# PHYSICS

# BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

# FORCE AND MOTION-II

## Sample Problem

**1.** A block of mass 2 kg is at rest on a floor . The coefficient of static friction between block and the floor is 0.54. A horizonatl force of 2.8 N is applied to the block . What should be the frictional force between the block and the floor ? ( take , $g = 10m / s^2$)

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**2.** Some of the funniest videos on the web involve motorists sliding uncontrollably on icy roads. Here let's compare the typical stopping distances for a car sliding to a stop from an initial speed of 10.0 m/s on a dry horizontal road, an icy horizontal road, and (everyone's favorite) an icy hill.

(a) How far does the car take to slide to a stop on a horizontal road (Fig.6-4a) if the coefficient of kinetic friction is $\mu_k = 0.60$, which is typical of regular tires on dry pavement? Let's neglect any effect of the air on the car, assume that the wheels lock up and the tires slide, and extend an x axis in the car's direction of motion.

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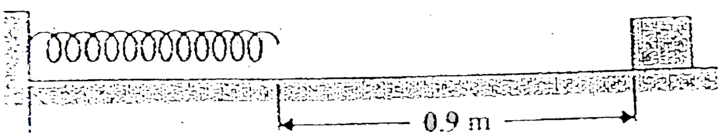
**3.** A block of mass 2.0 kg is given an initial speed along the floor towards a spring as shown. The coefficient of kinetic friction between the floor and the block is 0.4 and force constant of the spring is $5.6 \times 10^3$ N/m. The block compresses the spring by 10cm before it stops for a moment. What is the initial speed (m/s) of the block?

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**4.** A 68 kg crate is dragged across a floor by pulling on a rope attached to the crate and inclined $15^\circ$ above the horizontal.

(a) If the coefficient of static friction is 0.50, what minimum force magnitude is required from the rope to start the crate moving?

(b) If $\mu_k = 0.35$, what is the magnitude of the initial acceleration of the crate?

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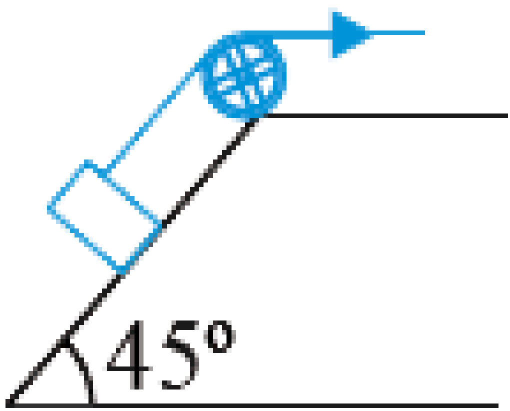
**5.** A block of mass 200kg is being pulled by mean on an inclined plane at angle of $45^{\circ}$ as shown. The coefficient of static friction of 0.5. Each man can only apply a maximum force of 500N. The number of men required for the block to just start moving up the plane is :

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**6.** Block B in Fig. 6-12 weighs 711 N. The coefficient of static friction between block and table is 0.25 angle $\theta$ is $30^\circ$, assume that the cord between B and the knot is horizontal. Find the maximum weight of block A for which the system will be stationary.

Figure 6-12 A block hanging from a knotted position.

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**7.** A block of mass $m_1$ is kept on a fixed inclined plane and attached to a block of mass $m_2$ by a rope as shown in Fig. 6-14a. The incline makes angle $\theta$ with horizontal and coefficient of friction is $\mu$. Find range of $m_2$ for which $m_1$ remains at rest (given $\theta > \tan^{-1} \mu_s$ ).

Figure 6-14 (a) A block of mass $m_1$ is kept on a fixed rough inclined plane and attached to a block of mass $m_2$ by a rope.

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**8.** A person pushes horizontally with a force of 220 N on a 55 kg crate to move it across a level floor. The coefficient of kinetic friction between the crate and the floor is 0.35. What is the magnitude of (a) the frictional force?

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**9.** REPRESENTATION OF VECTORS

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**10.** A block $m_1$ of mass 10 kg kept on a rough, horizontal surface is connected to a sphere $m_2$ of mass 1 kg by a string over an idcal pulley as shown in Fig. 6-18a. A force F of magnitude 50 N at an angle $37^\circ$ with the horizontal is applied to the block as shown and the block slides to the right. The coefficient of kinetic friction between the block and surface is 0.1. Determine the magnitude of the acceleration of the two objects.

Figure 6-18 (a) A block of mass m, connected to sphere of mass m, by a string over an ideal pulley.

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**11.** Blocks are given velocities as shown in Fig. 6-19a at t=0 s. Find velocity and position of 10 kg block at given values oft: (a) t = 1 s and (b) t=4s, (c) t = 4s and $\mu = 0.6$.

Figure 5.19 (a) A block kept on rough

horizontal rough table and attached to another block of mass 5 kg moving with initial speeds.

(a) t=1s.

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**12.** (a) Friction coefficient between blocks is 0.5 and between ground and 10 kg block is 0.2. Find acceleration of blocks if force F = 40 N is applied on 5 kg block as shown in Fig. 6-21a.

Figure 6-21 (a) Two blocks kept one over the other and force of 40 N applied on the upper block.

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**13.** A bar of mass $m_1$ is placed on a plank of mass $m_2$, which rests on a smooth horizontal plane (Fig. 6-24a). The coefficient of friction between the surfaces of the bar and the plank is equal to $\mu$. The plank is subjected to the horizontal force F depending on time t as F=

at (a is a constant).

A bar kept on a plank which is subjected to a horizontal force.

Find (a) the moment of time $t_0$ at which the plank starts sliding from under the bar and (b) the acceleration of the bar $a_1$ and that of plank $a_2$ during motion.

**14.** A rain drop with radus 1.5 mm falls from a cloud at a height 1200 m from ground . The density of water is 1000 $kg/m^3$ and density of air is $1.2 kg/m^3$. Assume the drop was spherical throughout the fall and there is no air drag. The impact speed of the drop will be :

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Checkpoints

**1.** A block lies on a floor. (a) What is the magnitude of the frictional force on it from the floor ? (b) If a horizontal force of 5N is now applied to the block. But the block dose not move. What is the magnitude of the fricition on it ? (c) If the maximum value $f_{c\max}$ of the static frictional force on the block is 10 N, will the block move if the magnitude of the horizontally applied force is 8 N? (d) If it is 12 N ? (e) What is te magnitude of the frictional force in part (c) ?

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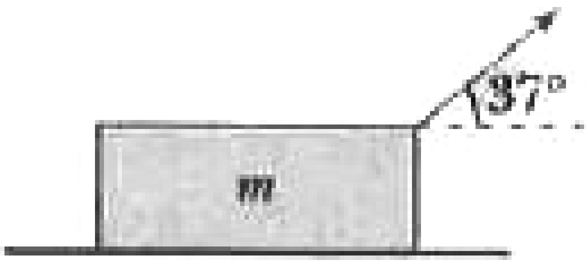
**2.** If a block kept on rough horizontal surface is pulled to an angle by applying 100 N force at $37^{\circ}$ with horizontal as depicted in the figure, find the force of friction acting aon the block. Given that $m = 20kg$ and $\mu_s = 0.5$

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**3.** A student wants to determine the coefficients of static frction and kinetic friciton between a box and a plank. She places the box on the plank and gradually raises on end on of the plank. When the angle of inclination with horizontal reaches $30^\circ$ , the box stars to slip, and it then slides 2.5m dwon the plank in 4.0 s at constant acceleration. What are (a) the coefficient of static frictio and (b) the coefficient of kinetic friction between the box and the plank ?

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**4.** A block of mass m slips on a rough horizontal table under the action of horiozontal force applied to it. The coefficient of friction between the block and the table is $\mu$. The table does not move on the floor. Find the total frictional force applied by the floor on the legs of the table. Do you need the friction coefficient between the table and the floor or the mass of the table?

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**5.** Find maximum force for which the two blocks can move together.

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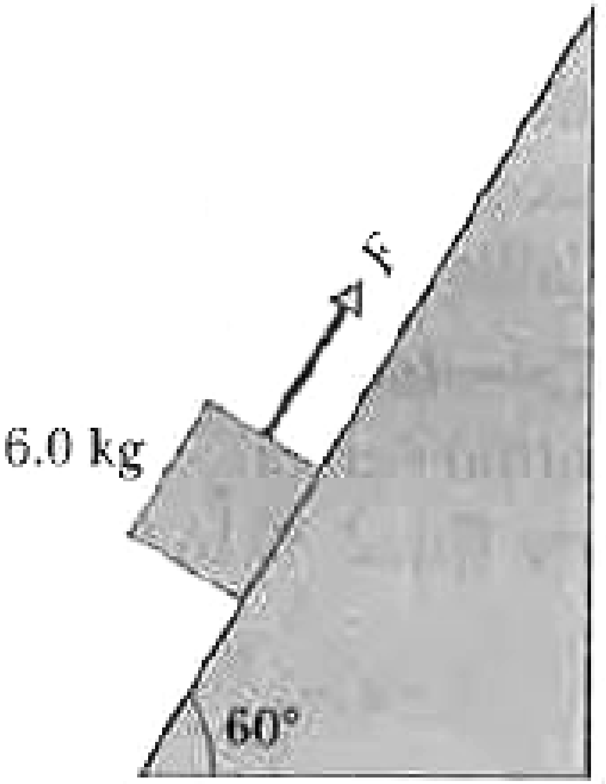
## Problems

**1.** Figure 6-28 shows a 6.0 kg block on a $60^{\circ}$ ramp with a coefficient of static friction of 0.60. A force $\overrightarrow{F}$ is applied up the ramp. What magnitude of that force puts the block on the verge of sliding down the ramp? 6.0 kg

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**2.** In a pickup game of dorm shuffleboard, students crazed by final exams use a broom to propel a calculus book along the dorm hallway. If the 3.5 kg book is pushed from rest through a distance of 1.20 m by the horizontal 25 N force from the broom and then has a speed of 1.75 m/s, what is the coefficient of kinetic friction between the book and floor?

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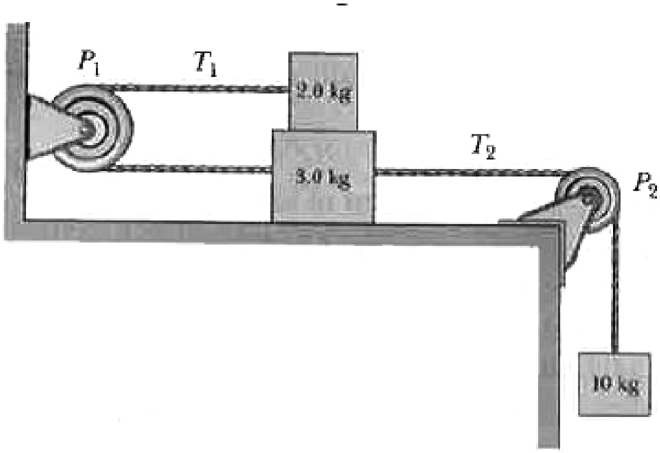
**3.** In Fig. 6-29, a 2.0 kg block is placed on top of a 3.0 kg block, which lies on a frictionless surface. The coefficient of kinetic friction between the two blocks is 0.30, they are connected via a pulley and a string. A hanging block of mass 10 kg is connected to the 3.0 kg block via another pulley and string. Both strings have negligible mass and both pulleys are frictionless and have negligible mass. When the assembly is released, what are (a) the acceleration magnitude of the blocks, (b) the tension in string 1, and (c) the tension in string 2?

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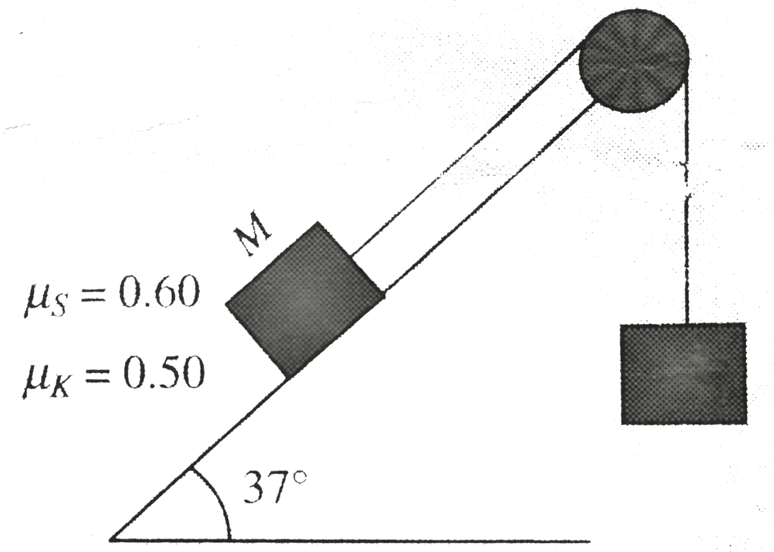
**4.** Two block $M$ and and m are arranged as shows in figure . If $M = 50kg$ then determine the minimum and maximum value of mass of block the heavy block $M$ stationary

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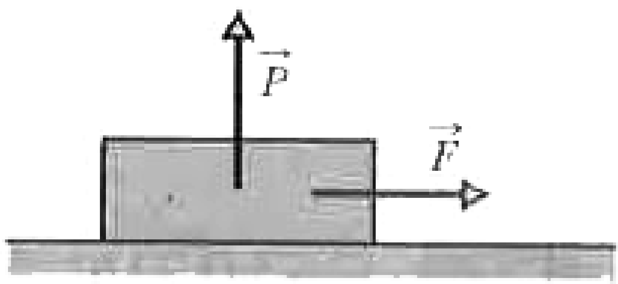
5. A 2.5 kg block is initially at rest on a horizontal surface. A horizontal force $\vec{F}$ of magnitude 6.0 N and a vertical force $\vec{P}$ are

then applied to the block (Fig. 6-31). The coefficients of friction for the block and surface are $\mu = 0.40$ and $\mu = 0.25$. Determine the magnitude of the frictional force acting on the block if the magnitude of $\vec{P}$ is (a) 8.0 N. (b) 10 N, and (c) 12 N

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**6.** A body of mass 2 kg is moving on the ground comes to rest after some time. The coefficient of kinetic friction between the body and the ground is 0.2. The etardation in the body is

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**7.** The mysterious sliding stones. Along the remote Racetrack Play a in Death Valley, California, stones sometimes gouge out prominent trails in the desert floor, as if the stones had been migrating (Fig. 6-32). For years curiosity mounted about why the stones moved. One explanation was that strong winds during occasional rainstorms would drag the rough stones over ground softened by rain. When the desert dried out, the trails behind the stones were hardbaked in place. According to measurements, the coefficient of kinetic friction between the stones and the wet playa ground is about 0.80. What horizontal force must act on a 20 kg stone (a typical mass) to maintain the stone's motion once a gust has started it moving? (Story continues with Problem 34.)

Jerry Schad/Photo Researchers, Inc.

Figure 6-32 Problem 7. What moved the stone?

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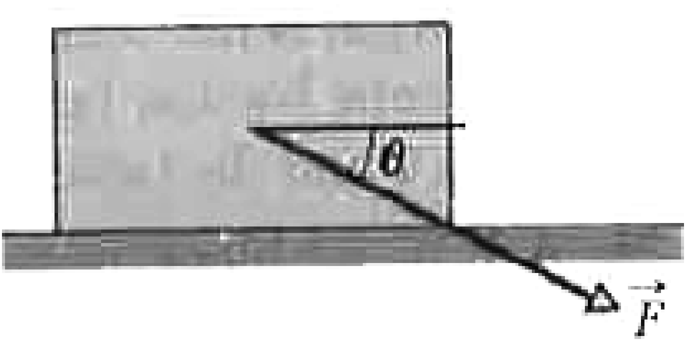
**8.** A 3.5 kg block is pushed along a horizontal floor by a force $\overrightarrow{F}$ of magnitude 15 N at an angle $\theta = 40^\circ$ with the horizontal (Fig. 6-33). The coefficient of kinetic friction between the block and the floor is 0.25. Calculate the magnitudes of (a) the frictional force on the block from the floor and (b) the block's acceleration.

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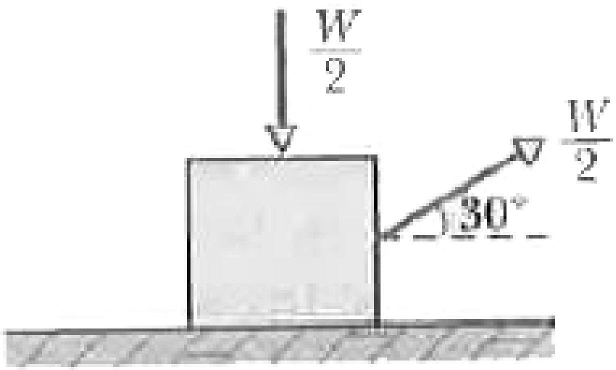
**9.** In Fig. 6-34 a block of weight W experiences two applied forces, each of magnitude W/2. What coefficient of static friction between the block and the floor puts the block on the verge of sliding?

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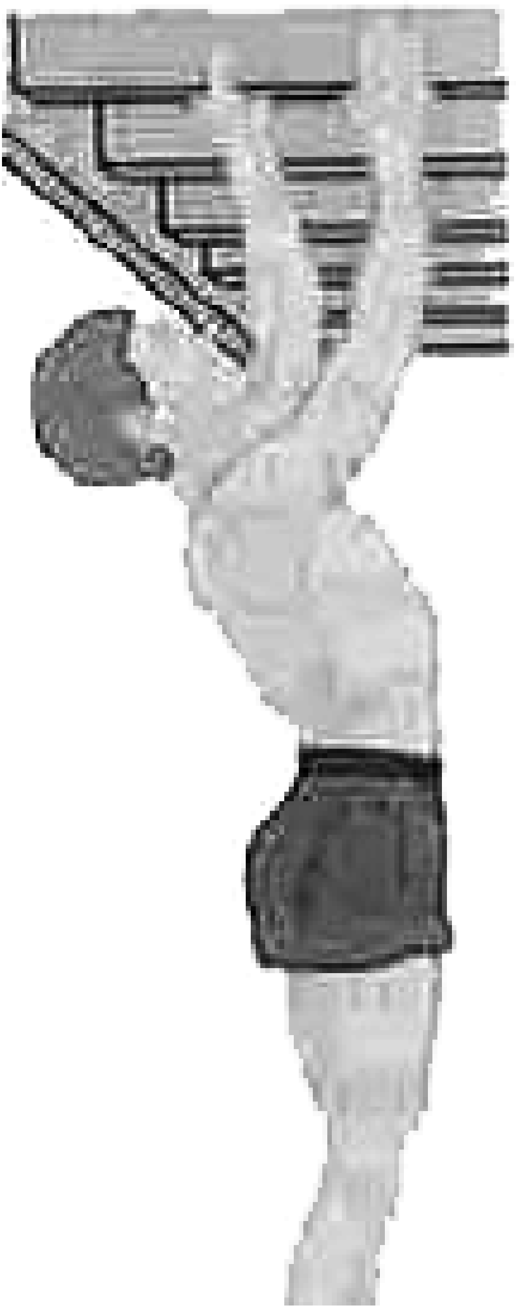
**10.** In about 1915, Henry Sincosky of Philadelphia suspended himself from a rafter by gripping the rafter with the thumb of each hand on one side and the fingers on the opposite side (Fig. 6-35). Sincosky's mass was 79 kg. If the coefficient of static friction between hand and rafter was 0.70, what was the least magnitude of the normal force on the rafter from each thumb or opposite fingers? (After suspending himself, Sincosky chinned himself on the rafter and then moved hand-over-hand along the rafter. If you do not think Sincosky's grip was remarkable, try to repeat his stunt.)



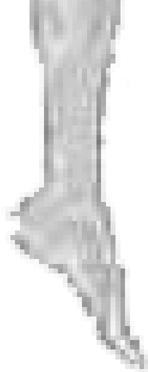


Figure 6-35

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11. A crate of mass 20 kg is sliding across a wooden floor. The coefficient of kinetic friction between the crate and the floor is 0.3.

Determine the magnitude of the friction force acting on the crate.

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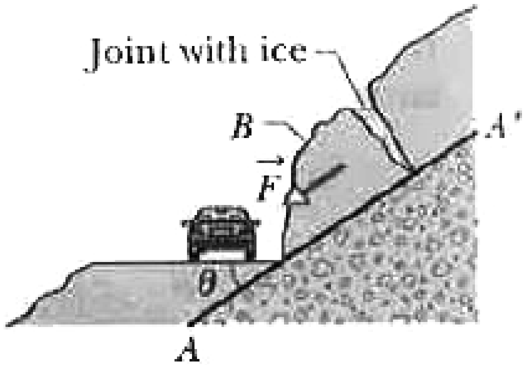
**12.** Figure 6-36 shows the cross section of a road cut Joint with ice into the side of a mountain. The solid line AA' represents a weak bedding plane along which sliding is possible. Block B directly above the highway is separated from uphill rock by a large crack (called a joint), so that only friction between the block and the bedding plane prevents sliding. The mass of the block is $1.5 \times 10^7 kg$, the dip angle $\theta$ of the bedding plane is $24^\circ$, and the coefficient of static friction between block and plane is 0.63. (a) Show that the block will not slide under these circumstances. (b) Next, water seeps into the joint and expands upon freezing, exerting on the block a force F parallel to AA'. What minimum value of force magnitude $\overrightarrow{F}$ will trigger a slide down the plane?

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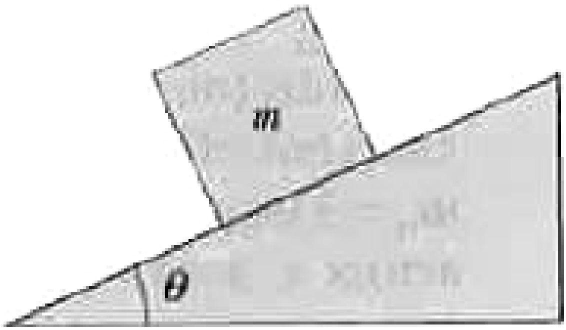
**13.** In Fig. 6-37, a block of mass m = 5.0 kg is at rest on a ramp. The coefficient of static friction between the block and ramp is not known. Find the magnitude of the net force exerted by the ramp on the block.

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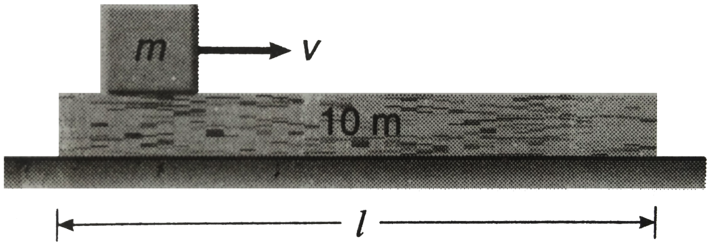
14. A small block of mass $m$ is projected on a larger block of mass $10m$ and length $l$ with a velocity $v$ as shown in the figure. The coefficient of friction between the two block is $\mu_2$ while that between the lower block and the

ground is $\mu_1$. Given that $\mu_2 > 11\mu_1$.




(a) Find the minimum value of $v$, such that the mass $m$ falls off the block of mass $10m$ .

(b) If $v$ has minimum value, find the time taken by block $m$ to do so.

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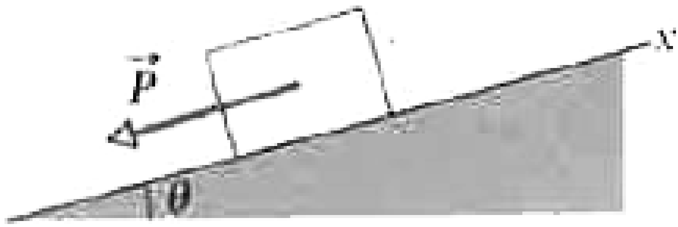
**15.** In Fig. 6-29, a force $\overrightarrow{P}$ acts on a block weighing 45 N. The block is initially at rest on a plane inclined at angle $\theta = 15^\circ$ to the horizontal. The positive direction of the r axis is up the plane. Between block and plane, the coefficient of static friction is $\mu_s = 0.50$ and the coefficient of kinetic friction is $\mu_k = 0.34$. In unitvector notation, what is the frictional force on the block from the plane when $\overrightarrow{P}$ is

(a)

$(-5.0N)\hat{\imath}, (b)(-8.0N)\hat{\imath},\ \text{and}\ (c)(-15N)\hat{\imath}$

?

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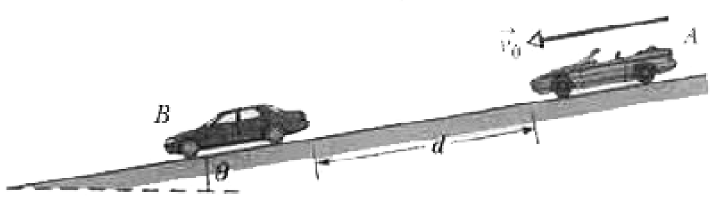
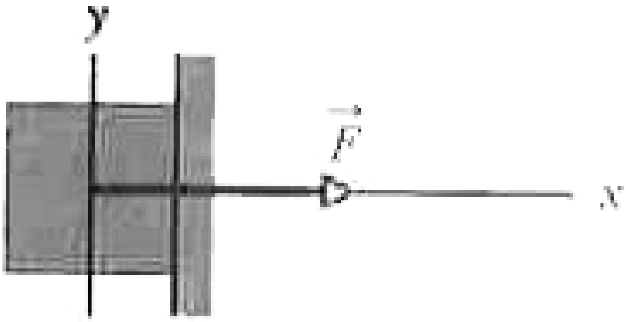
**16.** You testify as an expert witness in a case involving an accident in which car A slid into the rear of car B, which was stopped at a red light along a road headed down a hill (Fig. 6-40). You find that the slope of the hill is

$\theta = 1.0^\circ$, that the cars were separated by distance d = 30.0 m when the driver of car A put the car into a slide (it lacked any automatic anti-brake-lock system), and that the speed of car A at the onset of braking was $v = 18.0$ m/s. With what speed did car A hit car B if the coefficient of kinetic friction was (a) 0.60 (dry road surface) and (b) 0.10 (road surface covered with wet leaves)? mu Figure 6-20 Problem 16



**17.** A 12 N horizontal force $\vec{F}$ pushes a block weighing 5.0 N against a vertical wall (Fig. 6-41). The coefficient of static friction between the wall and the block is 0.00, and the . coefficient of kinetic friction is 0.40. Assume that the block is not moving initially. (a) Will the block move? (b) In unit-vector notation, what is the force on the block from the wall?

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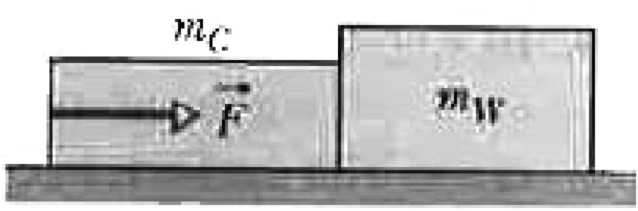
**18.** In Fig. 6-42, a box of Cheerios (mass $m_c = 1.0 kg$) and a box of Wheaties (mass $m_w = 3.0 kg$) are accelerated across a horizontal surface by a horizontal force $\vec{F}$ applied to the Cheerios box. The magnitude of the frictional force on the Cheerios box is 2.0 N, and the magnitude of the frictional force on the Wheaties box is 3.5 N. If the magnitude of $\vec{F}$ is 12 N, what is the magnitude of the force on the Wheaties box from the Cheerios box?

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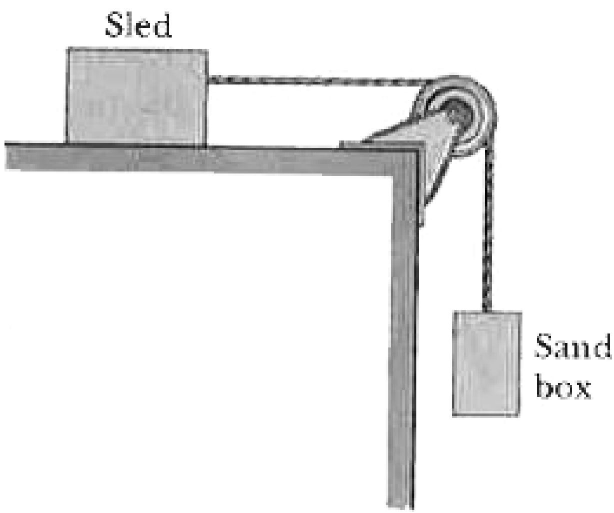
**19.** In Fig. 6-43, a 15 kg sled is attached to a 2.0 kg sand box by a string of negligible mass, wrapped over a pulley of negligible mass and friction. The coefficient of kinetic friction between the sled and table top is 0.040. Find (a) the acceleration of the sled and (b) the tension of the string.

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**20.** In Fig. 6-44a, a sled is held on an inclined plane by a cord pulling directly up the plane. The sled is to be on the verge of moving up the plane. In Fig. 6-44h, the magnitude F required of the cord's force on the sled is plotted versus a range of values for the coefficient of static friction u between sled and plane: $F_1 2.0 N$, $F_2 = 5.0 N$, and $\mu_2 = 0.25$. At what angle $\theta$ is the plane inclined?

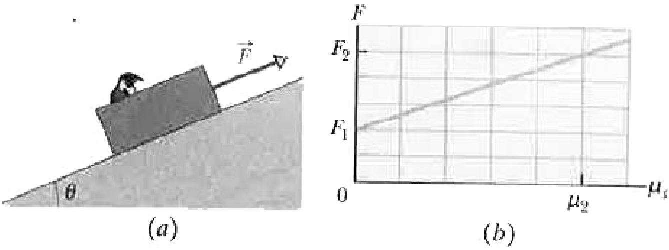


Figure 6-44 Problem 20.

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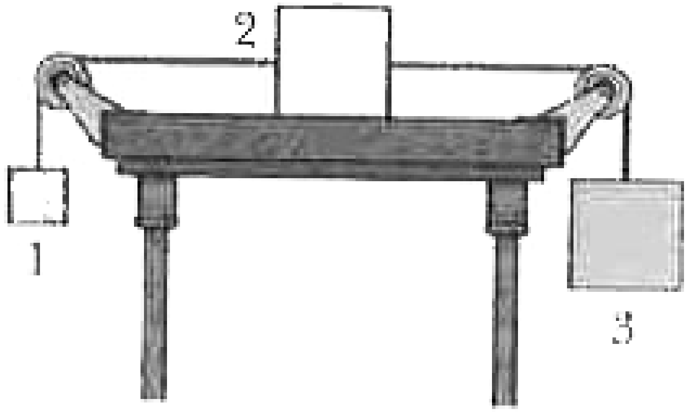
**21.** When the three blocks in Fig. 6-45 are released from rest, they accelerate with a magnitude of 0.500 m/s2 Block 1 has mass M, block 2 has 2M, and block 3 has 2M. What is the coefficient of kinetic friction between block

2 and the table?

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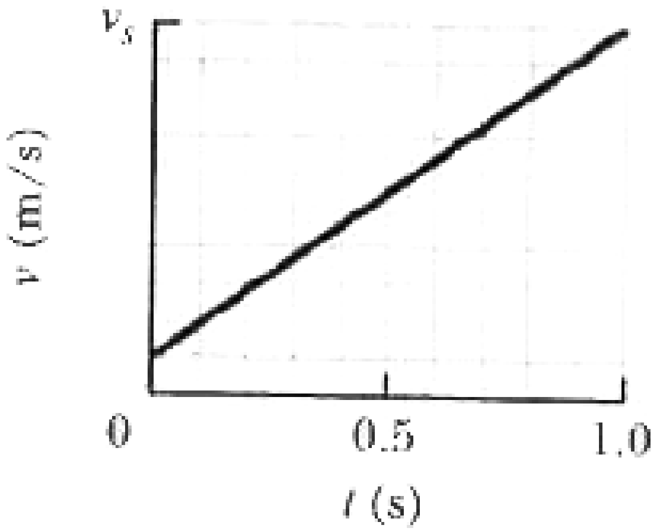
**22.** A 4.10 kg block is pushed along a floor by a constant applied force that is horizontal and has a magnitude of 50.0 N. Figure 6-46 gives the block's speed v versus time t as the block moves 0.5 1.0 along an x axis on the floor. The scale of the figure's vertical axis is set by $v_s = 5.0$ m/s. What is the coefficient of kinetic friction between the block and the floor?

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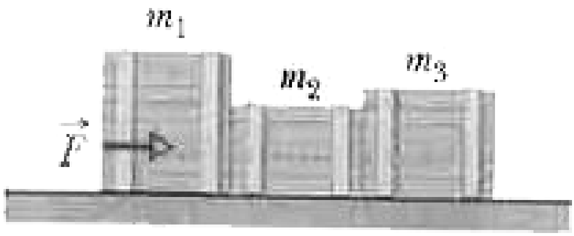
**23.** Figure 6-47 shows three crates being pushed over a concrete floor by a horizontal force F of magnitude 425 N. The masses of the crates are

$m_1 = 30.0kg, m_2 = 10.0kg,$ and $m_3 = 20.0kg$

The coefficient of kinetic friction between the floor and each of the crates is 0.700. (a) What is the magnitude $F_{32}$ of the force on crate 3 from crate 2? (b) If the crates then slide onto a polished floor, where the coefficient of kinetic friction is less than 0.700, is magnitude $F_{32}$ more than, less than, or the same as it was when the coefficient was 0.700?

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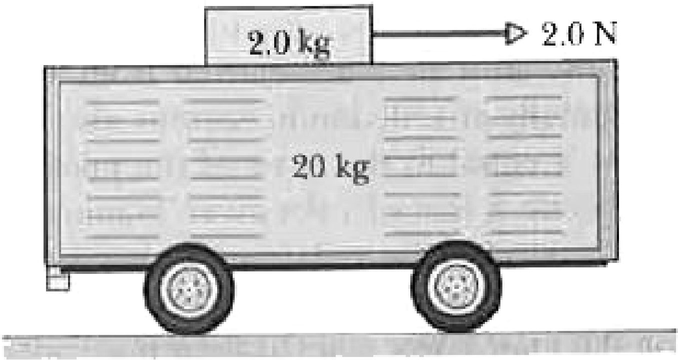
**24.** In Fig. 6-48, a 2.0 kg block lies on a 20 kg trolley that can roll across a floor on frictionless bearings. Between the block and the trolley, the coefficient of kinetic friction is 0.20 and the coefficient of static friction is 0.25. When a horizontal 2.0 N force is applied to the block, what are the magnitudes of (a) the frictional force between the block and the trolley and (b) the acceleration of the trolley?

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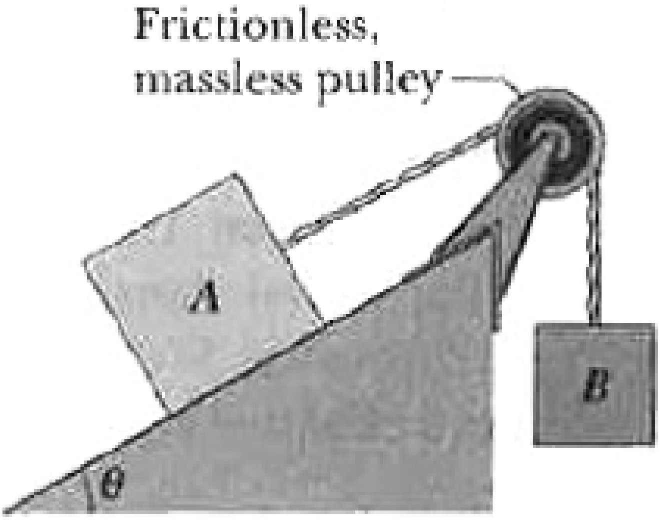
**25.** In Fig. 6-49, two blocks are connected over a pulley. The mass of block A is 15 kg, and the coefficient of kinetic friction between A and the incline is 0.20 Angle $\theta$ of the incline is $30^{\circ}$.

Block A slides down the incline at constant speed. What is the mass of block B?

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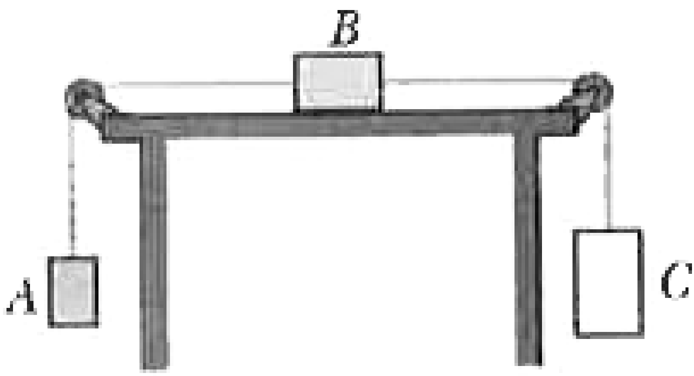
**26.** In Fig. 6-50, block A of mass 2.0 kg, block B of 3.0kg, and block Cof 6.0 kg are connected by strings of negligible mass that run over pulleys of negligible mass and friction. The coef ficient of kinetic friction between block B and the table top is 0.40. When the system is released, the blocks move. What is the magnitude of their acceleration?



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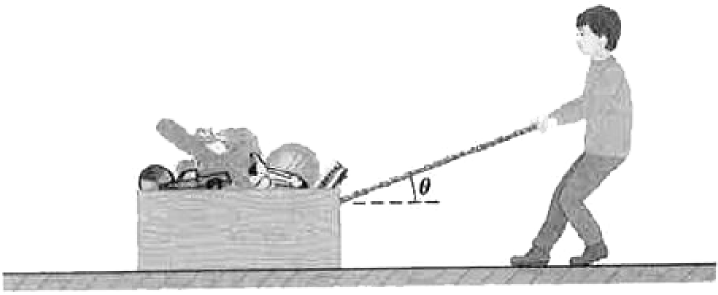
**27.** A toy chest and its contents have a combined weight of 200 N. The coefficient of static friction between toy chest and floor is 0.47. The child in Fig. 6-51 attempts to move the chest across the floor by pulling on an attached rope. (a) If $\theta$ is $42^{\circ}$ what is the magnitude of the force F that the child must exert on the rope to put the chest on the verge of moving? (b) Write an expression for the magnitude Frequired to put the chest on the verge of moving as a function of the angle $\theta$. Determine (c) the value of $\theta$ for which F is a minimum and (d) that minimum magnitude.

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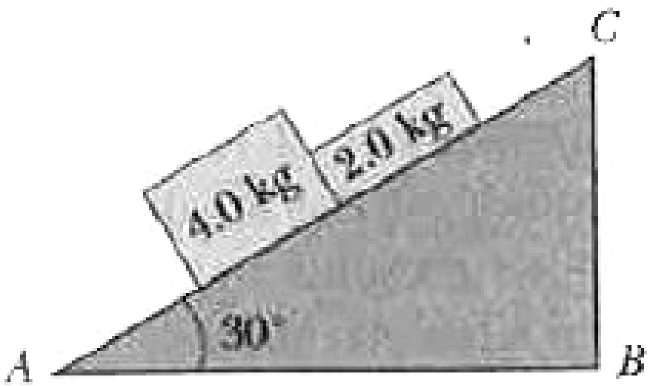
**28.** In Fig. 6-52, two blocks, in contact, slide down an inclined plane AC of inclination $30^\circ$. The coefficient of kinetic friction between the

2.0 kg block and the incline is $u_1 = 0.20$ and that between the 4.0 kg block and the incline is $\mu_2 = 0.30$. Find the magnitude of the acceleration.

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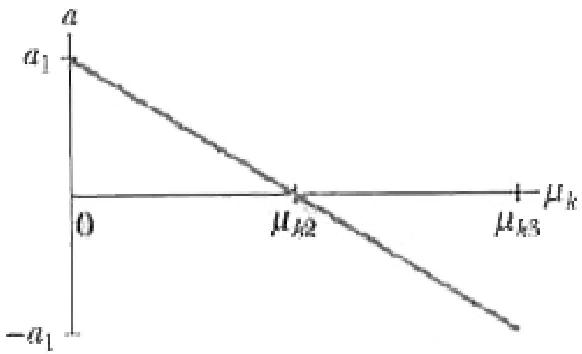
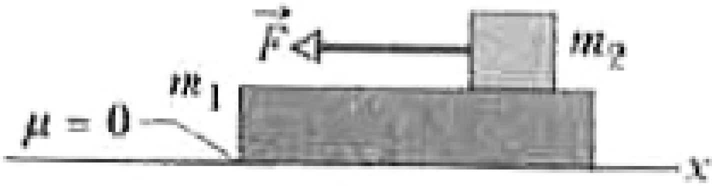
**29.** A block is pushed across a floor by a constant force that is applied at downward angle $\theta$ (Fig. 6-33). Figure 6-53 gives the acceleration magnitude a versus a range of values for the coefficient of kinetic friction $\mu_k$ between block and floor: $a_1 = 3.0 m/s^2 \mu_2 = 0.20,$ and $\mu_{k3} = 0.40.$

What is the value of $\theta$ ?



**30.** In Fig. 6-54, a slab of mass $m_1 = 40$ kg rests on a frictionless floor, and a block of mass $m_2 = 12$ kg rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force $\overrightarrow{F}$ of magnitude 120 N begins to pull directly on the the block, as shown. In unit-vector notation, what are the resulting accelerations of (a) the block and (b) the slab?

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**31.** A water droplet 4.0 mm in diameter is falling with a speed of 10 km/h at an altitude of 20 km. Another droplet 6.0 mm in diameter is falling at 25% of that speed and at 25% of that altitude. The density of air at 20 km is

$0.20kg/m^3$and that at 5.0 km is $0.70kg/m^3$ Assume that the drag coefficient C is the same for the two drops. Find the ratio of the drag force on the higher drop to that on the lower drop.

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**32.** Continuation of Problem z Now assume that Eq, 6-29 gives the magnitude of the air drag force on the typical 20 kg stone, which presents to the wind a vertical crosssectional area of 0.040 m2 and has a drag coefficient C of 0.80.Take the air density to be $1.21 kg/m^3$ and the coefficient of kinetic friction to be 0.80. (a) In kilometers per hour, what wind speed Valong the ground is needed to maintain the stone's motion once it has started moving? Because winds along the ground are retarded by the ground, the wind speeds reported for storms are often measured at a height of 10 m. Assume wind speeds are 2.00 times those along the ground. (b) For your answer to (a), what wind speed would be reported for the storm? (c) Is that value reasonable for a high speed wind in a storm?

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**33.** Assume Eq. 6-29 gives the drag force on a pilot plus ejec-tion seat just after they are ejected from a plane traveling horizontally at 1300 km/h. Assume also that the mass of the seat is equal to the mass of the pilot and that the drag coefficient is that of a sky diver. Making a reasonable guess of the pilot's mass and using the appropriate v, value from Table 6-2, estimate the magnitudes of (a) the drag force on the pilot + seat and (b) their horizontal deceleration (in terms of g), both just after ejection. (The result of (a) should indicate an engineering requirement: The seat must include a protective barrier to deflect the initial wind blast away from the pilot's head.)

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## Practice Questions Single Correct Choice Type

**1.** A person, sunbathing on a warm day, is lying horizontally on the deck of a boat. Her mass is 59 kg, and the coefficient of static friction between the deck and her is 0.70. Assume that the person is moving horizontally, and that the static frictional force is the only force acting on her in this direction. What is the magnitude of the static frictional force when the boat moves with a constant velocity of +8.0 m/s?

A. 94N

B. 370 N

C. zero N

D. 130 N

**Answer: C**

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**2.** The wheels of an automobile are locked as it slides to a stop from an initial speed of 30.0 m/s. If the coefficient of kinetic friction is 0.600

and the road is horizontal, approximately how long does it take the car to stop?

A. $4.22s$

B. $5.10s$

C. $8.75s$

D. $10.4s$

**Answer: B**

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**3.** A body of mass M is kept n a rough horizontal surfasce (friction coefficient $= \mu$). A person is trying to pull he body by applying a horizontal force but the body is not moving. The force by the surface on A is F, where

A. $F = Mg$

B. $F = \mu Mg$

C. $Mg \leq F \leq Mg\sqrt{1+\mu^2}$

D. $Mg \geq F \geq Mg\sqrt{1-\mu^2}$

**Answer: C**

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**4.** A smooth block is released at rest on a $45^\circ$ incline and then slides a distance $d$. The time taken to slide is n times as much to slide on rough incline than on a smooth incline. The coefficient of friction is

A. $\mu_s = 1 - \frac{1}{n^2}$

B. $\mu_k = \sqrt{1 - \frac{1}{n^2}}$

C. $\mu_s = 1 - \frac{1}{n^2}$

D. $\mu_s = \sqrt{1 - \frac{1}{n^2}}$

**Answer: A**

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**5.** A boy pulls a sled of mass 5.0 kg with a rope that makes a $60.0^\circ$ angle with respect to the horizontal surface of a frozen pond. The boy pulls on the rope with a force of 10.0 N, and the sled moves with constant velocity. What is the coefficient of friction between the sled and the ice?

A. $0.09$

B. $0.18$

C. $0.24$

D. $0.12$

**Answer: C**

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**6.** A 6.00 kg box is sliding across the horizontal floor of an elevator. The coefficient of kinetic friction between the box and the floor is 0.360. Determine the kinetic frictional force that acts on the box when the elevator is stationary.

A. $18.6N$

B. $22.4B$

C. $21.2N$

D. $23.8N$

**Answer: A**

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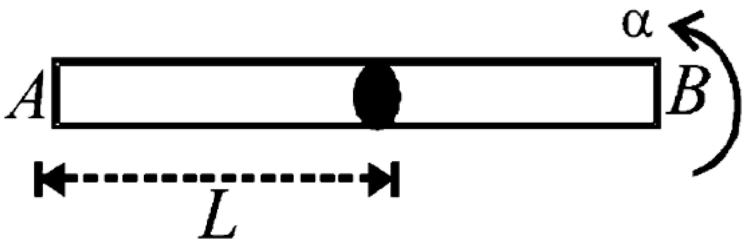
7. A long horizontal rod has a bead which can slide along its length and initially placed at a




distance L from one end A of the rod. The rod is set in angular motion about A with constant angular acceleration $\alpha$. if the coefficient of friction between the rod and the bead is $\mu$, and gravity is neglected, then the time after which the bead starts slipping is

A. $\sqrt{\frac{\mu}{a}}$

B. $\frac{\mu}{\sqrt{\alpha}}$

C. $\frac{L}{\sqrt{\alpha}}$

D. Infinitesimal

**Answer: D**

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**8.** A scooter starting from rest moves wilth as constant acceleration for a time $\triangle t_1$, then with a constant velocity for the next $\triangle t_2$ and finally with a constant deceleration for the next $\triangle t_3$ to come to rest with resect to the scooter wilthout touching any other part. The force exerted by the seat on the man is

A. 500 N throughout the journey

B. less than 500 N throughout the journey.

C. more than 500 N throughout the journey.

D. $> 500N$ for time

$\Delta t_1$ and $\Delta t_3$ and $500N$ for $\Delta t_2$

**Answer: D**

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**9.** A 10 kg block is set moving with an initial speed of 6 m/s on a rough horizontal surface. If the force of friction is 20 N, approximately how far does the block travel before it stops?

A. $1.5m$

B. 6 m

C. 3 m

D. 9 m

**Answer: D**

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**10.** Traveling at a speed of 16.1 m/s, the driver of an automobile suddenly locks the wheels by slamming on the brakes. The coefficient of kinetic friction between the tires and the road is 0.720. What is the speed of the automobile after 1.30 s have elapsed? Ignore the effects of air resistance

A. $5.2m/s$

B. $6.9m/s$

C. $9.2m/s$

D. $5.7m/s$

**Answer:**

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**11.** A block of mass 2kg rests on a rough inclined plane making an angle of $30^\circ$ with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is

A. $9.8N$

B. $0.7 \times 9.8 \times \sqrt{4}$

C. $9.8 \times \sqrt{3}N$

D. $0.7 \times 9.8N$

**Answer: A**

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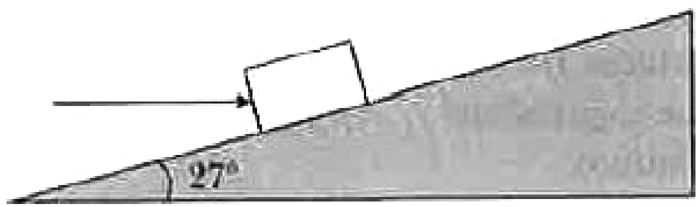
**12.** A 250 N force is directed horizontally as shown in the figure to push a 29 kg box up an inclined plane at a constant speed. Determine the magnitude of the normal force, $F_N$ and the coefficient of kinetic friction, $\mu_2$



A. $\begin{matrix} F_N & \mu_k \\ 330N & 0.31 \end{matrix}$

B. $\begin{matrix} F_N & \mu_k \\ 310N & 0.33 \end{matrix}$

C. $\begin{matrix} F_N & \mu_k \\ 290N & 0.30 \end{matrix}$

D. $\begin{matrix} F_N & \mu_k \\ 370N & 0.26 \end{matrix}$

**Answer: D**

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**13.** A body of mass m kept on the floor of a lift moving downwards is pulled horizontally. If $\mu$

is the coefficient of friction between the surface in contact, then

A. frictional resistance offered by the floor is 2 $\mu mg$, when lift moves up with a uniform velocity of 5 m/s.

B. rictional resistance offered by the floor is $\mu umg$, when lift moves lift moves up with uniform velocity of 3 m/s.

C. frictional resistance offered by the floor is $4.8\mu mg$, when lift accelerates down with an acceleration of $4.8m/s^2$

D. frictional resistance offered by the floor must lie in the range $0 \leq f < \infty$

**Answer: B**

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**14.** A body of mass $M$ is applying horizontal force to slide a box of mass $M_1$ on a rough horizontal surface The coefficient of friction between the shoe of the boy and the floor is $\mu$

and that between the box and the floor is $'\mu_1'$ In which of the following cases is it certainly not possible to slide the box ? .

A. $\mu < \mu, M < M'$

B. $\mu > \mu', M < M'$

C. $\mu < \mu', M > M'$

D. $\mu > \mu' M > M'$

**Answer: A**

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**15.** Is large brake on a bicycle wheel more effective than a small one ? Explain

A. the force of friction is independent of the area of contact

B. the force of friction is directly proportional to the area of contact.

C. the force of friction is dependent on the frame of reference.

D. the force of friction is independent on the frame of reference.

**Answer: A**

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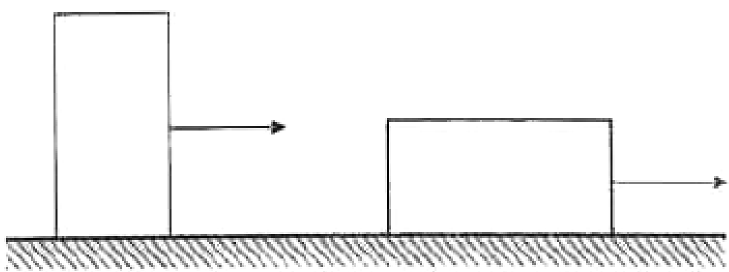
**16.** Two identical blocks are pulled along a rough surface as suggested in the figure. Which one of the following statements is false?



A. The coefficient of kinetic friction is the same in each case.

B. A force of the same magnitude is needed to keep each block moving

C. A force of the same magnitude was required to start each block moving.

D. The magnitude of the force of kinetic friction is greater for the block on the right

**Answer: D**

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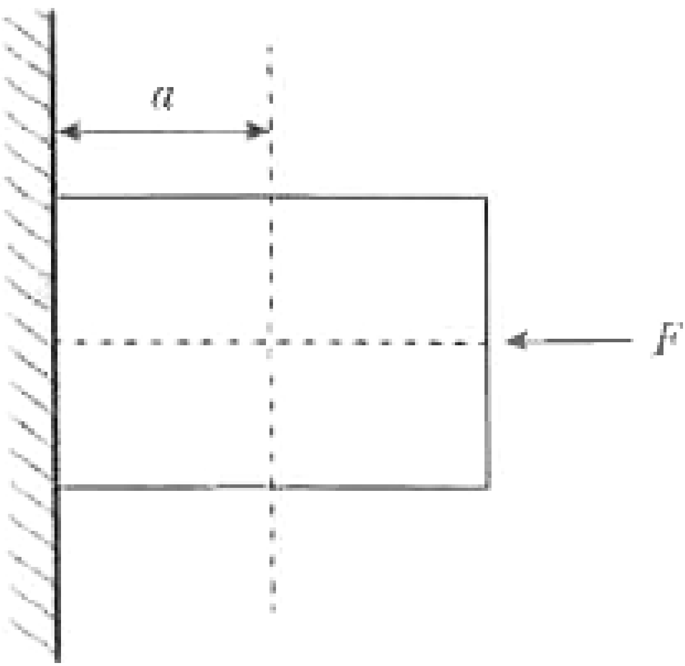
**17.** A block of mass m is at rest under the action of force F against a wall as shown in the figure. Which of the following statements is incorrect?



A. f = mg (where f is frictional force)

B. F-N (where N is normal force)

C. No net torque acts on the block

D. N will not produce torque

**Answer: D**

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**18.** A block of mass 0.1 is held against a wall applying a horizontal force of 5N on block. If the coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is:

A. $2.5N$

B. $0.98N$

C. $4.9N$

D. $0.49N$

**Answer: B**

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**19.** A block of mass is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is:

A. $\frac{1}{6}m$

B. $\frac{2}{3}m$

C. $\frac{1}{3}m$

D. $\frac{1}{2}m$

**Answer:**

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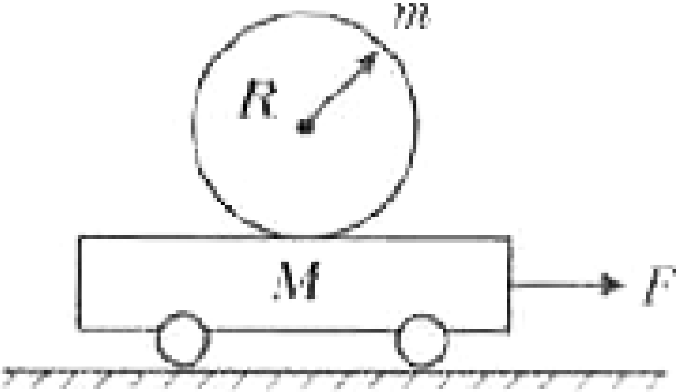
**20.** A sphere of mass m and radius R is kept on a trolley of mass Mas shown in the figure. The coefficient of static and kinetic friction between the sphere and the trolley are $\mu_s$ and $\mu_k$ respectively. The maximum horizontal force F that can be applied to the trolley for which the solid sphere does not slip is




A. $\mu_s g\left( + \frac{7}{2}M\right)$

B. $\mu_k g\left( + \frac{7}{2}M\right)$

C. $\mu_s g\left( + \frac{5}{2}M\right)$

D. $\frac{9}{2}\mu_s mg$

**Answer: A**

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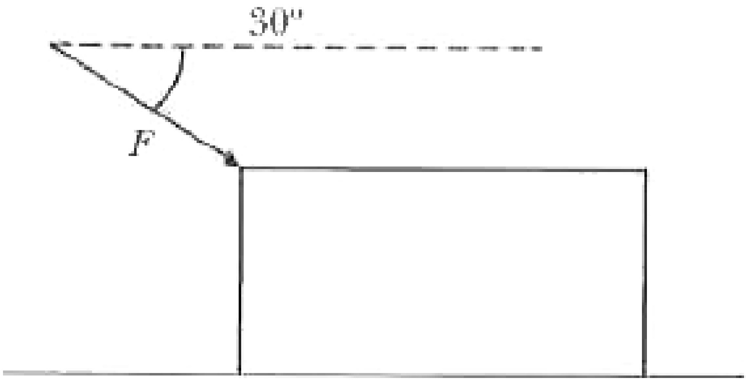
**21.** A force of F = 12.0 N is applied to a 8.00 kg block at a downward angle of $30^\circ$ as shown in the figure.




The coefficient of static friction between the block and the floor is 0.700 and the coefficient of kinetic friction is 0.400. What is the magnitude of the frictional force on the block?

A. 19 N

B. 59 N

C. $12\sqrt{3}N$

D. $6\sqrt{3}N$

**Answer: D**

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**22.** A crate rests on the flatbed of a truck that is initially traveling at 15 m/s on a level road. The driver applies the brakes and the truck is brought to a halt in a distance of 38 m. If the deceleration of the truck is constant, what is the minimum coefficient of friction between the crate and the truck that is required to keep the crate from sliding?

A. $0.20$

B. $0.39$

C. $0.30$

D. $0.59$

**Answer: C**

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**23.** A 225 kg crate rests on a surface that is inclined above the horizontal at an angle of $20.0^\circ$.A horizontal force (magnitude = 535 N and parallel to the ground, not the incline) is required to start the crate moving down the incline. What is the coefficient of static friction between the crate and the incline?

A. $0.425$

B. $0.592$

C. $0.665$

D. $0.740$

**Answer: C**

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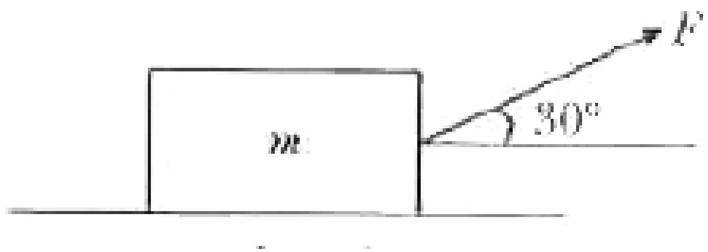
## Practice Questions More Than One Correct Choice Type

**1.** A mass m is at rest under the action of a force F. as shown in the figure, on a horizontal surface. The coefficient of friction between mass and surface is u. Then, find the correct choice(s)



A. The force of friction between the mass and surface is $F\sqrt{3}/2$

B. The force of friction between the mass and surface is $\mu mg$.

C. Normal force is (mg +F)

D. Normal force is (mg - F/2)

**Answer: A::D**

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**2.** Consider a vehicle going on a horizontal rod towards east. Neglect any force by the air. The frictional forces on the vehicle by the road

A. is towards east if the vehicle is accelerating

B. is zero if the vehicle is moving with a uniform velocity.

C. must be towards east.

D. must be towards west.

**Answer: A::B**

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**3.** Mark the correct statement (s) regarding friction .

A. Friction force can be zero, even though the contact surface is rough

B. Even though there is no relative motion between surfaces, frictional force may exist between them.

C. The expressions $f_L = \mu_s F_N$ or $f_k F_N$, are empirical relations.

D. The expression $f_L = \mu_s F_N$ says that direction of $f_L$ and $F_N$ are the same

**Answer: A::B::C**

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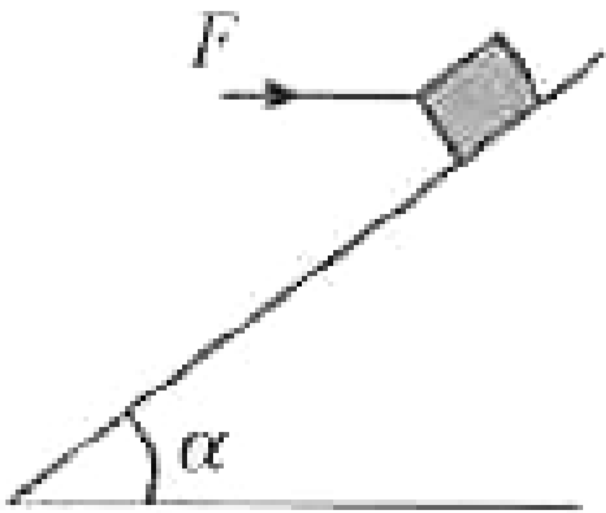
**4.** A block of mass m in the equilib rium on a rough inclined plane with inclination $\alpha$ and coefficient of friction as shown in the figure $(\mu < \tan\alpha)$. A force F is applied on the block which makes an angle $\theta$ with the horizontal as shown in diagram.



A. Normal force on the block

$mg\cos\alpha + F\sin\theta.$

B. Minimum force f to keep the blockin

equilibrium

$$F_{\min} = \frac{mg(\sin\alpha - \mu\cos\alpha)}{2\mu}\sqrt{1+\mu^2}$$

C. $\mu = \tan\theta$

D. None of these

**Answer: A::C**

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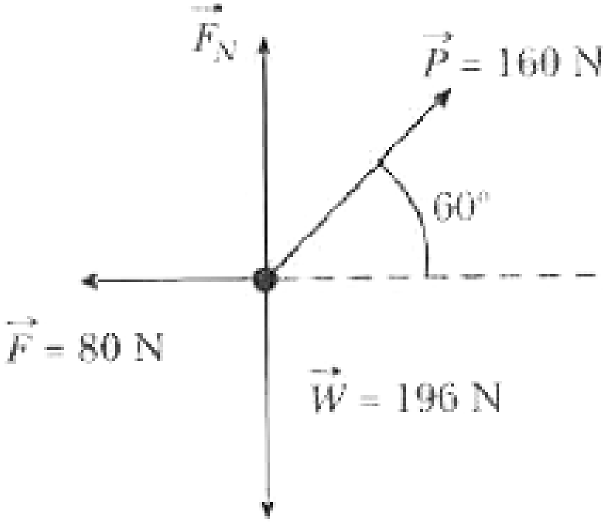
# Practice Questions Linked Comprehension

**1.** A force P pulls on a crate of mass m that is in contact with a rough surface. The figure shows the magnitudes and directions of the forces that act on the crate in this situation. W represents the weight of the crate. Fy represents the normal force on the crate, and F represents the frictional force.




Which statement best describes the motion of the crate?

A. The crate must be at rest

B. The crate must be moving with constant velocity.

C. The crate must be moving with constant acceleration.

D. The crate may be either at rest or moving with constant velocity

**Answer: D**

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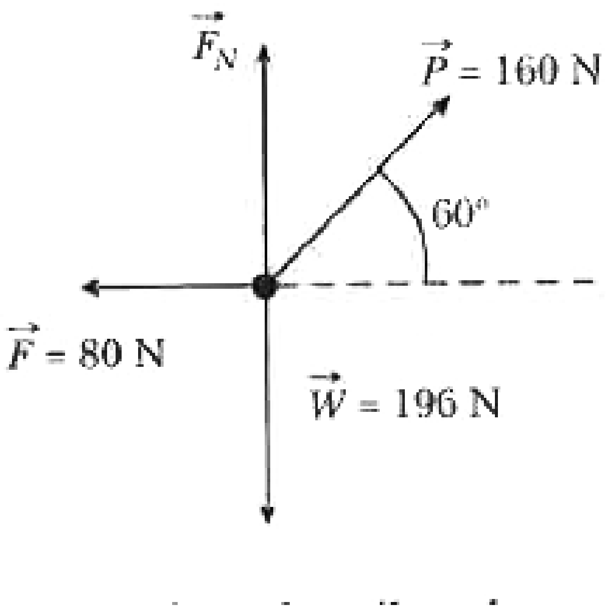
**2.** A force P pulls on a crate of mass m that is in contact with a rough surface. The figure shows the magnitudes and directions of the forces that act on the crate in this situation. W represents the weight of the crate. Fy represents the normal force on the crate, and F represents the frictional force.




What is the magnitude of F, the normal force on the crate?

A. 57 N

B. 160 N

C. 230 N

D. 80 N

**Answer: A**

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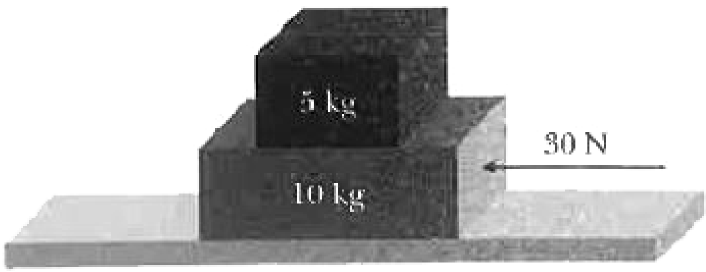
**3.** Two blocks rest on a horizontal frictionless surface as shown in the figure. The surface between the top and bottom blocks is roughened so that there is no slipping between the two blocks. A 30-N force is applied to the bottom block as suggested in the figure.




What is the magnitude of the force of static friction between the top and bottom blocks?

A. 0 N

B. 20 N

C. 30 N

D. 10 N

**Answer: D**

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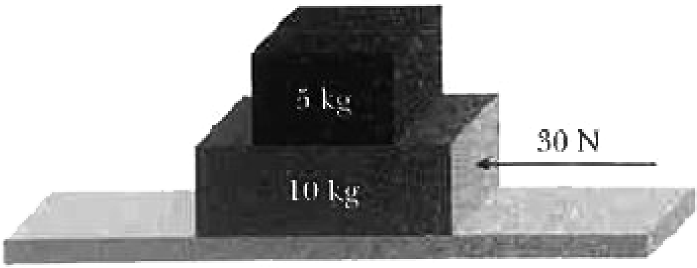
**4.** Two blocks rest on a horizontal frictionless surface as shown in the figure. The surface between the top and bottom blocks is roughened so that there is no slipping between the two blocks. A 30-N force is applied to the bottom block as suggested in the figure.




A. What is the minimum coefficient of static friction necessary to keep the top block from slipping on the bottom block?

B. 0.05

C. 0.20

D. 0.10

**Answer: B**

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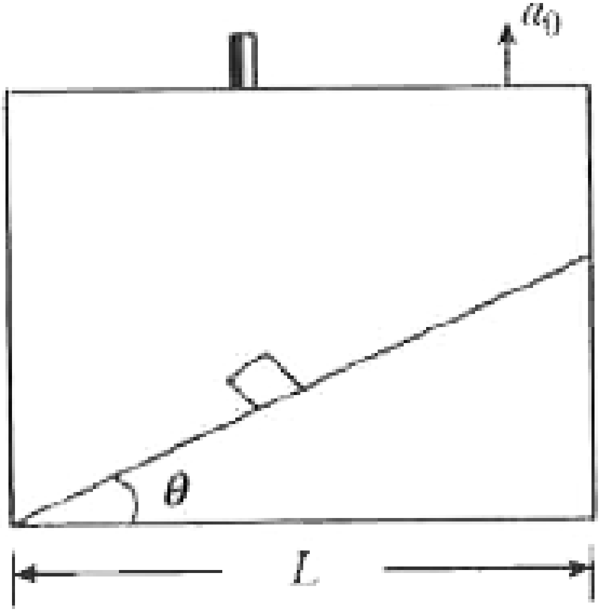
**5.** A particle slides down a smooth inclined plane of elevation fixed in an elevator going with an acceleration a as shown in the figure. The base of the incline has a length L.




If the elevator going up with constant velocity, the time taken by the particle to reach the bottom is

A. $\left(\frac{2L}{(g\sin\theta\cos\theta)}\right)^{1/2}$

B. $\left(\frac{2L}{g\sin\theta}\right)^{1/2}$

C. $\left(\frac{2L}{g\cos\theta}\right)^{1/2}$

D. None of these

**Answer: A**

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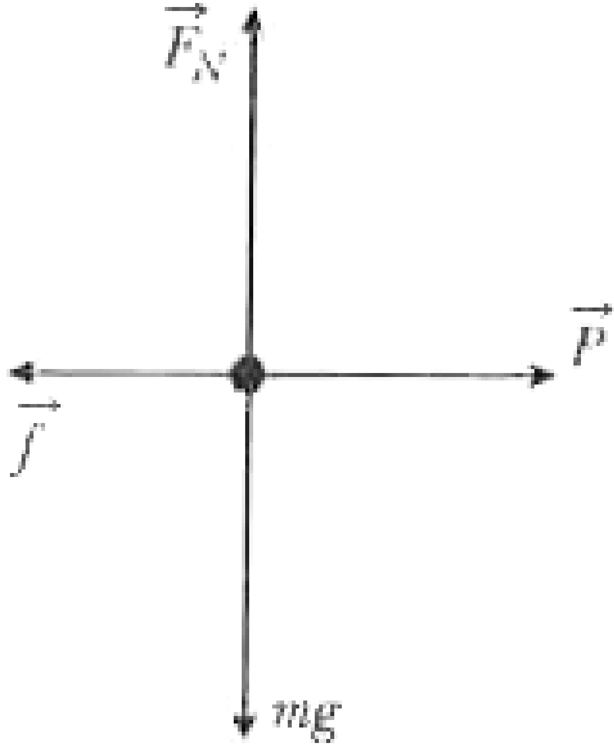
**6.** A block is pulled along a rough level surface at constant speed by the force $\overrightarrow{P}$. The figure shows the free-body diagram for the block. $\overrightarrow{F}_N$ represents the normal force on the block, and $\overrightarrow{f}$ represents the force of kinetic friction




What is the magnitude of $\overrightarrow{F_N}$ ?

A. What is the magnitude of ?

B. 2mg

C. f

D. P

**Answer: D**

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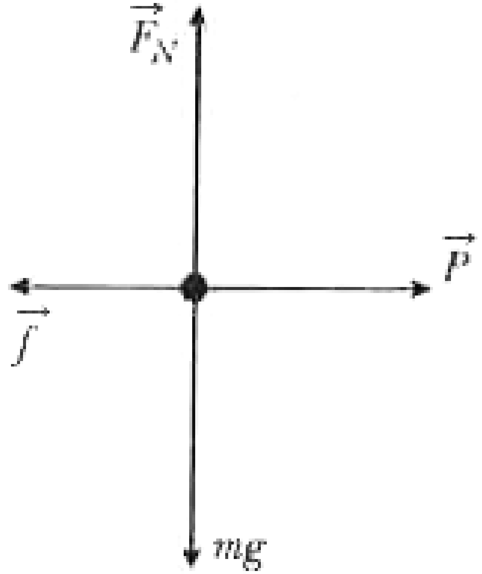
**7.** A block is pulled along a rough level surface at constant speed by the force $\overrightarrow{P}$. The figure shows the free-body diagram for the block. $\overrightarrow{F}_N$ represents the normal force on the block, and $\overrightarrow{f}$ represents the force of kinetic friction




If the coefficient of kinetic friction, u, between the block and the surface is 0.30 and the magnitude of the frictional force is 80.0 N, what is the weight of the block?

A. $1.6N$

B. $160N$

C. $4.0N$

D. $270N$

**Answer: D**

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## Practice Questions Matrix Match

**1.** Two blocks of mass m and 2m are slowly just placed in contact with each other on a rough fixed inclined plane as shown in the figure initially both the blocks are rest on inclined plane. The coefficient of friction between the block together and inclined surface is m. There is no friction between both blocks. Neglect the tendency of rotation of blocks on the inclined surface.

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2. Types of friction and their formulas

What are the characteristics of rolling friction?

A. (IV) (iv) (J)

B. (IV) (ii) (L)

C. (II) (i) (K)

D. (I) (i) (L)

**Answer:**

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**3.** Coefficients of limiting and kinetic friction of different surfaces

What are the coefficients of friction for surface in contanct wood on wood ?

A. (1) (iii) (L)

B. (III) (i) (K)

C. (1) (iv) (J)

D. (I) (iii) (M)

**Answer:**

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## Practice Questions Integer Type

**1.** A block moving on an inclined plane making an angle $45^\circ$ with the horizontal and the coefficient of friction is $\mu$ the force required to just push it up the inclined plane is three times the force required to just prevent it from sliding down. If we define $N = 10\mu N$ then N is

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