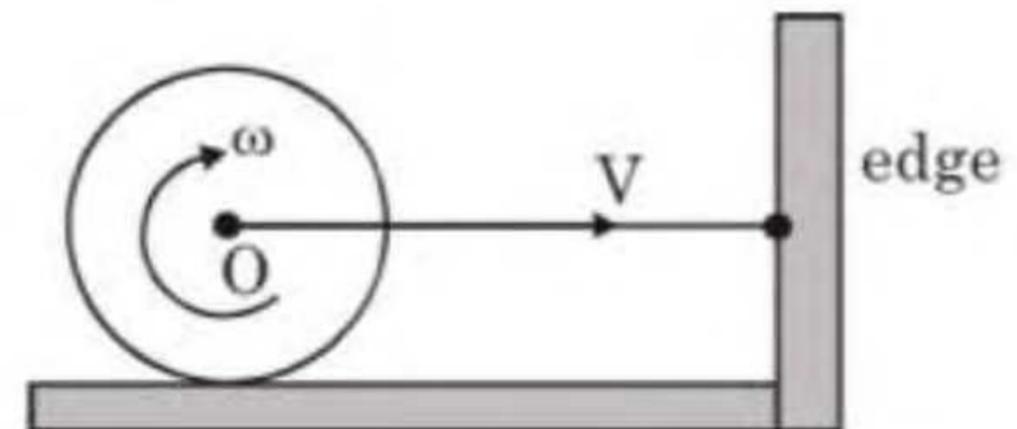


समान द्रव्यमान तथा समान बाह्य त्रिज्या वाले एक ठोस बेलन S तथा एक खोखले बेलन T पर एक पतला धागा चित्रानुसार लिपटा हुआ है। प्रत्येक धागे का एक सिरा छत से बँधा हुआ है। ये प्रारम्भ में धरातल से समान ऊँचाई पर एक-दूसरे के समान्तर विरामावस्था में हैं तथा इनकी अक्ष क्षैतिज है। यदि बेलनो को एकसाथ छोड़ा जाये तथा इनकी रस्सियाँ तनी हुई रहे तो सही कथन चुनिये:-

- (A) S, T की तुलना में धरातल पर पहले पहुँचेगा।
- (B) T, S की तुलना में धरातल पर पहले पहुँचेगा।
- (C) दोनों धरातल पर एकसाथ पहुँचेंगे।
- (D) अल्प ऊँचाई होने पर S तथा अधिक ऊँचाई होने पर T पहले पहुँचेगा।

Ans. (A)

A uniform solid sphere of radius r is rolling on a smooth horizontal surface with velocity v and angular velocity $\omega = (v = \omega r)$. The sphere collides with a sharp edge on the wall as shown in figure. The coefficient of friction between the sphere and the edge $\mu = 1/5$. Just after the collision the angular velocity of the sphere becomes equal to zero. The linear velocity of the sphere just after the collision is equal to



(A) v

(B) $\frac{v}{5}$

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

(D) $\frac{v}{6}$

Ans. (A)

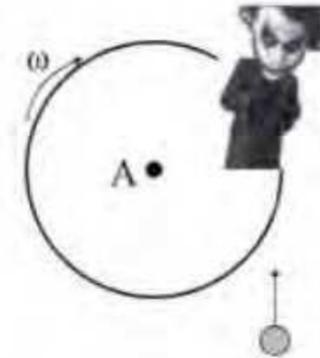
Ans. (A) ST (B) R (C) PRT (D) PQ

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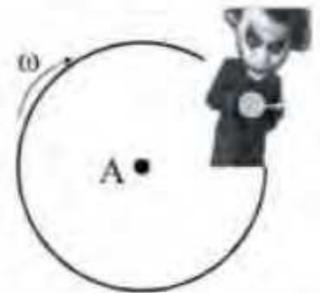
changes in various parameters of systems immediately after the events taking place in column-I.

Column-I

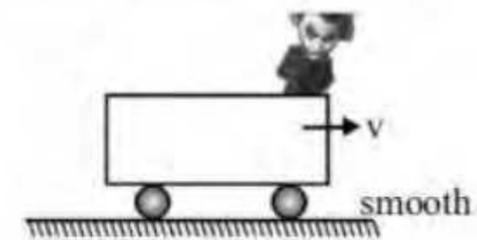
- (A) Joker is standing on revolving platform and batman throws the ball and joker catches the ball while it was moving horizontally,



- (B) Joker, ball and platform is system. Joker throws the ball horizontally and perpendicular to his motion while standing on the revolving platform.



- (C) Joker, ball and platform is system. Joker jumps horizontally towards right from the cart which is moving at speed v on smooth horizontal floor.



- (D) Joker and cart is the system. Joker drops himself vertically from the moving cart with no horizontal velocity relative

Column-II

- (P) Linear momentum remains conserved.

- (Q) Mechanical energy is conserved

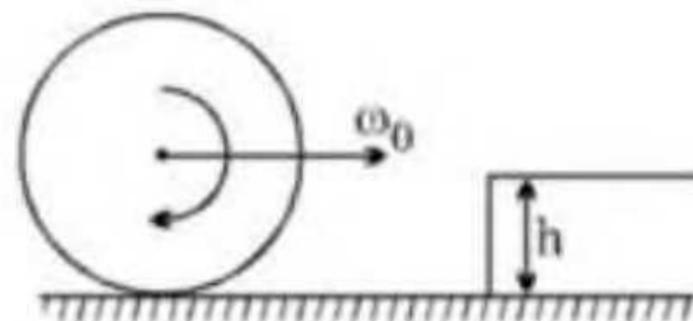
- (R) Mechanical energy increases.

- (S) Mechanical energy decreases.

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A solid uniform sphere of radius R and mass M rolls without slipping with angular velocity ω_0 when it encounters a step of height $0.4 R$. Find the angular velocity immediately after inelastic impact with the rough step.



(A) $\frac{5\omega_0}{7}$

(B) $\frac{3\omega_0}{7}$

(C) $\frac{2\omega_0}{7}$

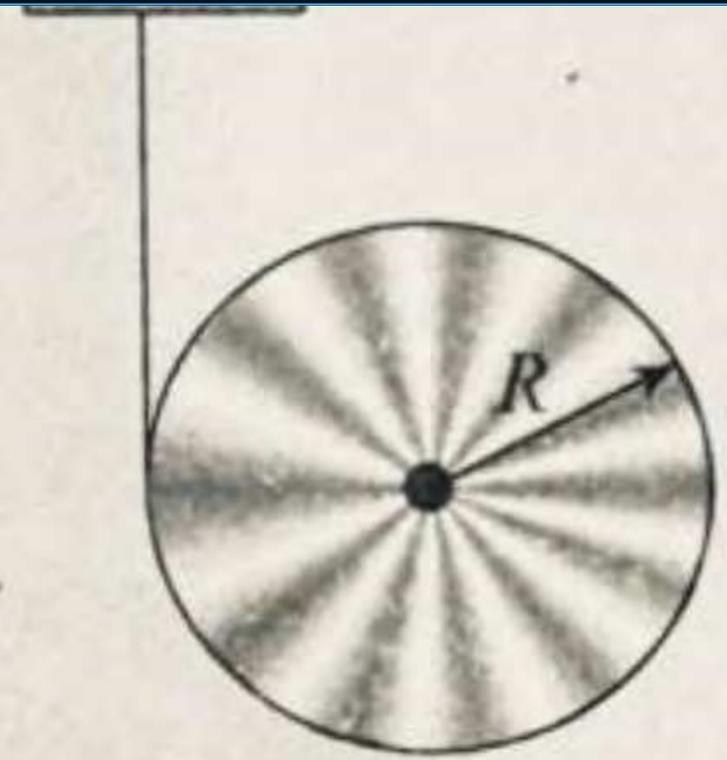
(D) $\frac{\omega_0}{7}$

Ans. (A)

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A uniform disc of mass M has a thin string wrapped several times around its circumference. The string is fixed at one end and the disc is released. Determine the magnitude of the downward acceleration of the mass as it falls.

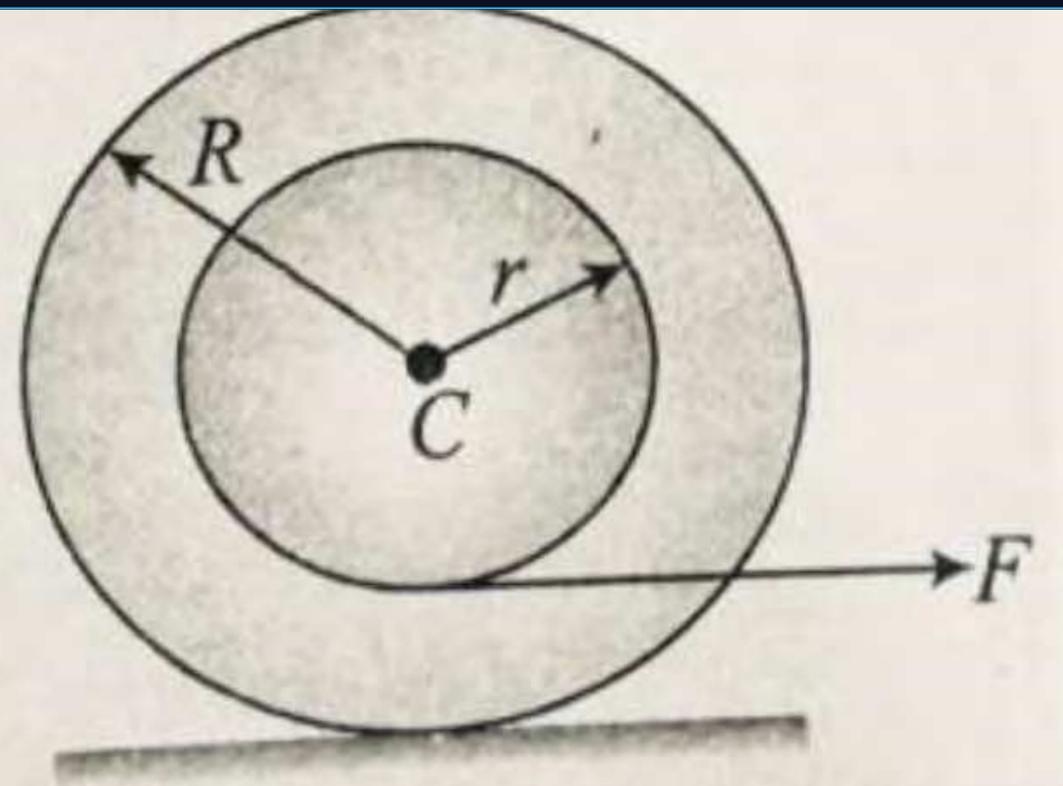
Ans $a = \frac{2g}{3}$



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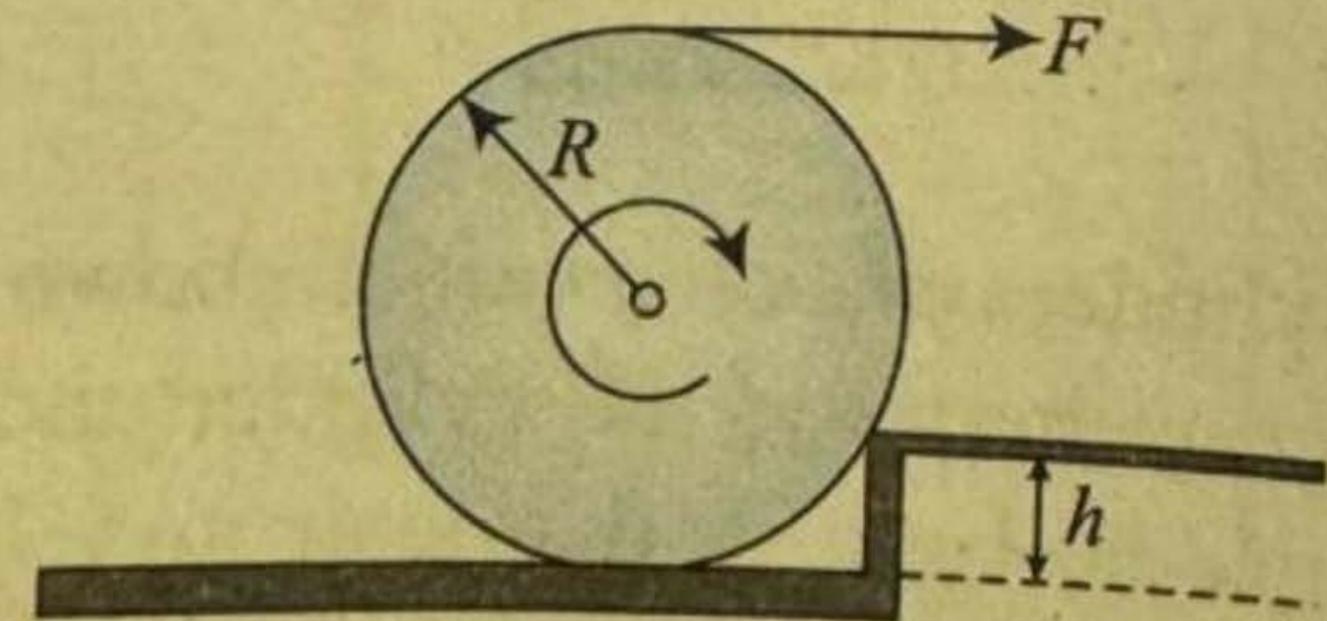
A stepped disc of mass m inner and outer radius r and R respectively is placed on a smooth horizontal surface. It is wrapped by a thread which is pulled by a horizontal force F . If the radius of gyration of the disc is k , find:

- the acceleration of CM of the disc
- the angular acceleration of the disc.



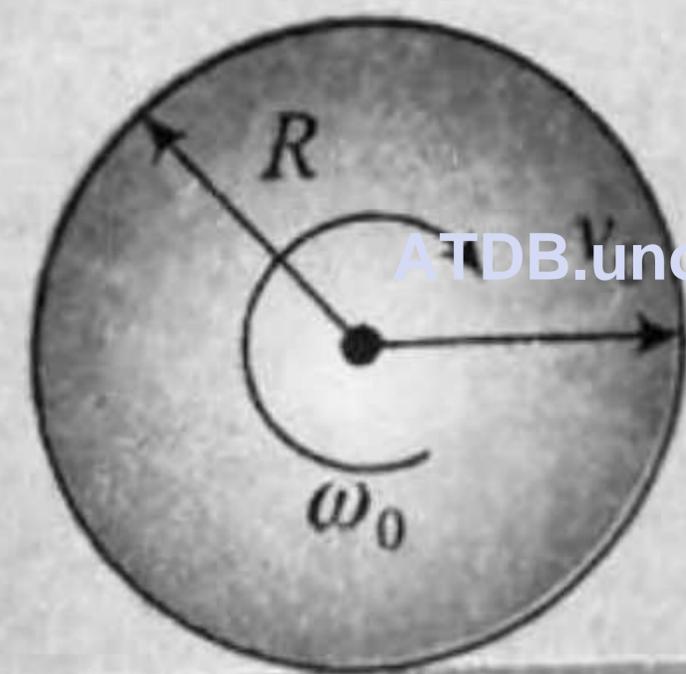
$$\alpha = \frac{F \cdot r}{m k^2}$$

A cylinder of mass 15 kg and radius R is to be raised onto a horizontal step of height $h = \frac{R}{5}$ as shown in figure. A rope is wrapped around the cylinder and pulled horizontally with force F . Assuming the cylinder does not slip on the step, find the minimum force F (in N) necessary to raise the cylinder.

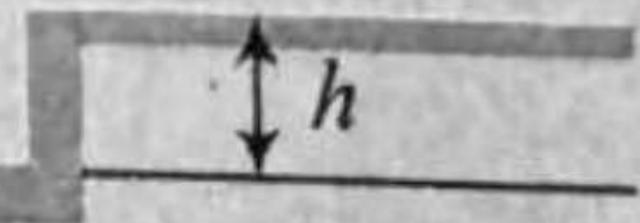


Ans 50

A uniform solid sphere of radius R is rolling without sliding on a horizontal surface with a velocity v_0 . It collides with an obstacle of height h ($< R$) inelastically. Find the angular speed of the sphere just after the collision.



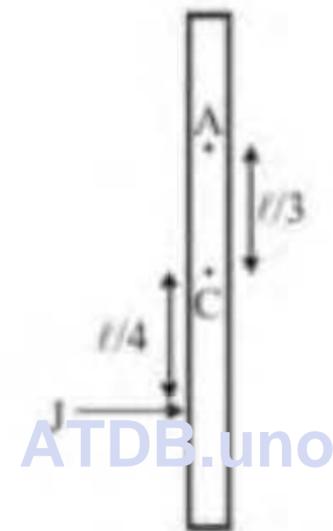
Ans $\rightarrow \left(1 - \frac{5h}{7R}\right) \frac{v_0}{R}$



A uniform rod of mass m and length ℓ is placed in gravity free space and linear impulse J is given to the rod at a distance $x = \ell/4$ from centre 'C' and perpendicular to the rod. Point A is at a distance $\ell/3$ from centre as shown in the figure. Then find

- (i) Speed of centre of rod
 (iii) Speed of upper end of rod

- (ii) Speed of point A
 (iv) Speed of lower end of rod



द्रव्यमान m तथा लम्बाई ℓ वाली एकसमान छड़ को गुरुत्वविहीन समष्टि में रखा गया है। छड़ के लम्बवत् तथा केन्द्र C से $x = \ell/4$ दूरी पर छड़ को रेखीय आवेग J प्रदान किया जाता है। बिन्दु A चित्रानुसार केन्द्र से $\ell/3$ दूरी पर है तो ज्ञात कीजिए

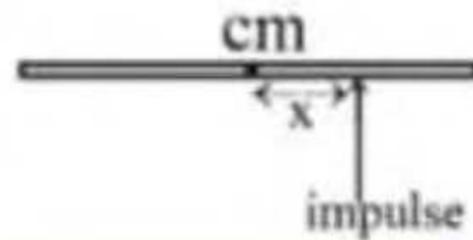
- (i) छड़ के केन्द्र की चाल
 (iii) छड़ के ऊपरी सिरे की चाल

- (ii) बिन्दु A की चाल
 (iv) छड़ के निचले सिरे की चाल

Ans. (i) $\frac{J}{m}$ (ii) zero (iii) $\frac{J}{2m}$ (iv) $\frac{5}{2} \frac{J}{m}$

A uniform rod of length l is given an impulse at right angle to its length as shown. Find the distance of instantaneous centre of rotation from the centre of the rod.

एक l लम्बाई की समरूप छड़ पर इसकी लम्बाई के लम्बवत् चित्रानुसार एक आवेग लगाया जाता है। छड़ के केन्द्र से तात्क्षणिक घूर्णन केन्द्र की दूरी ज्ञात कीजिए।



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A solid sphere is set into motion on a rough horizontal surface with a linear speed v in the forward direction and an angular speed v/R in the anticlockwise direction as shown in figure (10-E16). Find the linear speed of the sphere (a) when it stops rotating and (b) when slipping finally ceases and pure rolling starts.

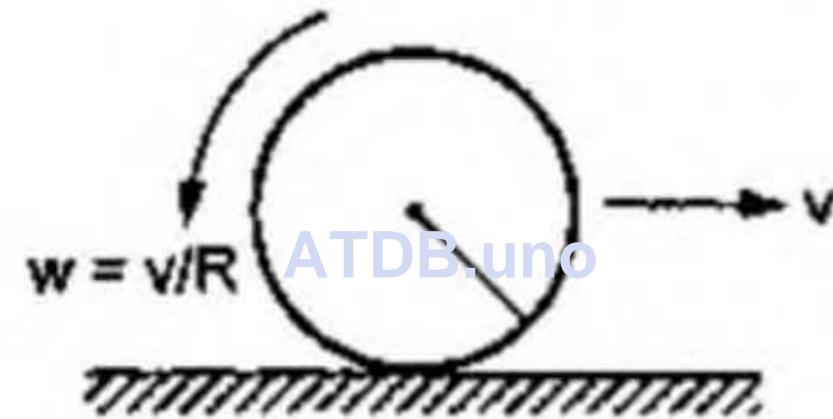


Figure 10-E16

A solid sphere rolling on a rough horizontal surface with a linear speed v collides elastically with a fixed, smooth, vertical wall. Find the speed of the sphere after it has started pure rolling in the backward direction.



A solid sphere of mass 0.50 kg is kept on a horizontal surface. The coefficient of static friction between the surfaces in contact is $2/7$. What maximum force can be applied at the highest point in the horizontal direction so that the sphere does not slip on the surface?

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A hollow sphere of radius R lies on a smooth horizontal surface. It is pulled by a horizontal force, acting tangentially from the highest point. Find the distance travelled by the sphere during the time it makes one full rotation.

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A thin spherical shell lying on a rough horizontal surface is hit by a cue in such a way that the line of action passes through the centre of the shell. As a result, the shell starts moving with a linear speed v without any initial angular velocity. Find the linear speed of the shell after it starts pure rolling on the surface.

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A uniform wheel of radius R is set into rotation about its axis at an angular speed ω . This rotating wheel is now placed on a rough horizontal surface with its axis horizontal. Because of friction at the contact, the wheel accelerates forward and its rotation decelerates till the wheel starts pure rolling on the surface. Find the linear speed of the wheel after it starts pure rolling.

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Figure (10-E14) shows a rough track, a portion of which is in the form of a cylinder of radius R . With what minimum linear speed should a sphere of radius r be set rolling on the horizontal part so that it completely goes round the circle on the cylindrical part.



Figure 10-E14

A hollow sphere is released from the top of an inclined plane of inclination θ . (a) What should be the minimum coefficient of friction between the sphere and the plane to prevent sliding? (b) Find the kinetic energy of the ball as it moves down a length l on the incline if the friction coefficient is half the value calculated in part (a).

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A sphere starts rolling down an incline of inclination θ .
Find the speed of its centre when it has covered a
distance l .

82.

70. A hollow sphere is released from the top of an inclined

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A small spherical ball is released from a point at a height h on a rough track shown in figure (10-E13). Assuming that it does not slip anywhere, find its linear speed when it rolls on the horizontal part of the track.



Figure 10-E13

A small disc is set rolling with a speed v on the horizontal part of the track of the previous problem from right to left. To what height will it climb up the curved part?

A cylinder rolls on a horizontal plane surface. If the speed of the centre is 25 m/s, what is the speed of the highest point?

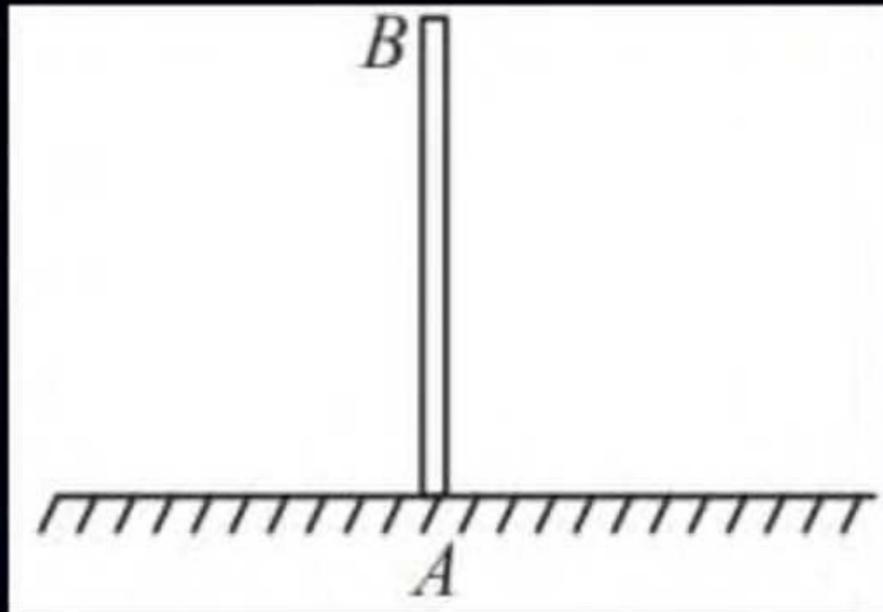


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QUESTION



A uniform rod AB of length L and mass m is held vertically on smooth horizontal surface. At $t = 0$, it is slightly disturbed so that it starts slipping on the smooth surface. Find the angular velocity ω and velocity v_0 of center of mass when rod makes an angle θ with the horizontal.



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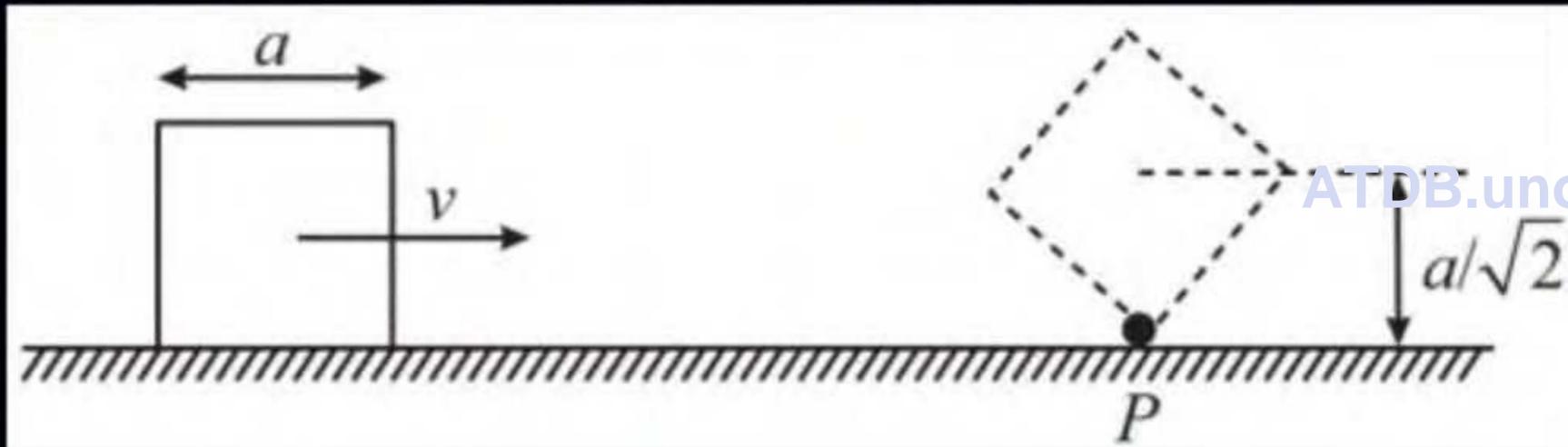
Ans.

$$= \sqrt{\frac{12(1 - \sin \theta)gL}{1 + 3 \cos^2 \theta}} \frac{\cos \theta}{2}$$

QUESTION



A cube of side length a moves on smooth horizontal surface (see fig.). At point P , it collides inelastically with a small obstacle. As a result it starts rotating about it. Find the minimum velocity v that should be imparted to the block so that it topples over.



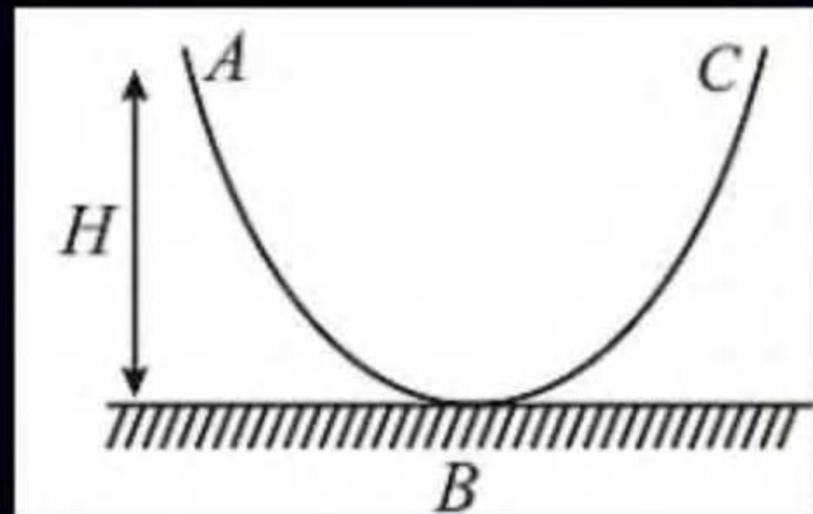
Ans.

$$v = \sqrt{\frac{8}{3}ga(\sqrt{2}-1)}$$

QUESTION



A sphere of mass m and radius r is released from rest at point A on a track in vertical plane. The track is rough enough to support rolling between A and B and from B onwards it is smooth. The maximum height attained by sphere from ground on its journey from B onwards is



- (a) H
- (b) $\frac{5}{7}H$
- (c) $\frac{2}{5}H$
- (d) $\frac{2}{7}H$

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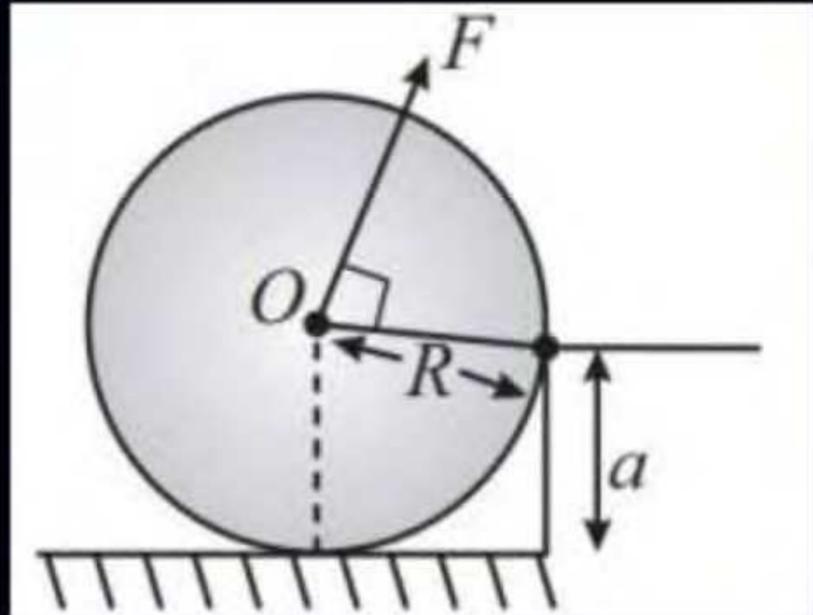
Ans. (b)

QUESTION

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

(a) $Mg\sqrt{1-\left(\frac{R-a}{R}\right)^2}$ (b) $Mg\sqrt{\left(\frac{R}{R-a}\right)^2-1}$

(c) $Mg\sqrt{1-\frac{a^2}{R^2}}$ (d) $Mg\frac{a}{R}$

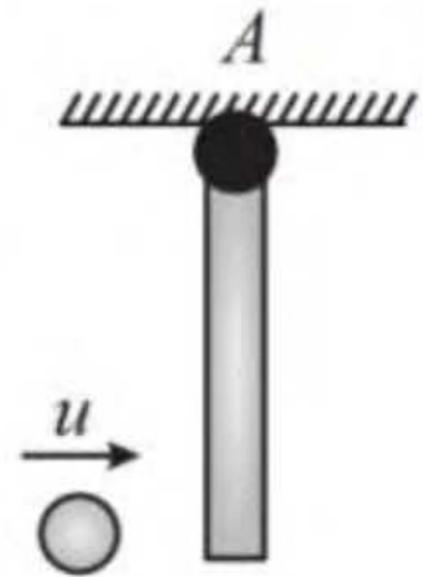


Ans. (a)

QUESTION



In the given figure a ball strikes a rod elastically and rod is hinged at point A . Then which of the statement(s) is/are correct for the collision?



- (a) Linear momentum of system (ball + rod) is conserved
- (b) Angular momentum of system about hinged point A is conserved
- (c) Initial KE of the system is equal to final KE of the system
- (d) Linear momentum of ball is conserved.

Ans. (b, c)

QUESTION

A particle falls freely near the surface of the earth. Consider a fixed point O (not vertically below the particle) on the ground.

- (a) Angular momentum of the particle about O is increasing
- (b) Torque of the gravitational force on the particle about O is decreasing
- (c) The moment of inertia of the particle about O is decreasing
- (d) The angular velocity of the particle about O is increasing

Ans. (a, c, d)

QUESTION



A ring rolls without slipping on the ground. Its centre C moves with a constant speed u . P is any point on the ring. The speed of P with respect to the ground is v .

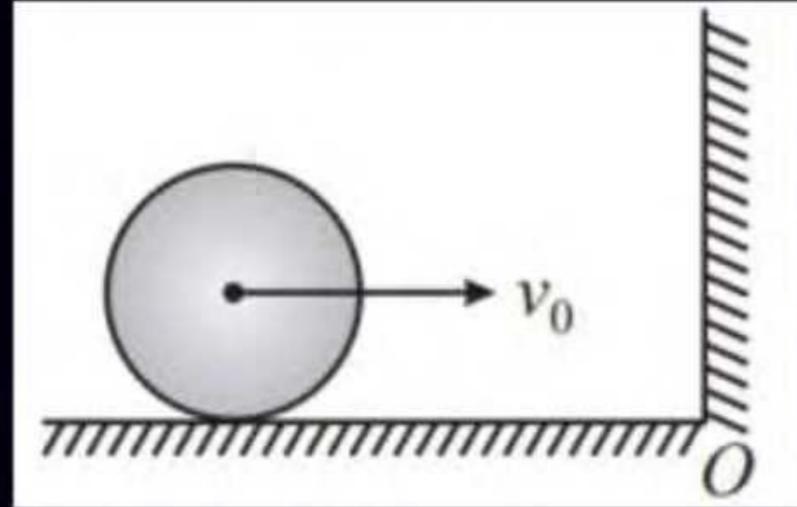
- (a) $0 \leq v \leq 2u$
- (b) $v = u$, if CP is horizontal
- (c) $v = u$, if CP makes an angle of 30° with the horizontal and P is below the horizontal level of C
- (d) $v = \sqrt{2}u$, if CP is horizontal

Ans. (a, c, d)

QUESTION



Consider a sphere of mass ' m ' radius ' R ' doing pure rolling motion on a rough surface having velocity \vec{v}_0 as shown in the figure. It makes an elastic impact with the smooth wall and moves back and starts pure rolling after some time again.



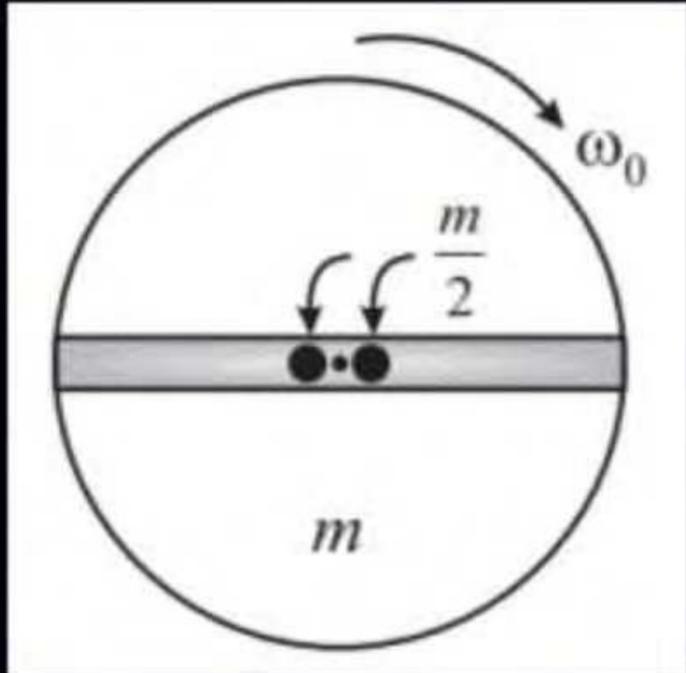
- (a) Change in angular momentum about ' O ' in the entire motion equals $2mv_0 R$ in magnitude.
- (b) Moment of impulse provided by wall during impact about O equals $2mv_0 R$ in magnitude
- (c) Final velocity of ball will be $\frac{3}{7}\vec{v}_0$
- (d) Final velocity of ball will be $-\frac{3}{7}\vec{v}_0$

Ans. (a, b, d)

QUESTION



Comprehension (Q. 9 to 11): A uniform disc of mass ' m ' and radius R is free to rotate in horizontal plane about a vertical smooth fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass $\frac{m}{2}$ each are placed in it on either side of the centre of the disc as shown in figure. The disc is given initial angular velocity ω_0 and released.



9. The angular speed of the disc when the balls reach the end of the disc is :

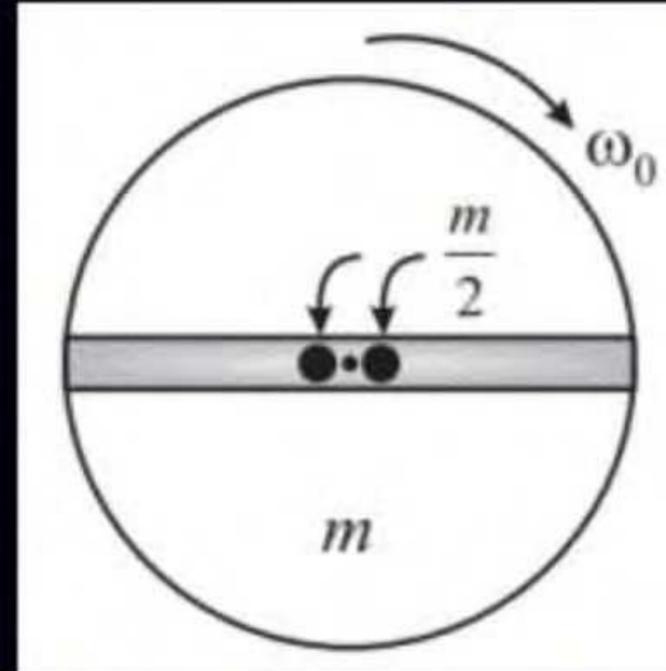
- (a) $\frac{\omega_0}{2}$ (b) $\frac{\omega_0}{3}$ (c) $\frac{2\omega_0}{3}$ (d) $\frac{\omega_0}{4}$

Ans. (b)

QUESTION



Comprehension (Q. 9 to 11): A uniform disc of mass ' m ' and radius R is free to rotate in horizontal plane about a vertical smooth fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass $\frac{m}{2}$ each are placed in it on either side of the centre of the disc as shown in figure. The disc is given initial angular velocity ω_0 and released.



10. The speed of each ball relative to ground just after they leave the disc is :

(a) $\frac{R\omega_0}{\sqrt{3}}$

(b) $\frac{R\omega_0}{\sqrt{2}}$

(c) $\frac{2R\omega_0}{3}$

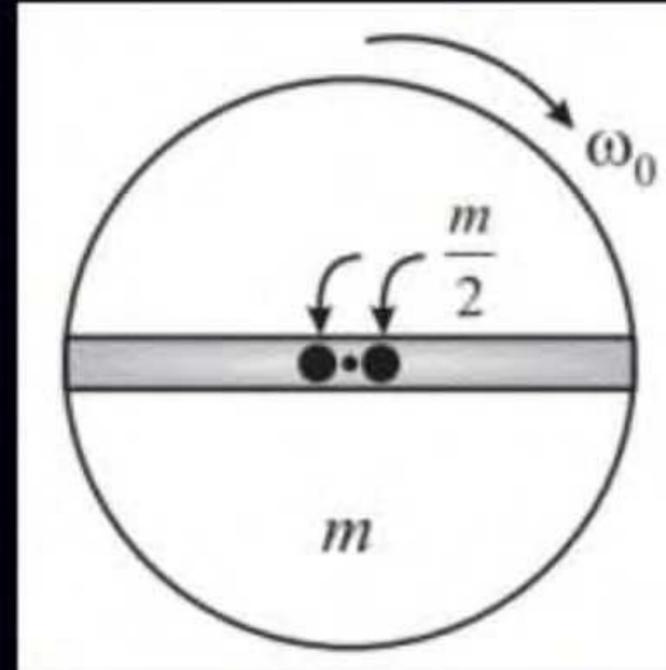
(d) $\frac{R\omega_0}{3}$

Ans. (C)

QUESTION



Comprehension (Q. 9 to 11): A uniform disc of mass ' m ' and radius R is free to rotate in horizontal plane about a vertical smooth fixed axis passing through its centre. There is a smooth groove along the diameter of the disc and two small balls of mass $\frac{m}{2}$ each are placed in it on either side of the centre of the disc as shown in figure. The disc is given initial angular velocity ω_0 and released.



11. The net work done by forces exerted by disc on one of the ball for the duration ball remains on the disc is

(a) $\frac{2mR^2\omega_0^2}{9}$

(b) $\frac{mR^2\omega_0^2}{18}$

(c) $\frac{mR^2\omega_0^2}{6}$

(d) $\frac{mR^2\omega_0^2}{9}$

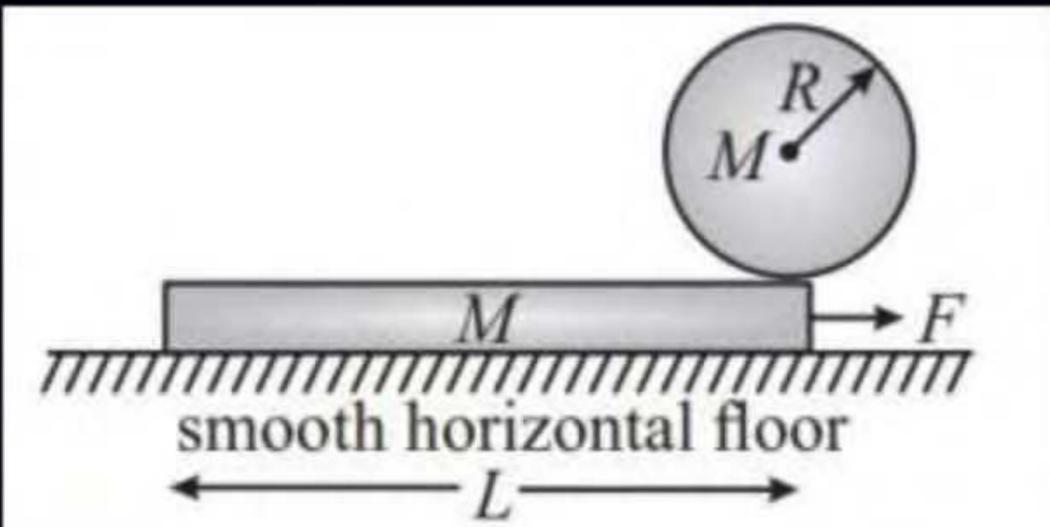
Ans. (d)

QUESTION



Comprehension (Q. 12 to 14): A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L , as shown in the figure.

The plank rests on smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping. The plank is pulled to right with a constant horizontal force of magnitude F .



12. The magnitude of acceleration of plank is-

- (a) $\frac{F}{8M}$ (b) $\frac{F}{4M}$ (c) $\frac{3F}{2M}$ (d) $\frac{3F}{4M}$

Ans. (d)

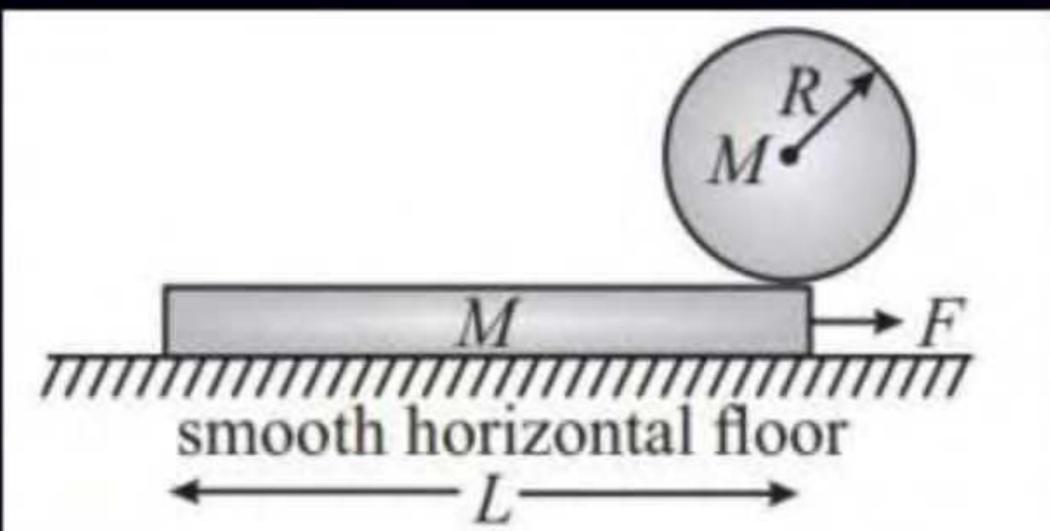
QUESTION



Comprehension (Q. 12 to 14): A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L , as shown in the figure.

The plank rests on smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping. The plank is pulled to right with a constant horizontal force of magnitude F .

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13. The magnitude of angular acceleration of the disc is:

(a) $\frac{F}{4MR}$

(b) $\frac{F}{8MR}$

(c) $\frac{F}{2MR}$

(d) $\frac{3F}{2MR}$

Ans. (c)

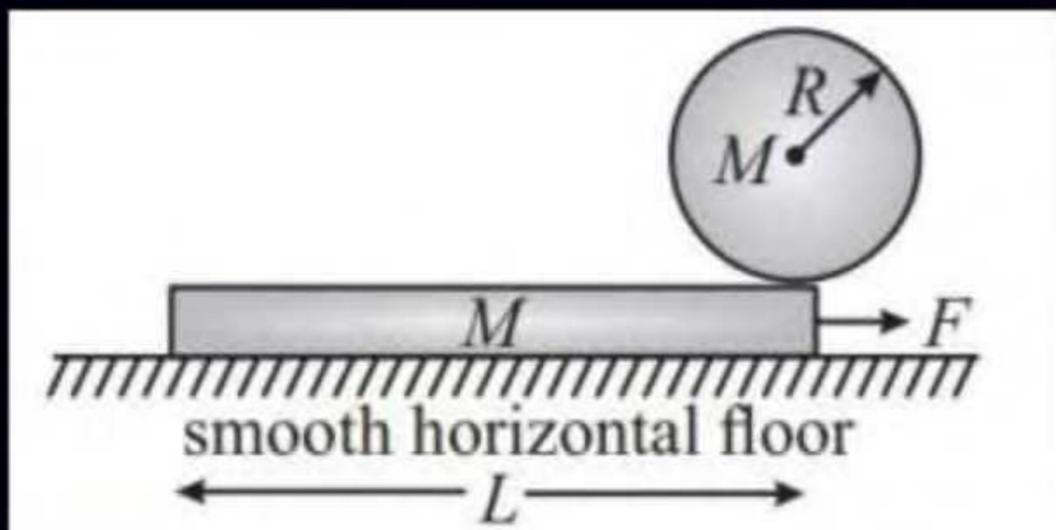
QUESTION



Comprehension (Q. 12 to 14): A uniform disc of mass M and radius R initially stands vertically on the right end of a horizontal plank of mass M and length L , as shown in the figure.

The plank rests on smooth horizontal floor and friction between disc and plank is sufficiently high such that disc rolls on plank without slipping. The plank is pulled to right with a constant horizontal force of magnitude F .

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14. The distance travelled by centre of disc from its initial position till the left end of plank comes vertically below the centre of disc is

(a) $\frac{L}{2}$

(b) $\frac{L}{4}$

(c) $\frac{L}{8}$

(d) L

Ans. (a)



Home Work

- Complete KPP com & then rotation.
- module → Rotation → Parikshit
- KPP rotation attached in this ppt too.
- (Also JA ques)
Attached

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THANK YOU

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