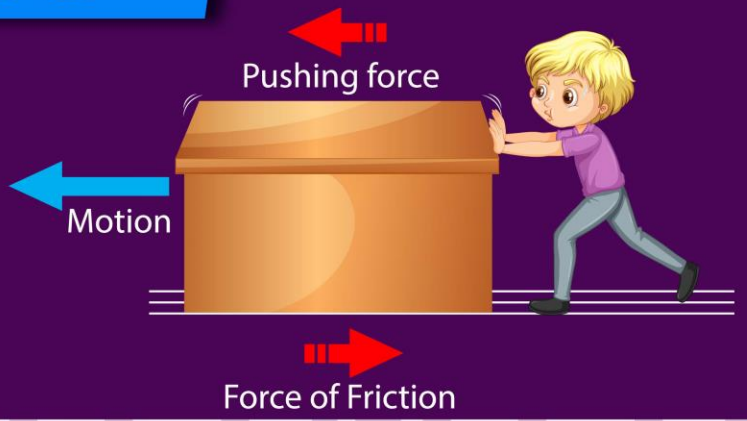
PRACTICE SESSION:

FRICTION

PHYSICS



NEET (UG) 2022

Champions Again!

Aakash + BYJU'S

715/720

1 AIR

RAJASTHAN TOPPER

Tanishka
Distance Program

715/720

2 AIR

DELHI (NCT) TOPPER

Vatsa A. Batra
2 Year Classroom Program

715/720

3 AIR

KARNATAKA TOPPER

Hrishikesh N Gangule
2 Year Classroom Program

710/720

9 AIR

GUJARAT TOPPER

Zeel Vyas
4 Year Classroom Program

710/720

10 AIR

JAMMU & KASHMIR TOPPER

Haziq Parveez Lone
2 Year Classroom Program

80918* Aakashians Qualified in NEET (UG) 2022

68097 Classroom, 12821 Distance & Digital

5	27	52	18
in Top 10 AIR (All India Rank)	in Top 50 AIR (All India Rank)	in Top 100 AIR (All India Rank)	State Toppers

*Till Counting

Other Toppers from Classroom Programs*

West Bengal

Sayantani Chatterjee
2 Year Classroom Program

Anuska Mandal
5 Year Classroom Program

Gujarat-Male

Jay Dipak Rajyaguru
2 Year Classroom Program

Anmol Garg
2 Year Classroom Program

Saahir Nawal Bajaj
2 Year Classroom Program

Maharashtra-Female

Vaidehi Jha
3 Year Classroom Program

Debankita Bera
2 Year Classroom Program

Goa

Anushka Kulkarni
2 Year Classroom Program

Avilash Bhaduri
Test Series Program

Madhya Pradesh

Sanika Agrawal
2 Year Classroom Program

Tamil Nadu

Thridev Vinayaka S
2 Year Classroom Program

Aksh Suryavanshi
3 Year Classroom Program

Haryana

Nisha
4 Year Classroom Program

Odisha

Priya Somadutta Nayak
3 Year Classroom Program

Rajasthan-Male

Shivam Gupta
1 Year Classroom Program

Haryana-Male

Akshat
3 Year Classroom Program

Scan the code to check all the ranks & hear what the toppers have to say

(*Including state toppers in female category)

Though every care has been taken to publish the result correctly, yet Aakash Educational Services Ltd. shall not be responsible for inadvertent error, if any.

Download **Aakash App**

GET IT ON Google Play | Download on App Store

CALL (TOLL-FREE)
1800-102-2727

VISIT
aakash.ac.in

Aakash BYJU'S

Aakash + BYJU'S

NEET/JEE 2023 Courses for Repeater/ XII Passed Batches

Up to 50%* Scholarship

REGISTER FOR FREE

Scholarship Test Details

Take the test at a date and time of your choice

Timings : 9AM to 7PM Daily | **Duration :** 35 mins

Mode : Online (from home)

Avail scholarship on

1-Year Integrated Classroom Courses for NEET and JEE

Who can Appear for the Test ?

Class 12th passed students

ANTHE

AAKASH NATIONAL TALENT HUNT EXAM

Your Gateway To Success

For Class VII to XII

Current Students & Passouts

12TH CLASS | TUESDAY, THURSDAY, SATURDAY
11TH CLASS | MONDAY, WEDNESDAY, FRIDAY

3 PM | 4 PM | 5 PM | 6 PM

MISSION MBBS

VIKAS SIR

CHEMISTRY | 3:00 PM

AKASH SIR

PHYSICS | 4:00 PM

SACHIN SIR

ZOOLOGY | 5:00 PM

PANKHURI MA'AM

BOTANY | 5:00, 6:00 PM

PUSHPENDU SIR

ZOOLOGY | 6:00 PM

Aakash + BYJU'S

DROPPERS BATCH

MONDAY AND WEDNESDAY | 2 PM PHYSICS, 3 PM BOTANY

TUESDAY AND THURSDAY | 2 PM CHEMISTRY, 3 PM ZOOLOGY

AKASH SIR

PHYSICS | 2:00 PM

PANKHURI MA'AM

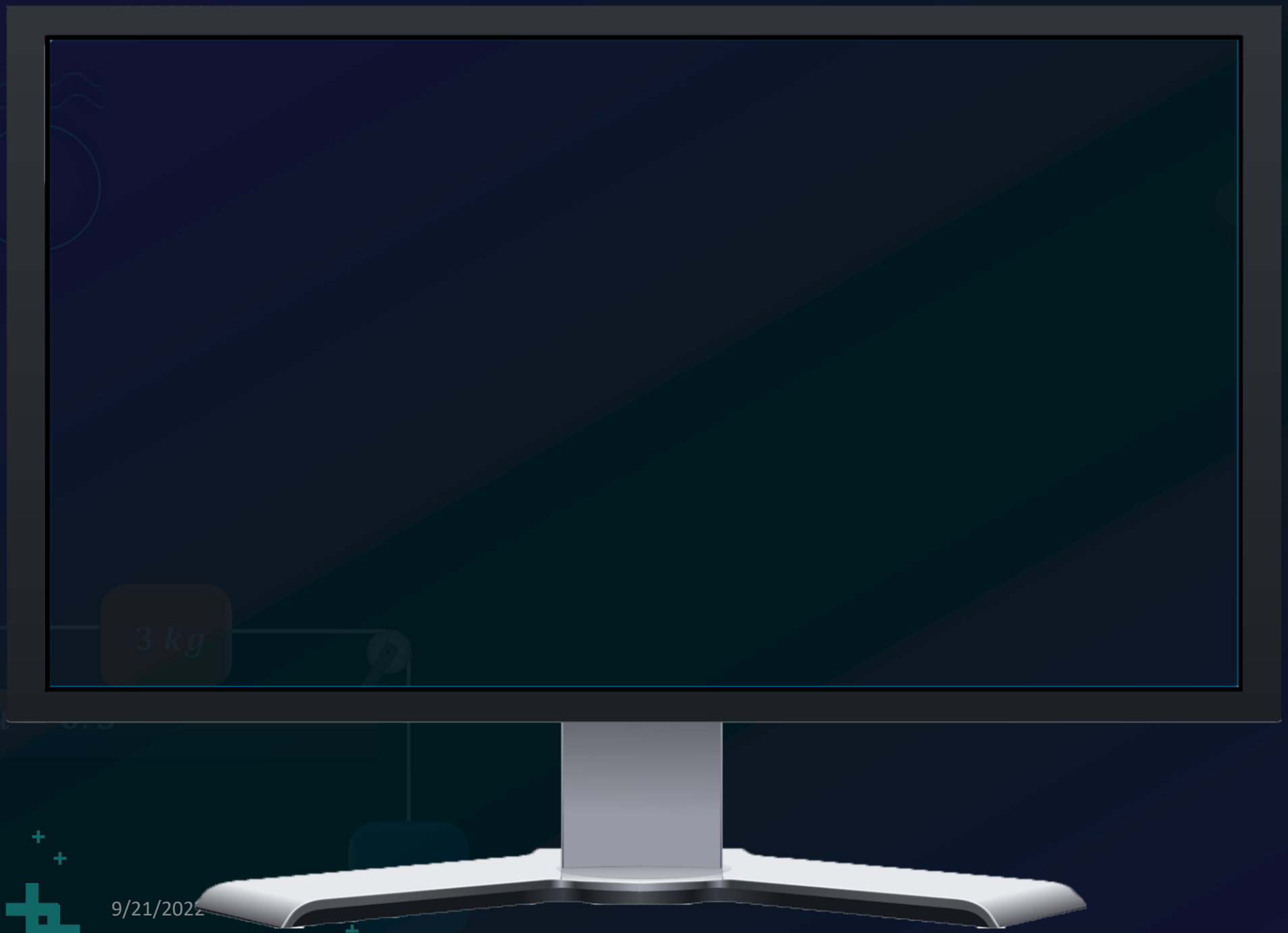
BOTANY | 3:00 PM

VIKAS SIR

CHEMISTRY | 2:00 PM

SACHIN SIR

ZOOLOGY | 3:00 PM



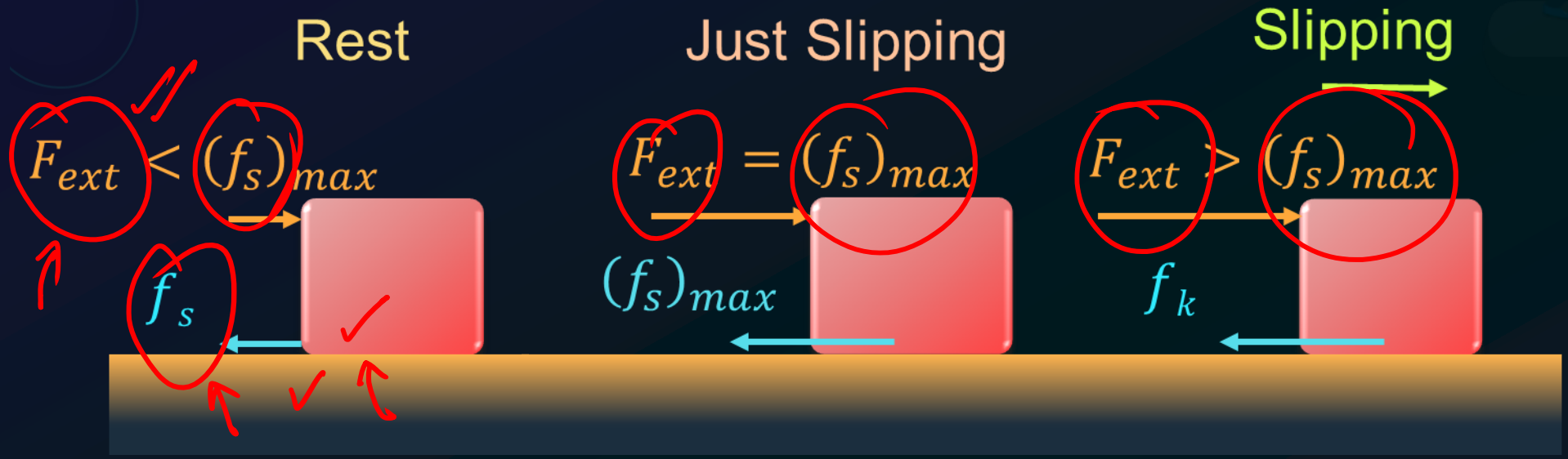
EXAMPLE

Which one of the following statements is incorrect ?

a. Rolling friction is smaller than sliding friction.
b. Limiting value of static friction is directly proportional to normal reaction.
c. Frictional force opposes the relative motion.
d. Coefficient of sliding friction has dimensions of length.

NEET-2018

SOLUTION

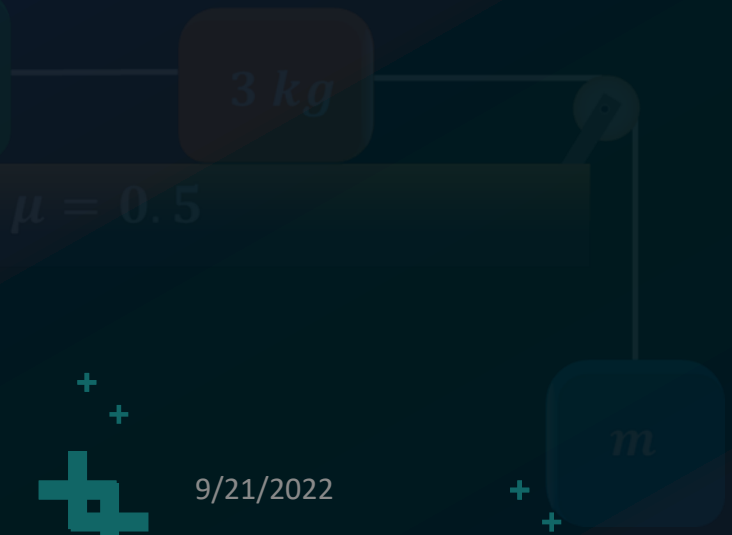


Coefficient of sliding friction has no dimension.

ANSWER

Which one of the following statements is incorrect ?

a. Rolling friction is smaller than sliding friction.
b. Limiting value of static friction is directly proportional to normal reaction.
c. Frictional force opposes the relative motion.
d. Coefficient of sliding friction has dimensions of length.



EXAMPLE

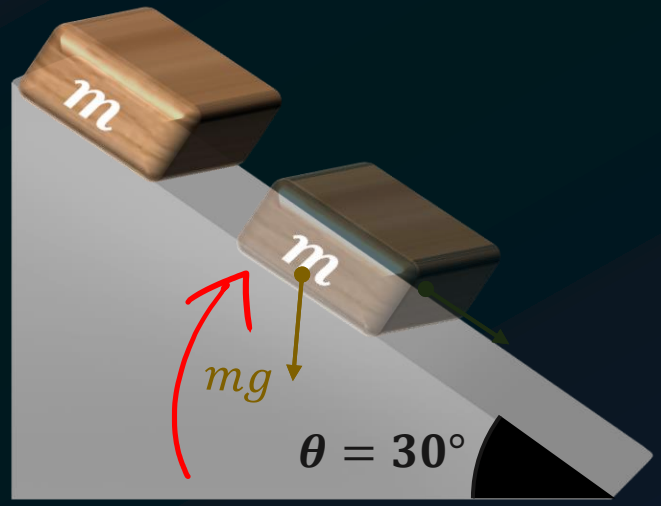
A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30^0, the box starts to slip and slides $4\ m$ down the plank in $4\ s$. The coefficients of static and kinetic friction between the box and the plank will be, respectively

a. 0.4 and 0.3

b. 0.6 and 0.6

c. 0.6 and 0.5

d. 0.5 and 0.6



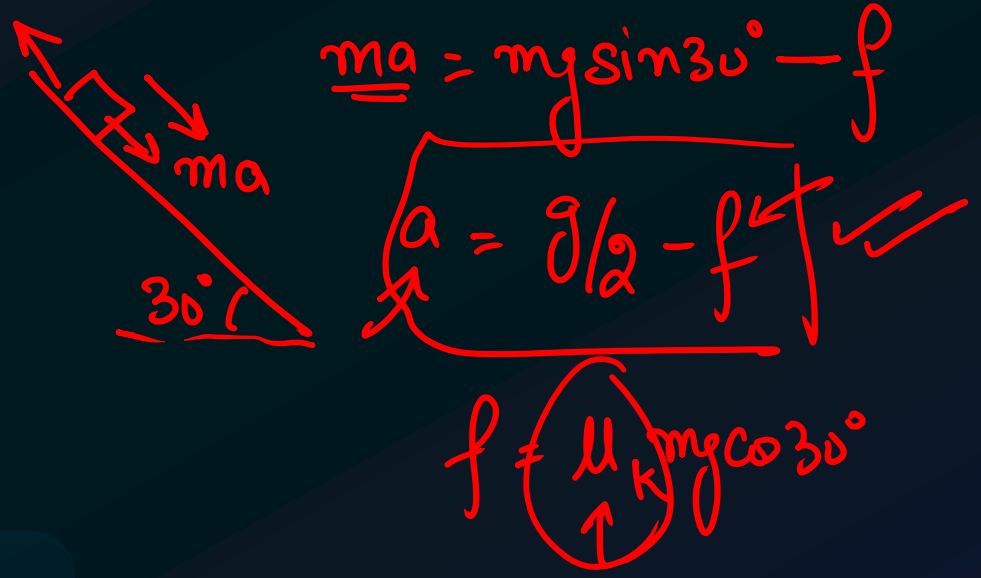
NEET-2015

SOLUTION

Given: $t = 4\ s, \theta = 30^o, l = 4\ m$

Coefficient of static friction, $\mu_s = \tan 30^0$

Coefficient of kinetic friction, $ma = mg\sin 30^0 - f$



SOLUTION

Given: $t = 4\ s, \theta = 30^0, l = 4\ m$

Coefficient of static friction is,

$$\mu_s = \tan 30^0 = 0.577 \approx 0.6$$

For coefficient of kinetic friction,

$$ma = mg\sin 30^0 - f$$

$$= mg\sin 30^0 - \mu_k mg\cos 30^0 \ldots . (1)$$

and also using, $S = ut + \frac{1}{2}at^2$

$$\Rightarrow 4 = 0 + \frac{1}{2}a(4)^2 \text{ or } a = 0.5\ m/s^2$$

$a = 0.5\ m/s^2$

Now from (1)

$$0.5 = 10 \times \frac{1}{2} - \mu_k(10)\left(\frac{\sqrt{3}}{2}\right)$$

$$\text{or } \mu_k = \frac{4.5}{5\sqrt{3}} = 0.5$$

ANSWER

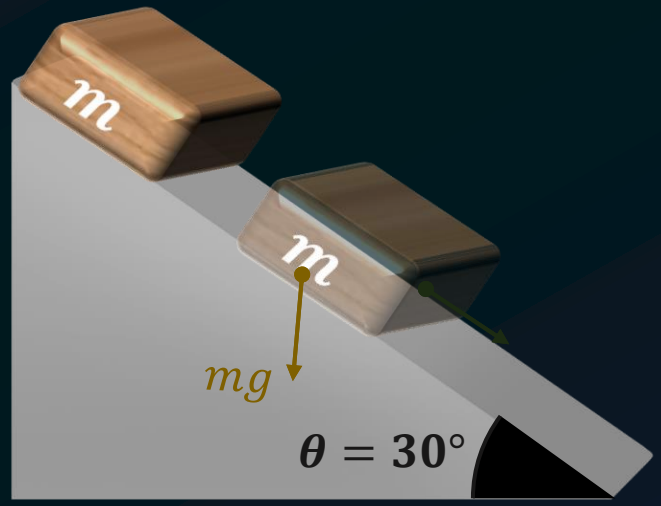
A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30^0, the box starts to slip and slides $4\ m$ down the plank in $4\ s$. The coefficients of static and kinetic friction between the box and the plank will be, respectively

a. 0.4 and 0.3

b. 0.6 and 0.6

c. 0.6 and 0.5

d. 0.5 and 0.6

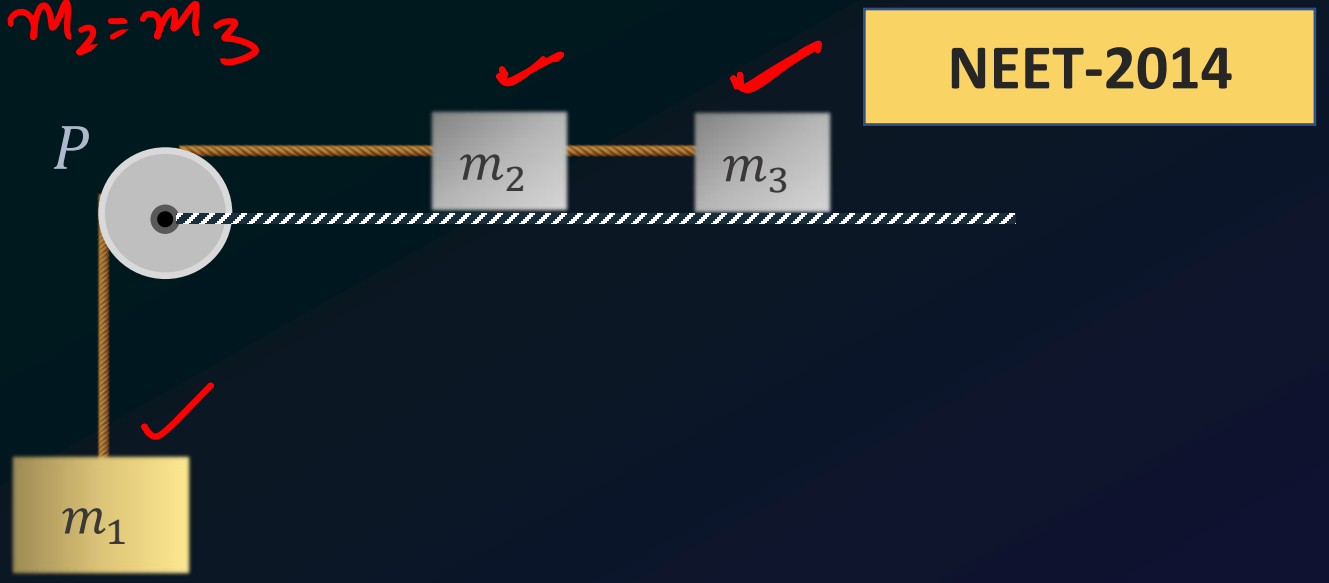


EXAMPLE

A system consists of three identical masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction=μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is

$m_1 = m_2 = m_3$

NEET-2014



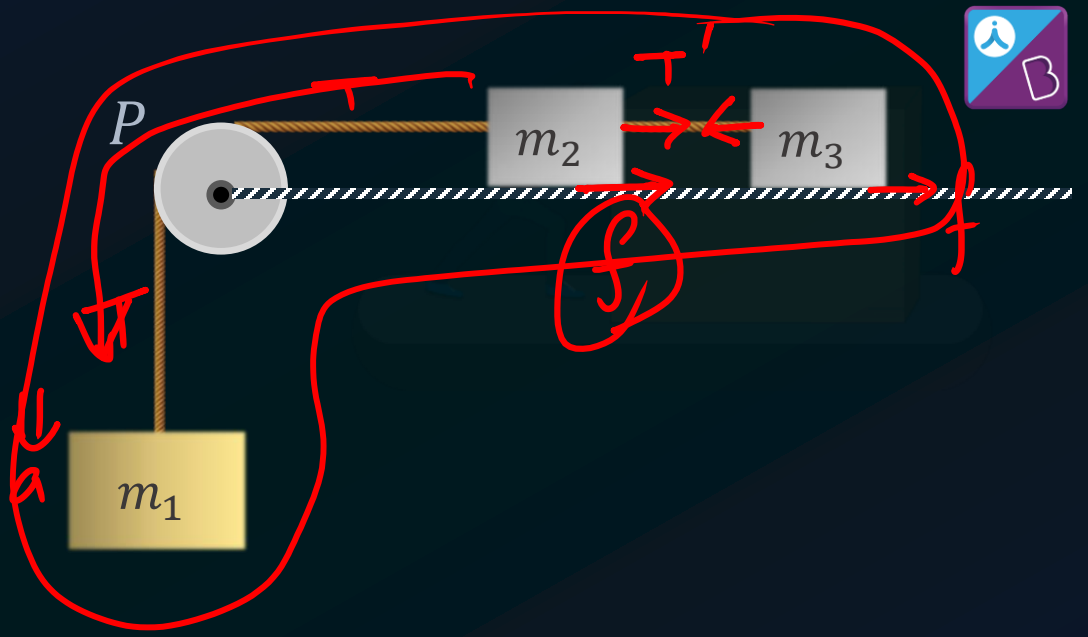
a. $\frac{g(1-2\mu)}{g}$

b. $\frac{2g\mu}{3}$

c. $\frac{g(1-2\mu)}{3}$

d. $\frac{g(1-2\mu)}{2}$

SOLUTION



$mg - T = ma$

$T - T' - f = ma$

$T' - f = ma$

(a)

$f = \mu mg$

$$a = \frac{m_1 g - (m_2 + m_3) g \mu}{m_1 + m_2 + m_3}$$

$$a = \frac{g - 2\mu g}{3} = \frac{g(1 - 2\mu)}{3}$$

SOLUTION

Tension in the string attached to mass m_1 is T_1 Tension in the string attached to mass m_3 is T_2

Apply newtons Second law, for each mass

$$m_1 g - T_1 = m_1 a \ldots (1)$$

$$T_1 - f_2 - T_2 = m_2 a \ldots (2)$$

$$T_3 - f_3 = m_3 a \ldots (3)$$

Adding above equations,

$$m_1 g - f_2 - f_3 = (m_1 + m_2 + m_3) a$$

As $m_1 = m_2 = m_3 = m$ and $f_2 = f_3 = \mu m g$

$$mg - 2\mu mg = 3ma$$

$$a = \frac{g(1-2\mu)}{3}$$

ANSWER

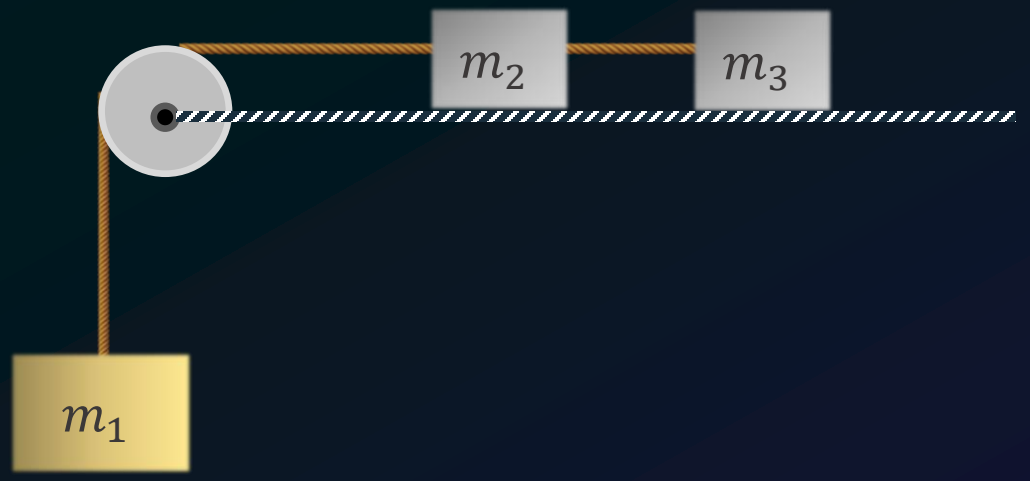
A system consists of three identical masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction=μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is

a. $\frac{g(1-2\mu)}{g}$

b. $\frac{2g\mu}{3}$

c. $\frac{g(1-2\mu)}{3}$

d. $\frac{g(1-2\mu)}{2}$



EXAMPLE

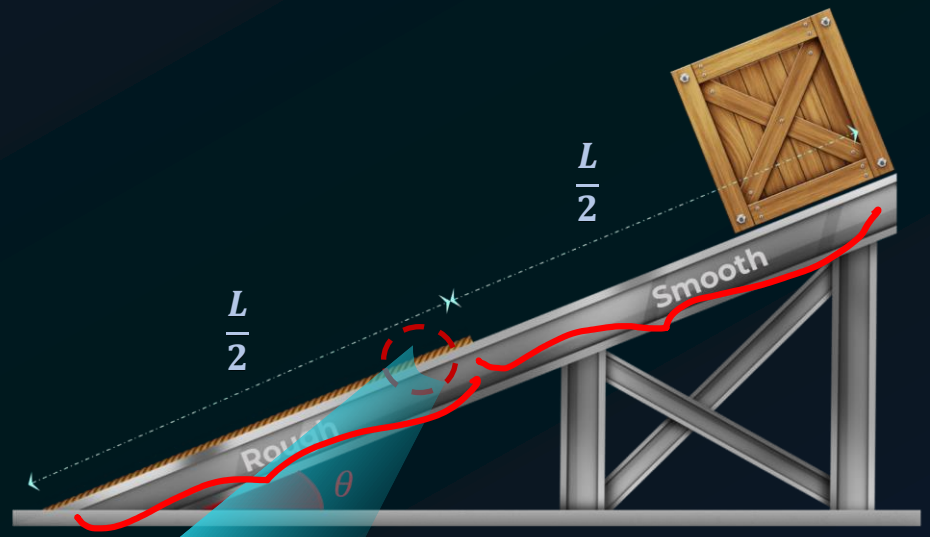
The upper half of an inclined plane of inclination θ is perfectly smooth, while the lower half is rough. A block, starting from rest at the top of the plane, again comes to rest at the bottom. The coefficient of friction between the block and lower half of the plane is -

a. $\mu = \tan\theta$

b. $\mu = \dfrac{1}{\tan\theta}$

c. $\mu = \dfrac{2}{\tan\theta}$

d. $\mu = 2\tan\theta$



NEET-2013

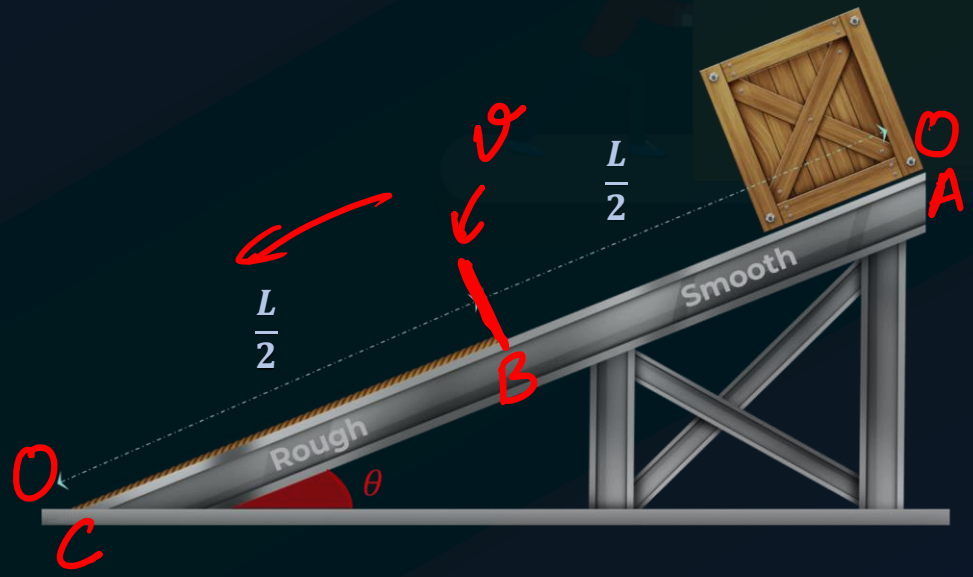
SOLUTION

$$2gsin\theta\frac{L}{2} = v^2$$

$$2(\mu gcos\theta - gsin\theta)\frac{L}{2} = v^2$$

$$gsin\theta = \mu gcos\theta - gsin\theta$$

$$\mu = 2tan\theta$$



SOLUTION

From work energy theorem $(W = \Delta KE)$

As the block starts from rest and finally comes to rest,

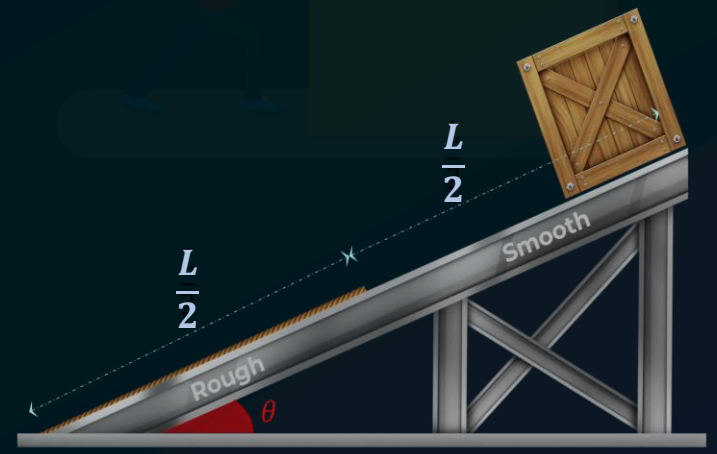
so $\Delta KE = 0$, so that we can write,

$$\text{Work done by friction + work done gravity} = 0$$

$$(mg\ \sin\theta)(2s) - (\mu\ mg\cos\theta)(s) = 0$$

$$2mg\sin\theta\ s = \mu mg\cos\theta\ s$$

$$\Rightarrow \mu = 2\tan\theta$$



ANSWER

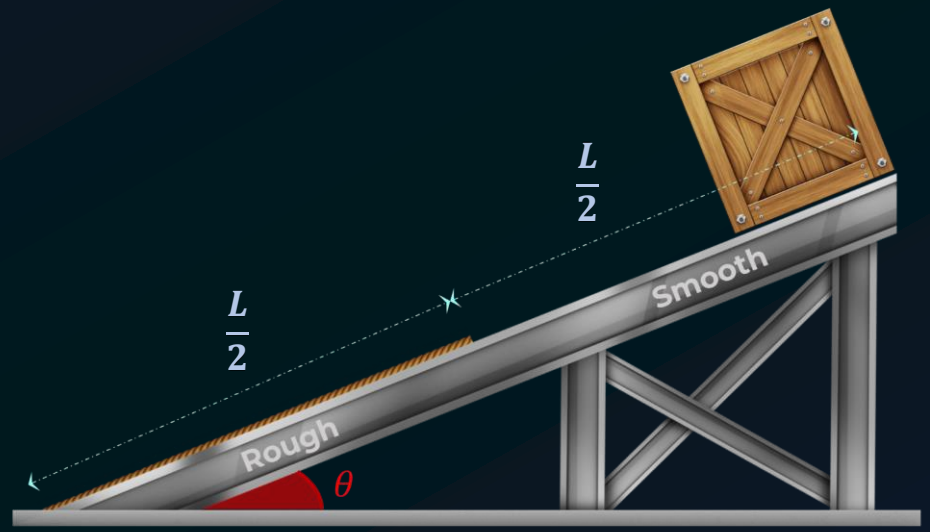
The upper half of an inclined plane of inclination θ is perfectly smooth, while the lower half is rough. A block, starting from rest at the top of the plane, again comes to rest at the bottom. The coefficient of friction between the block and lower half of the plane is -

a. $\mu = \tan\theta$

b. $\mu = \dfrac{1}{\tan\theta}$

c. $\mu = \dfrac{2}{\tan\theta}$

d. $\mu = 2\tan\theta$



EXAMPLE

A block of mass $10\ kg$ is placed on a rough horizontal surface whose coefficient of friction is 0.5. If a horizontal force of magnitude $100\ N$ is applied on the block, then acceleration of the block will be
[Take $g = 10\ m/s^2$]

a. $10\ m/s^2$

b. $5\ m/s^2$

c. $15\ m/s^2$

d. $0.5\ m/s^2$

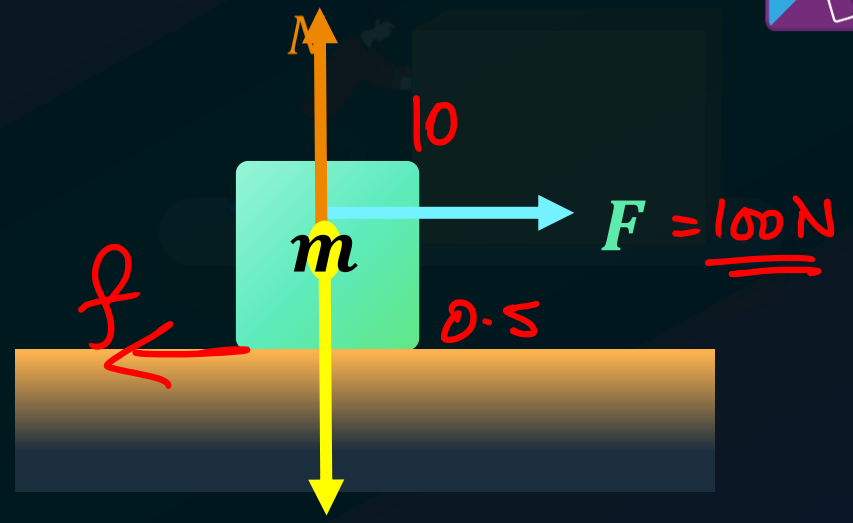
SOLUTION

μmg

$(0.5)(10)(10) = \boxed{50}$

$50N$

$a = \frac{50}{10} = 5 m/s^2$



SOLUTION

Given: $m = 10\ kg, g = 10\ ms^{-2}, \mu = 0.5$ and $F = 100\ N$

$\therefore$ Force of friction, $f = \mu N = \mu mg$

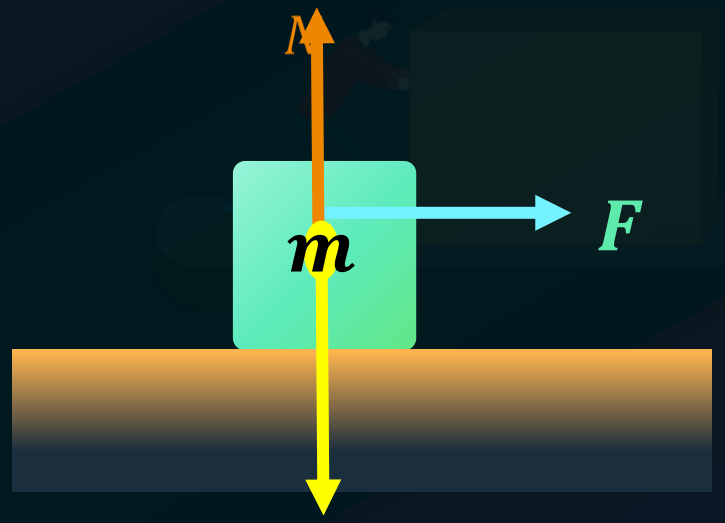
$$\Rightarrow f = 0.5 \times 10 \times 10 = 50\ N$$

Force that produces acceleration,

$$F' = F - f = 100\ N - 50\ N = 50\ N$$

Thus, acceleration of the block,

$$a = \frac{F'}{m} = \frac{50}{10} = 5\ ms^{-2}$$



ANSWER

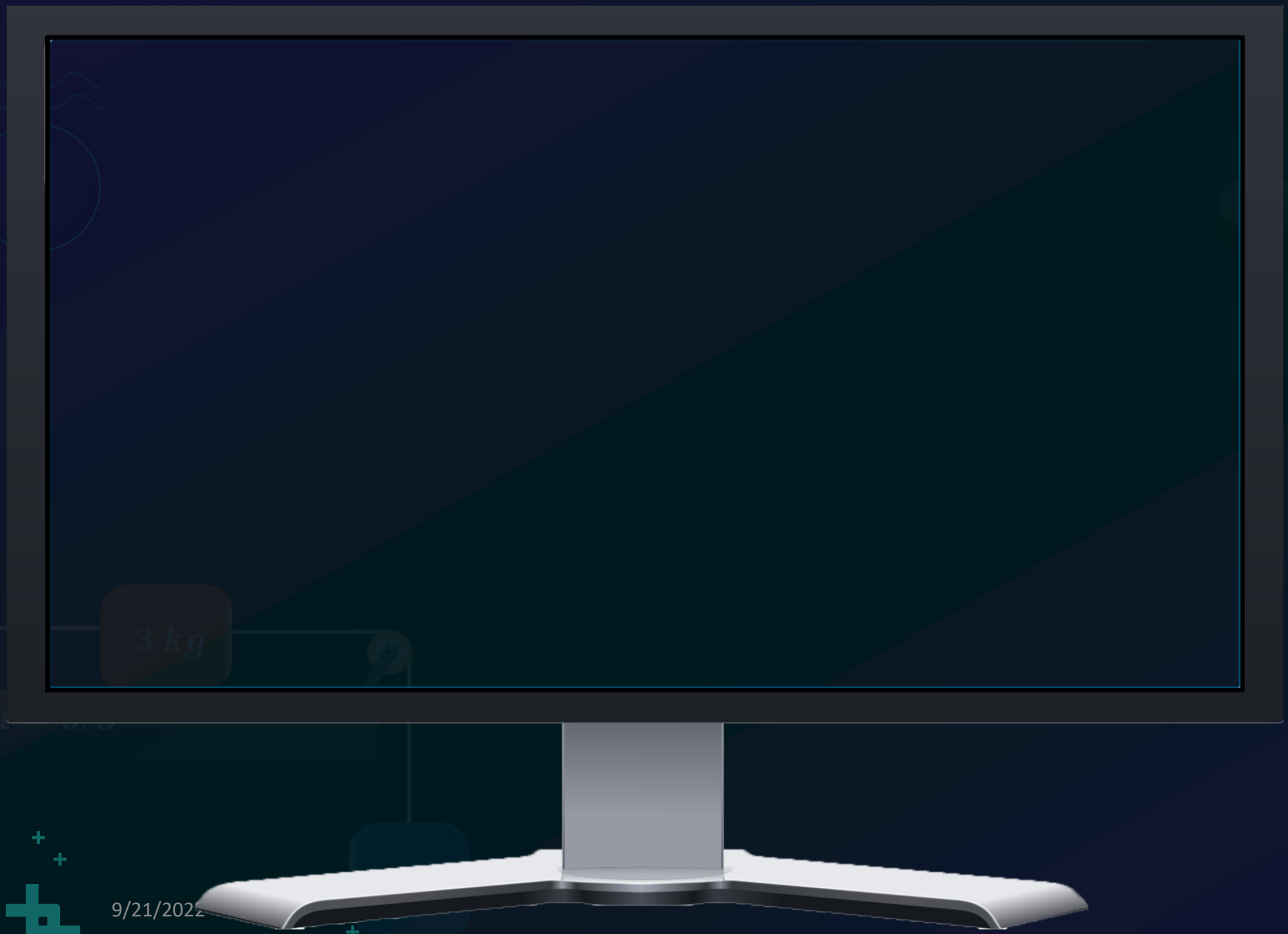
A block of mass $10\ kg$ is placed on a rough horizontal surface whose coefficient of friction is 0.5. If a horizontal force of magnitude $100\ N$ is applied on the block, then acceleration of the block will be
[Take $g = 10\ m/s^2$]

a. $10\ m/s^2$

b. $5\ m/s^2$

c. $15\ m/s^2$

d. $0.5\ m/s^2$



EXAMPLE

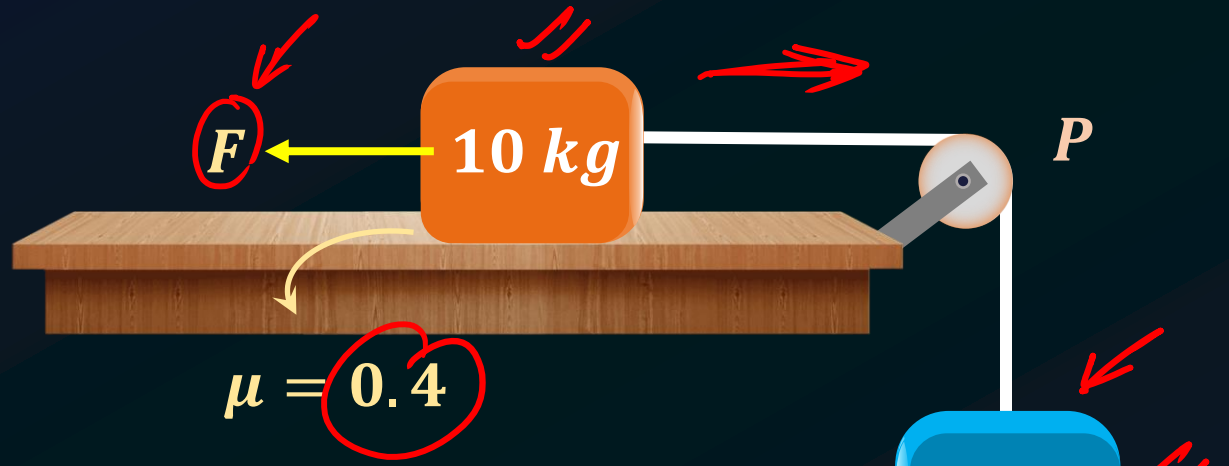
Find the minimum value of F for which the system is in equilibrium?
[Take $g = 10\ m/s^2$]

a. $5\ N$

b. $10\ N$

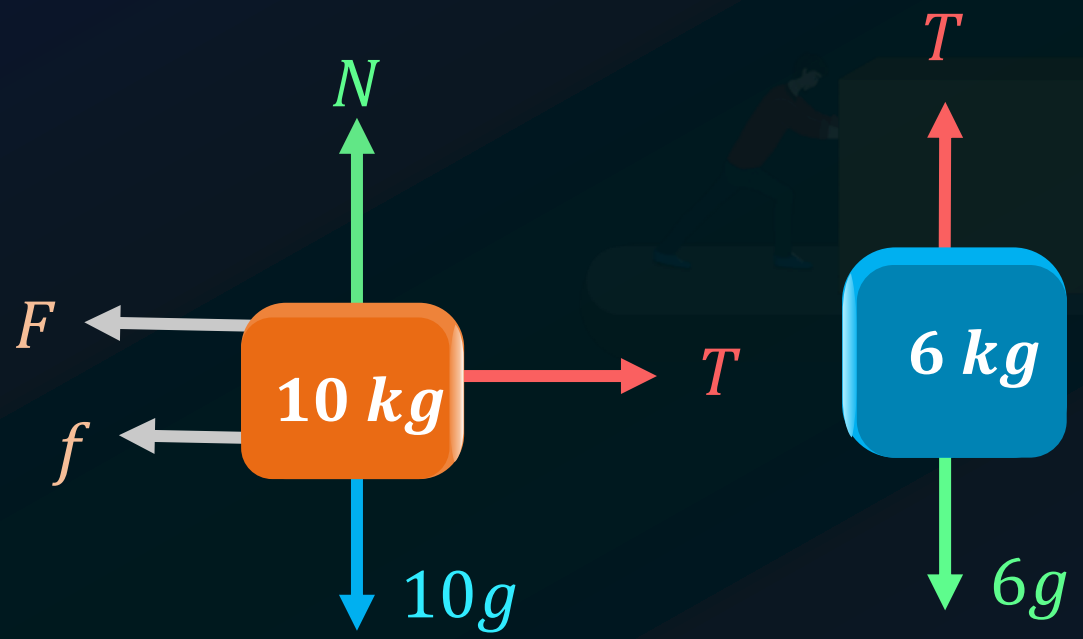
c. $15\ N$

d. $20\ N$



$f = 0.4 \times 10 \times 10 = 40N$

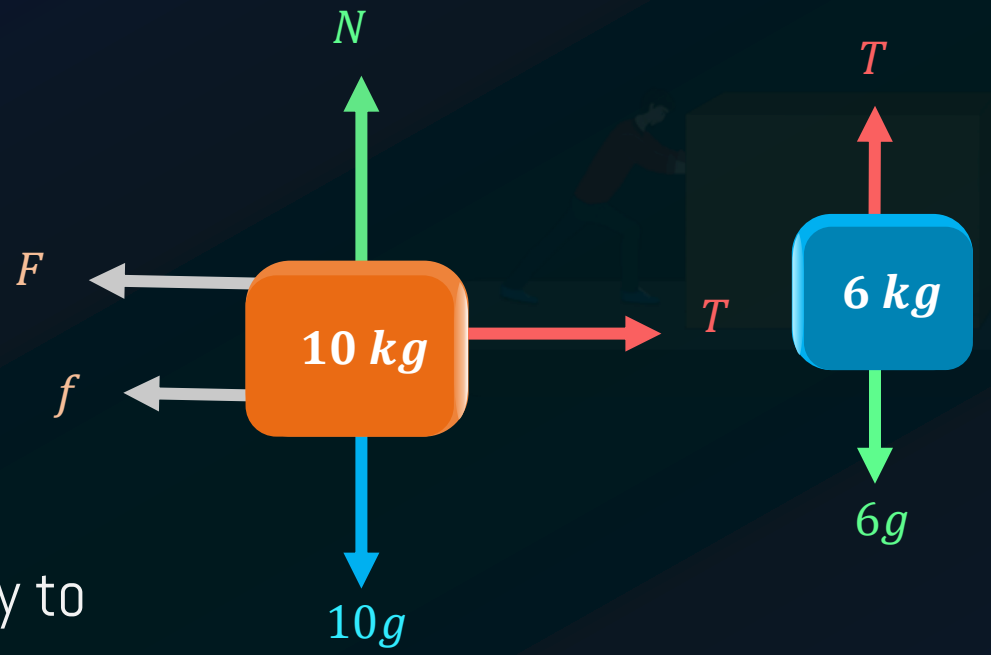
SOLUTION



SOLUTION

By FBD of the blocks

As the system is in equilibrium and the 10 kg block will have the frictional force f in the backward direction as the block has the tendency to move forward



$$T = 6g, \quad f = \mu mg$$

$$F + f = T$$

$$\Rightarrow 6g = F + 0.4(10)g$$

$$\therefore F = 2g = 2 \times 10 = 20 \text{ N}$$

ANSWER

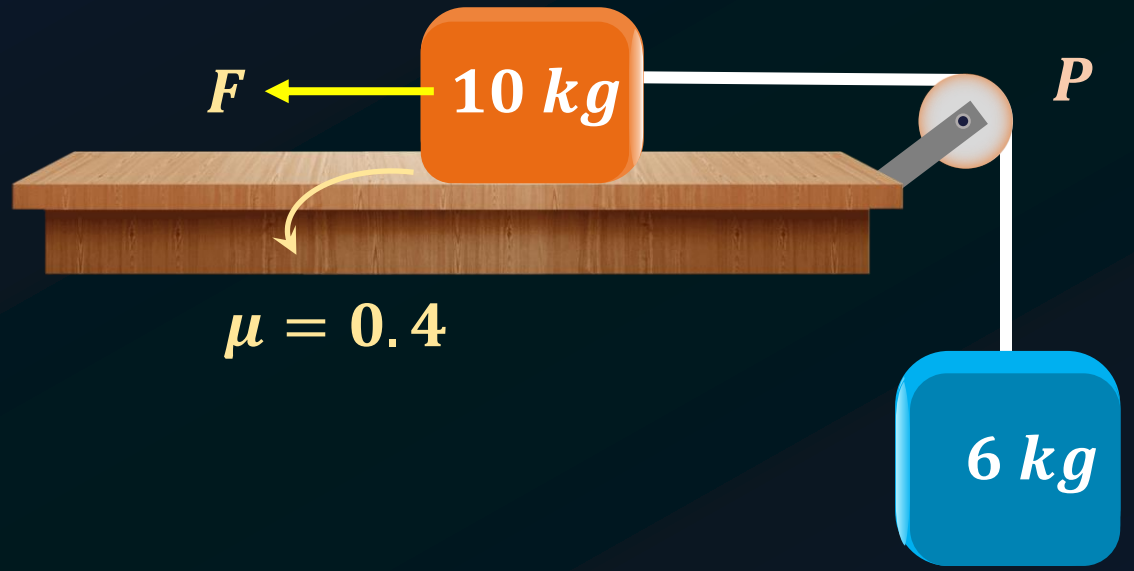
Find the value of F for which the system is in equilibrium?
[Take $g = 10\ m/s^2$]

a. $5\ N$

b. $10\ N$

c. $15\ N$

d. $20\ N$



EXAMPLE

A cubical block rests on a plane of $\mu=\sqrt{3}$. The angle through which the plane be inclined to the horizontal so that the block just slides down will be

a. 30^o

b. 45^o

c. 60^o

d. 75^o

SOLUTION

$$\mu = \tan\theta$$

$$\sqrt{3} = \tan\theta$$

$$\theta = 60^\circ$$

SOLUTION

The block will have force $mg\sin\theta$ along the incline plane and the frictional force will have

$$f_s = \mu N$$

where, $N = mg\cos\theta$

$$f_s = mg\sin\theta$$

For equilibrium, $\mu\, mg\cos\theta = mg\sin\theta$

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

$$\Rightarrow \theta = 60^\circ$$

ANSWER

A cubical block rests on a plane of $\mu=\sqrt{3}$. The angle through which the plane be inclined to the horizontal so that the block just slides down will be

a. 30^o

b. 45^o

c. 60^o

d. 75^o

EXAMPLE

A marble block of mass $2\ kg$ lying on ice when given a velocity of $6\ m/s$ is stopped by friction in $10\ s$. Then the coefficient of friction is

a. 0.01

b. 0.02

c. 0.03

d. 0.06

$a = \frac{\mu mg}{m}$

$= \mu g$

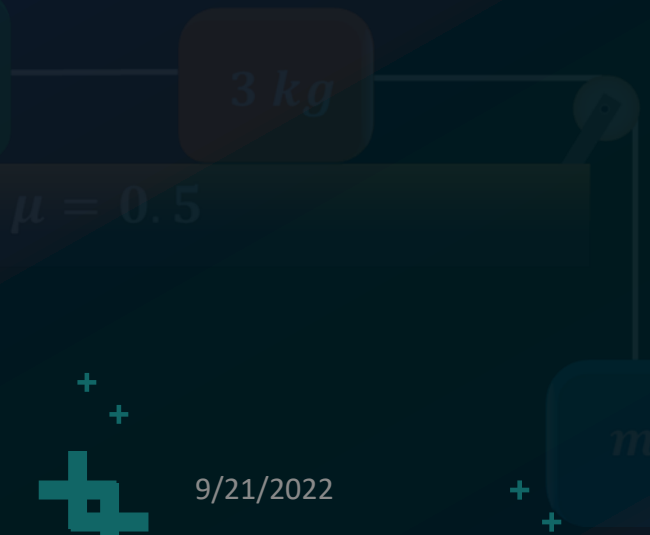
$v = u + at$

$0 = 6 - \mu g(10)$

$\mu = \frac{6}{100} = 0.01 \times 6$

$= 0.06$

SOLUTION



SOLUTION

As we know that, $v = u + at$

$$\Rightarrow u - at = 0$$

$$a = \frac{6}{10}$$

$\Rightarrow a = -0.6\ m/s^2 (-ive$ means retardation)

As block is stopped due to friction so,

$$F_{friction} = ma$$

$$\mu = \frac{0.6}{10} = 0.06$$

ANSWER

A marble block of mass $2\ kg$ lying on ice when given a velocity of $6\ m/s$ is stopped by friction in $10\ s$. Then the coefficient of friction is

a. 0.01

b. 0.02

c. 0.03

d. 0.06

EXAMPLE

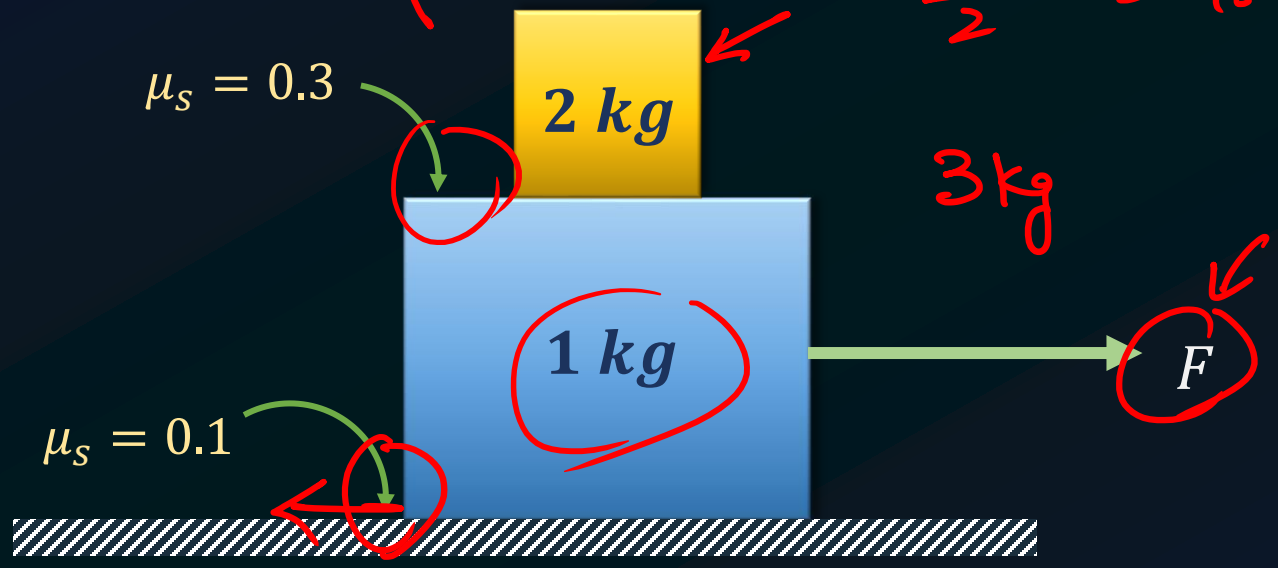
Find the maximum force that should act on the $1\ kg$ body for the system to accelerate together with $2\ m/s^2$. [Take $g = 10\ m/s^2$].

a. $4\ N$

b. $5\ N$

c. $7\ N$

d. $9\ N$



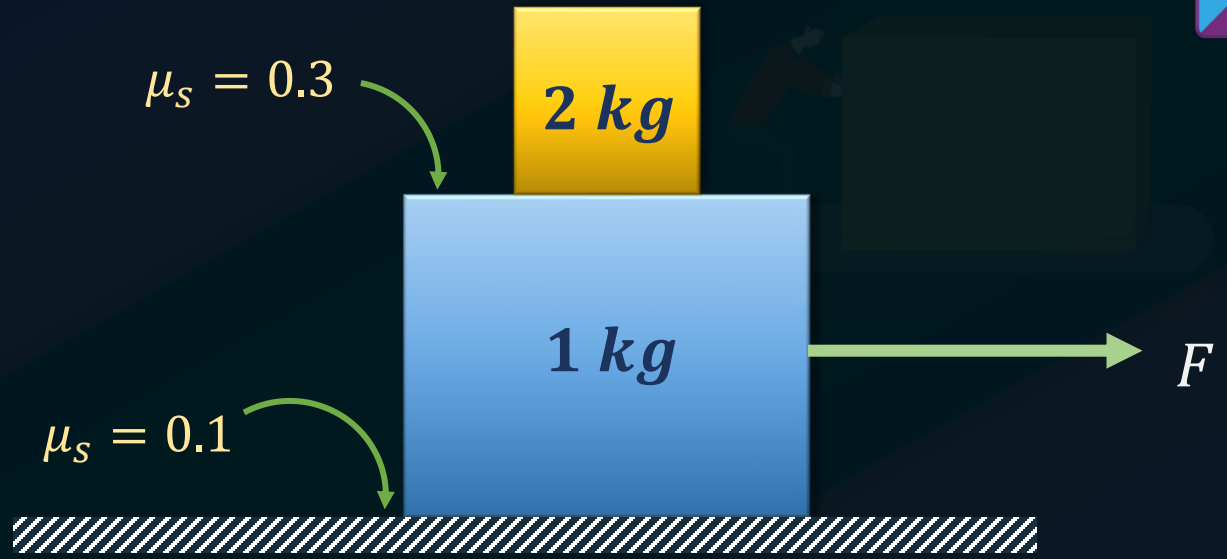
$\frac{6N}{2} = 3m/s^2$

3kg

$f - (0.1)(3)(10) = 3(2)$

$f = 9N$

SOLUTION



SOLUTION

From FBD of the system of blocks,

$$F - f = (m_1 + m_2)a_s$$

where a_s is the acceleration of the system.

For $F = F_{max}$,

friction will have limiting value,

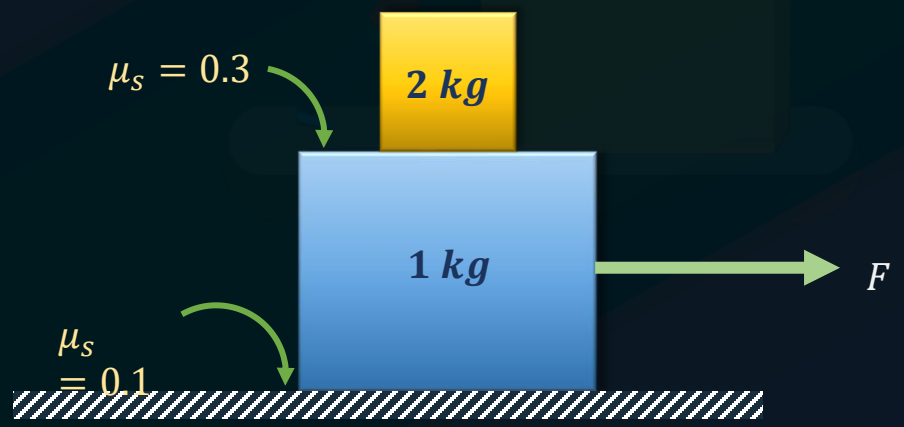
$$f = \mu_1 N = \mu_1 (m_1 + m_2) g$$

Then, $F_{\text{max}} = (m_1 + m_2)(\mu_1 g + a_s)$

Given: $m_1 = 1$ kg; $m_2 = 2$ kg; $\mu_1 = 0.1$; $a_s = 2\ \text{m/s}^2$

Hence,

$$F_{\text{max}} = (2 + 1)(0.1 \times 10 + 2) = 3 \times 3 = 9\ \text{N}$$



ANSWER

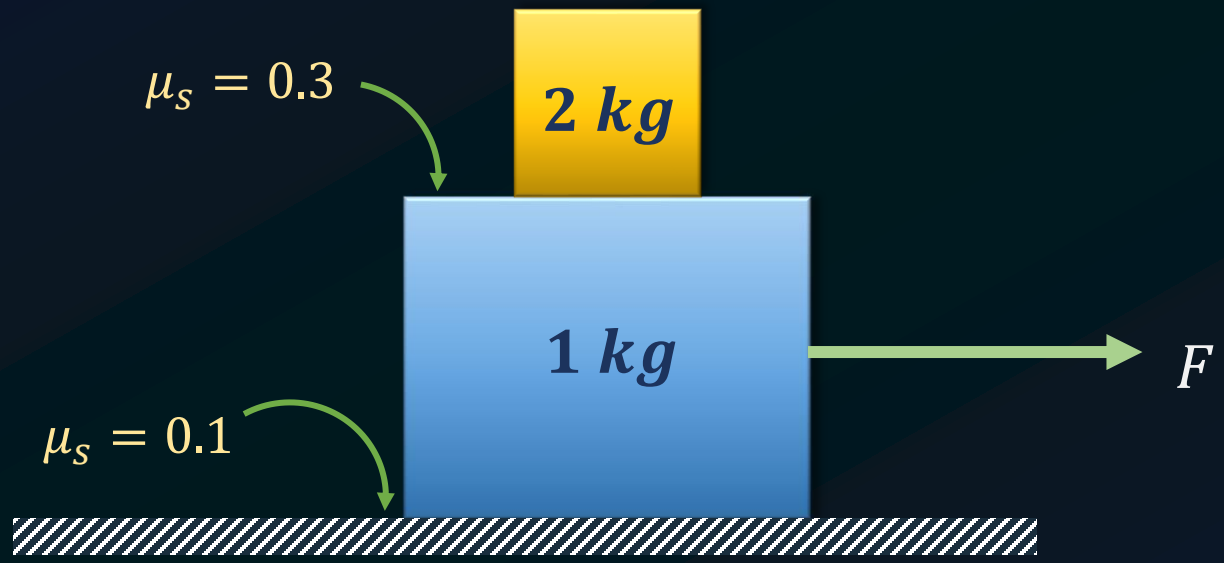
Find the maximum force that should act on the $1\ kg$ body for the system to accelerate together with $2\ m/s^2$. [Take $g = 10\ m/s^2$].

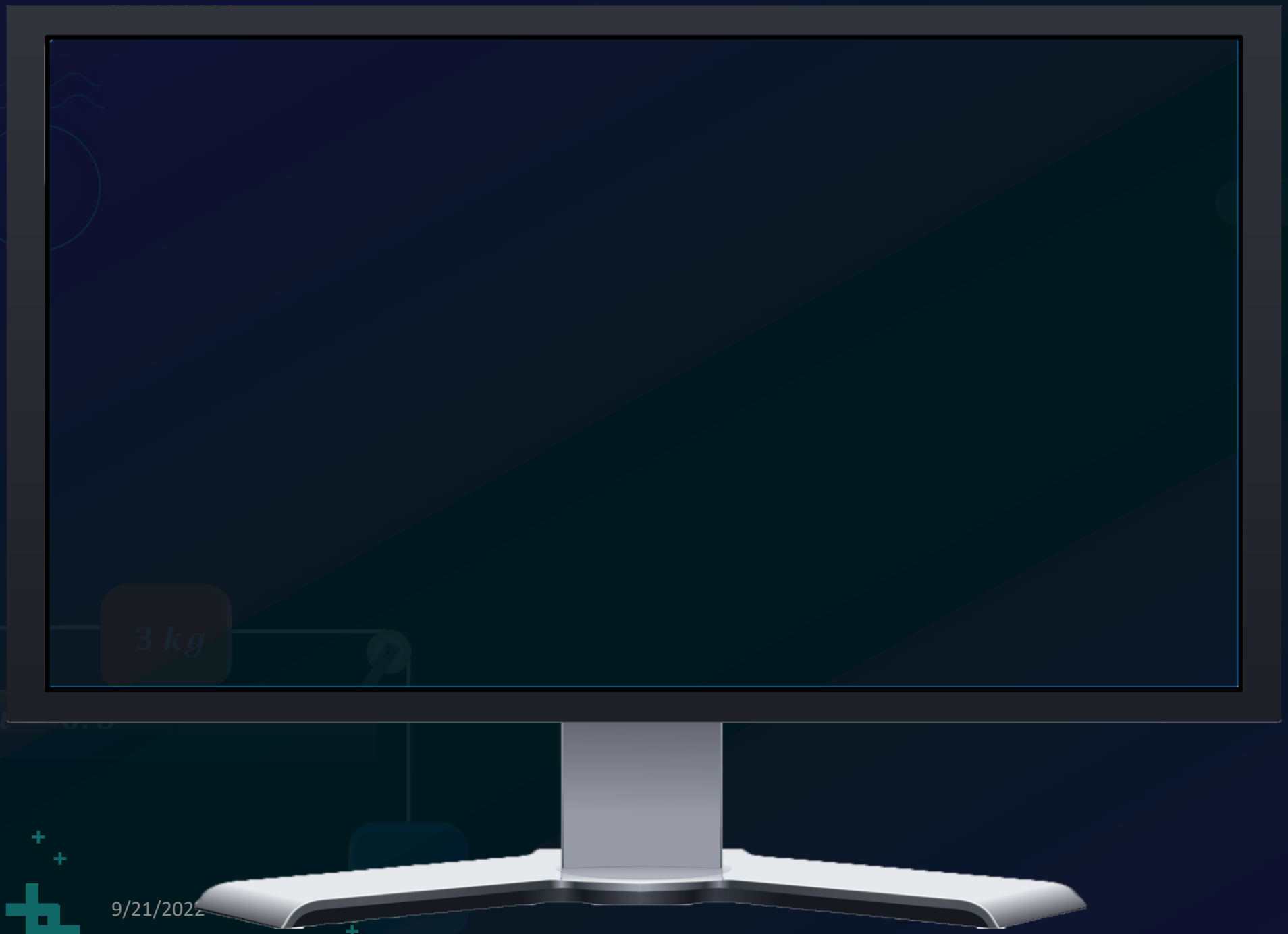
a. $4\ N$

b. $5\ N$

c. $7\ N$

d. $9\ N$





EXAMPLE

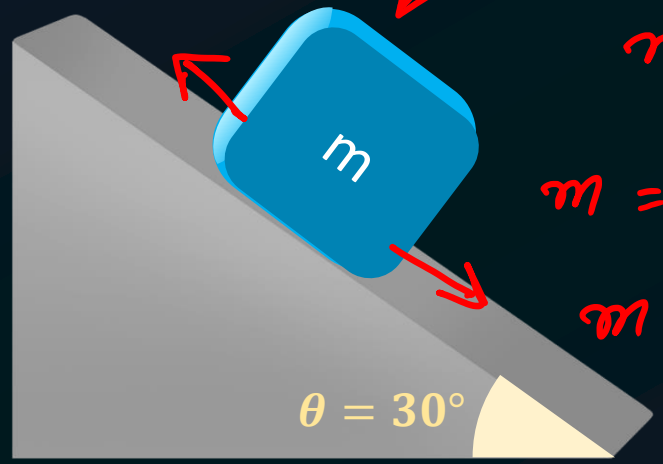
A block rests on a rough inclined plane making an angle of 30^o with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is $10\ N$, the mass of the block (in kg) is (take $g = 10\ m/s^2$)

a. $2.5\ kg$

b. $4\ kg$

c. $1.5\ kg$

d. $2\ kg$



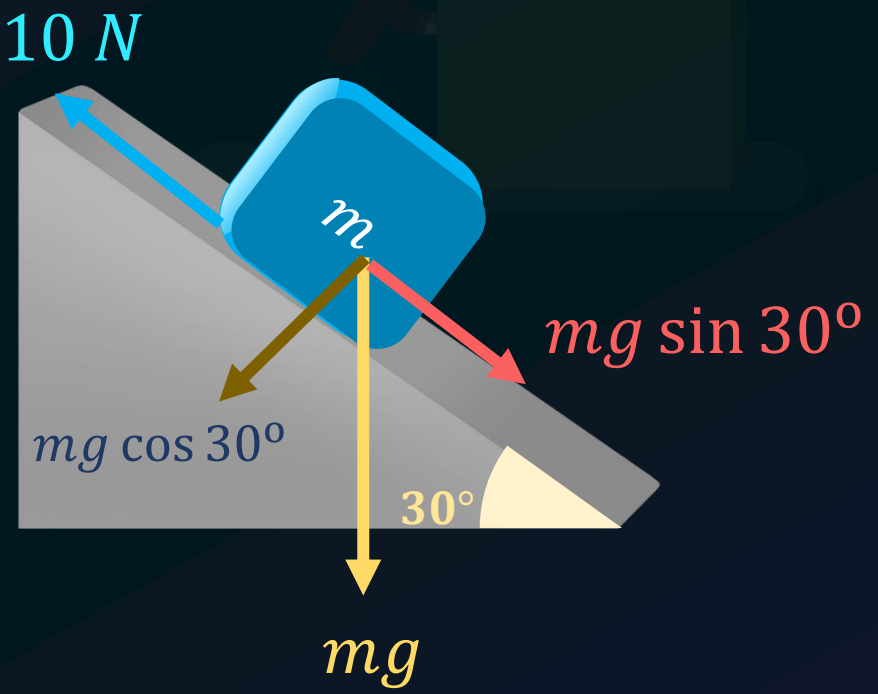
$\tan(30^\circ) = 0.6$

$mg\sin 30^\circ = 10$

$m = \frac{10}{5}$

$m = 2$

SOLUTION



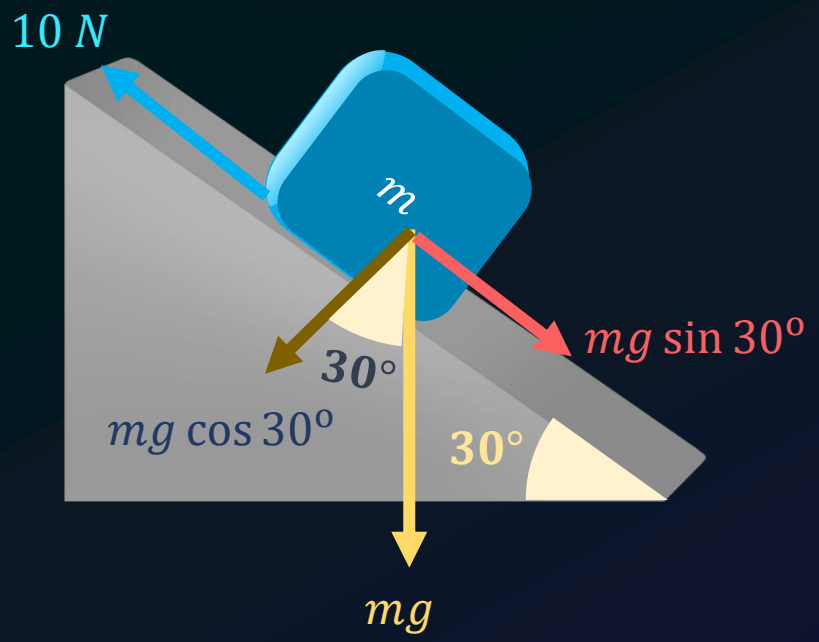
SOLUTION

By the FBD, It is given that the body is in rest and so the frictional force 10 N will be acting on the block opposite to the direction of component of mg along the incline plane.

$$\therefore f = mg\sin 30 = 10 \text{ N}$$

$$\Rightarrow \frac{m \times 10}{2} = 10$$

$$\Rightarrow m = 2 \text{ kg}$$



ANSWER

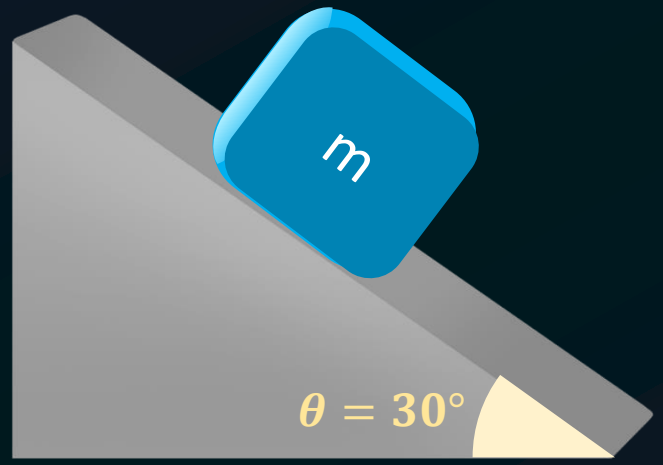
A block rests on a rough inclined plane making an angle of 30^o with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is $10\ N$, the mass of the block (in kg) is (take $g = 10\ m/s^2$)

a. $2.5\ kg$

b. $4\ kg$

c. $1.5\ kg$

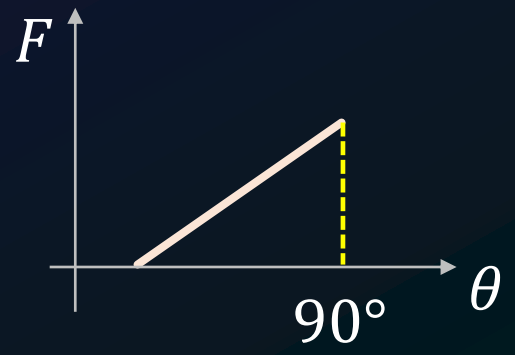
d. $2\ kg$



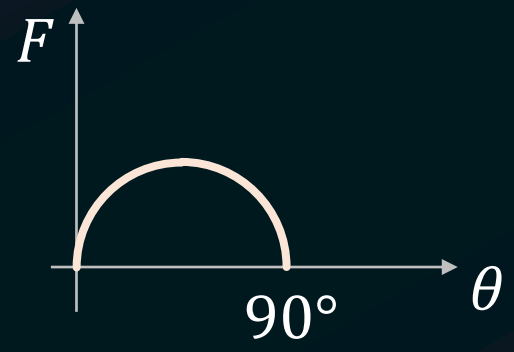
EXAMPLE

A block rests on a rough plane whose inclination θ to the horizontal can be varied. Which of the following graphs indicates how the frictional force F between the block and plane varies as θ is increased?

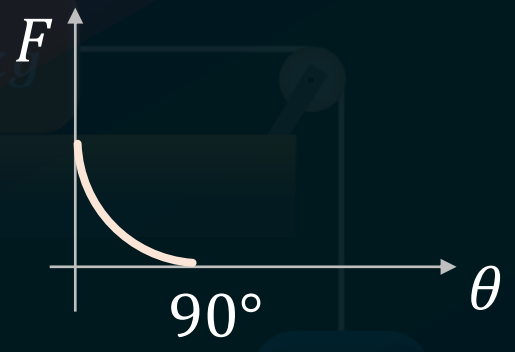
a.



b



c.

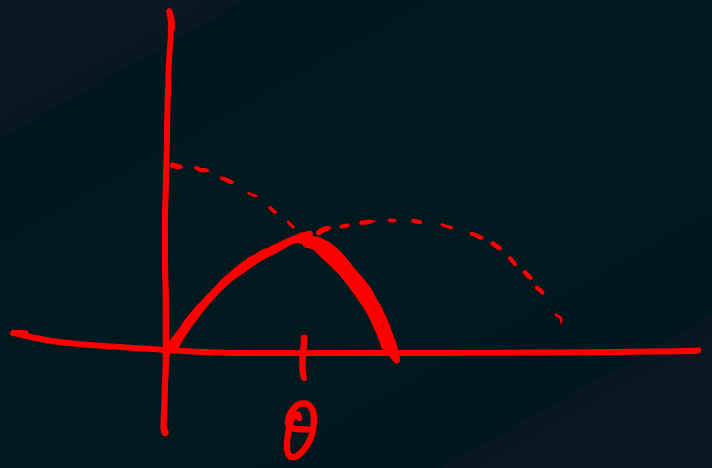


d.

SOLUTION

$f = mg\sin\theta$

$f = \mu mg\cos\theta \Rightarrow \mu N$



SOLUTION

When the plane is horizontal there will be no frictional force acting as there will be no driving force. The maximum angle for the which the block remains stationary is called the angle of repose

Let $\alpha =$ angle of repose
For $\theta \leq \alpha$, block is stationary and force of friction,

$$f = mg \sin\theta$$
Or $f \propto \sin\theta$

i.e, now it is sine graph
For $\theta \geq \alpha$ Block slides downwards

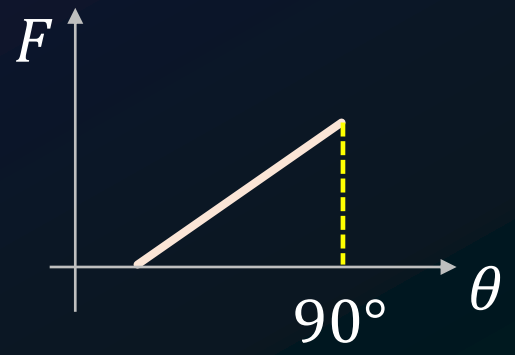
$$\therefore f = \mu mg \cos\theta$$
Or, $f \propto \cos\theta$

i.e, now it is cosine graph.

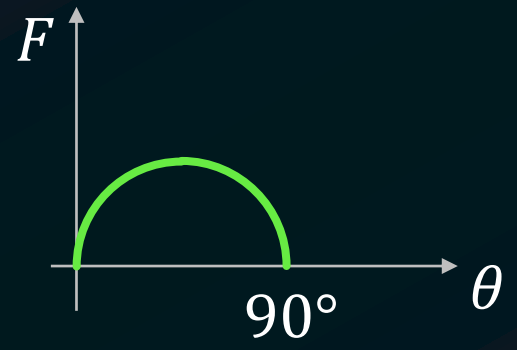
ANSWER

A block rests on a rough plane whose inclination θ to the horizontal can be varied. Which of the following graphs indicates how the frictional force F between the block and plane varies as θ is increased?

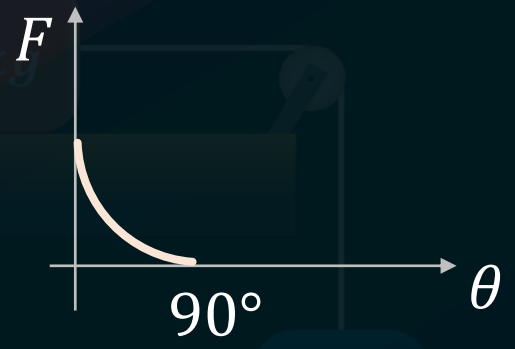
a.



b



c.



d.