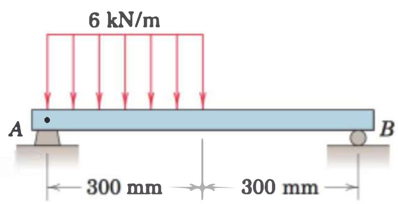
PROBLEMS

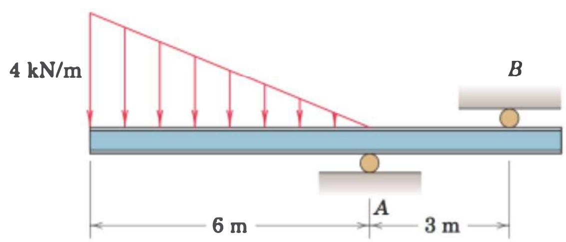
Introductory Problems

5/101 Determine the reactions at A and B for the beam subjected to the uniform load distribution.



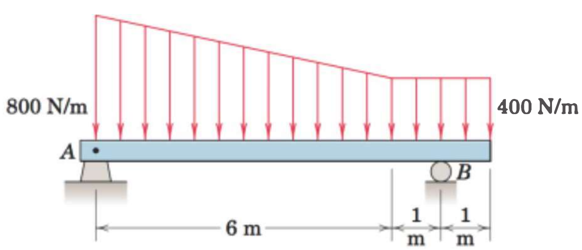
Problem 5/101

5/102 Calculate the reactions at A and B for the beam loaded as shown.



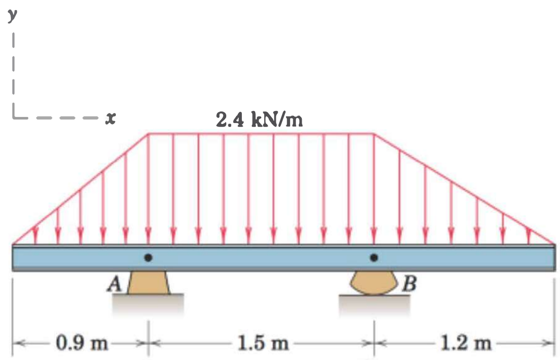
Problem 5/102

5/103 Determine the reactions at the supports of the beam which is loaded as shown.



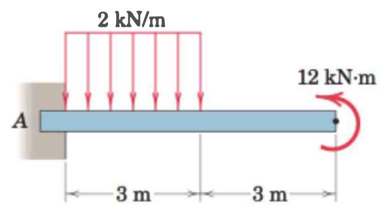
Problem 5/103

5/104 Determine the reactions at A and B for the loaded beam.



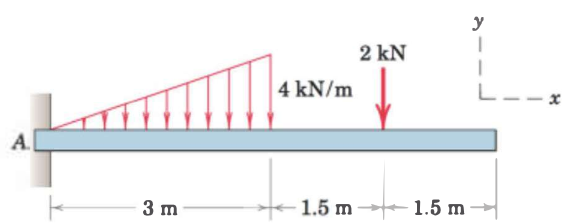
Problem 5/104

5/105 Find the reaction at A due to the uniform loading and the applied couple.



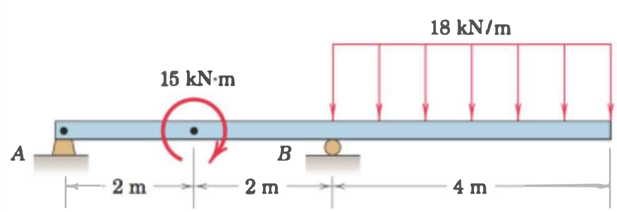
Problem 5/105

5/106 Determine the reactions at A for the cantilever beam subjected to the distributed and concentrated loads.



Problem 5/106

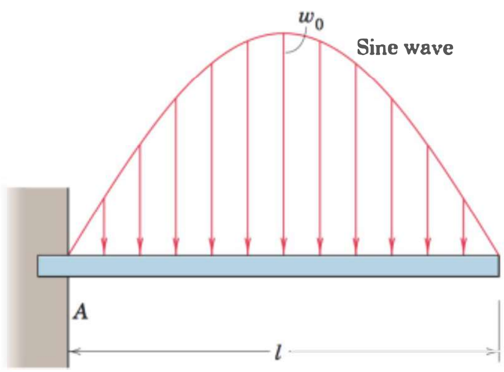
5/107 Determine the reactions at A and B for the beam loaded as shown.



Problem 5/107

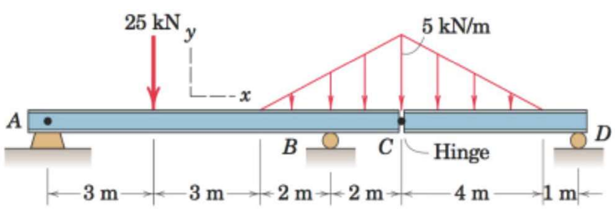
Representative Problems

5/108 Determine the force and moment reactions at the support A of the built-in beam which is subjected to the sine-wave load distribution.



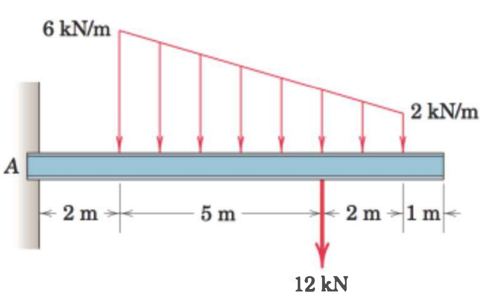
Problem 5/108

5/109 Determine the reactions at A, B, and D for the pair of beams connected by the ideal pin at C and subjected to the concentrated and distributed loads.



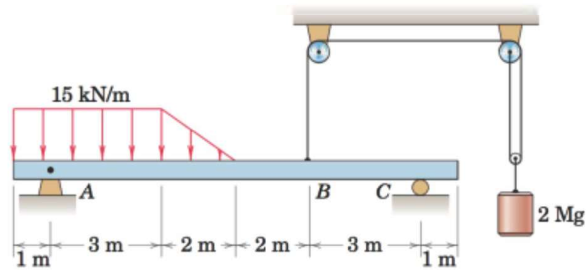
Problem 5/109

5/110 Determine the force and moment reactions at A for the cantilever beam subjected to the loading shown.



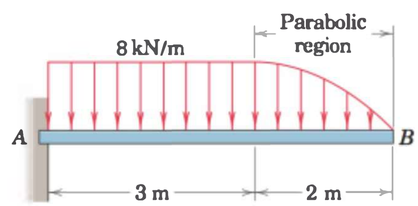
Problem 5/110

5/111 Determine the reactions at A and C for the beam subjected to the combination of point and distributed loads.



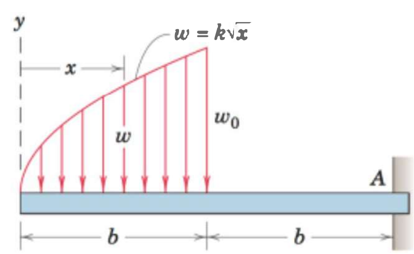
Problem 5/111

5/112 Determine the reactions at the support for the beam which is subjected to the combination of uniform and parabolic loading distributions.



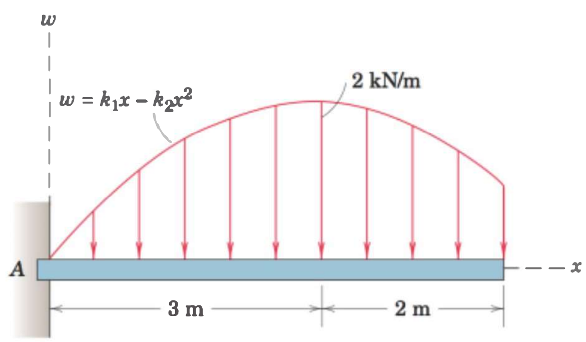
Problem 5/112

5/113 Determine the force and moment reactions at the support A of the cantilever beam subjected to the load distribution shown.



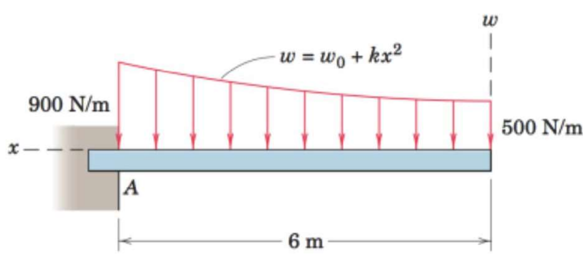
Problem 5/113

5/114 Compute the reactions at A for the cantilever beam subjected to the distributed load shown. The distributed load reaches a maximum value of 2 kN/m at x = 3 m.



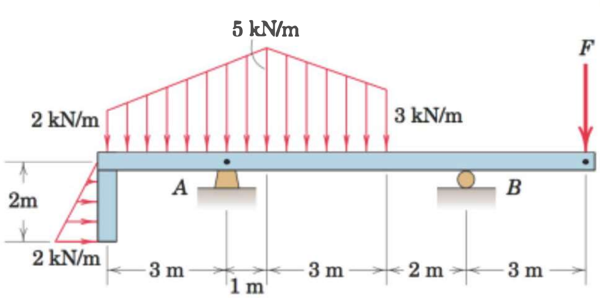
Problem 5/114

5/115 A cantilever beam supports the variable load shown. Calculate the supporting force R_A and moment M_A at A.



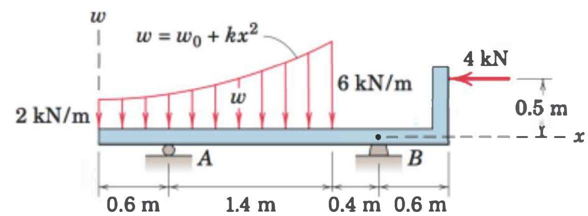
Problem 5/115

5/116 For the beam and loading shown, determine the magnitude of the force F for which the vertical reactions at A and B are equal. With this value of F, compute the magnitude of the pin reaction at A.



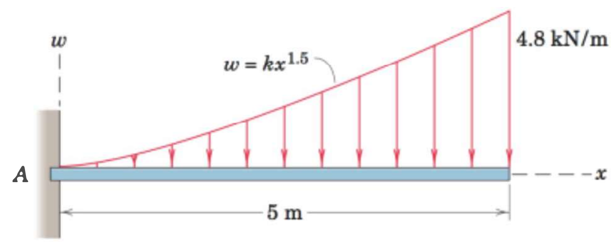
Problem 5/116

5/117 Determine the reactions at A and B for the beam subjected to the distributed and concentrated loads.



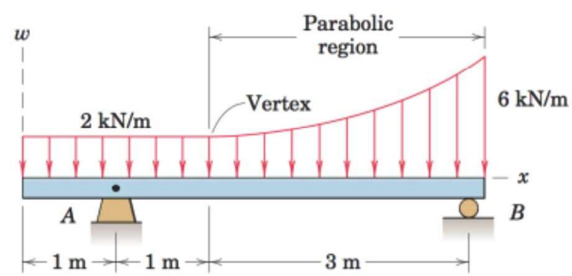
Problem 5/117

5/118 Determine the force and moment reactions at A for the beam which is subjected to the distributed load shown.



Problem 5/118

5/119 Determine the reactions at the supports of the beam which is acted on by the combination of uniform and parabolic loading distributions.

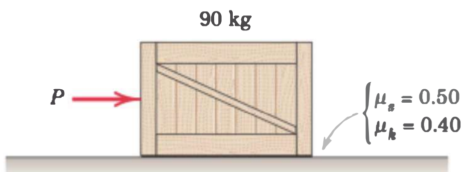


Problem 5/119

PROBLEMS

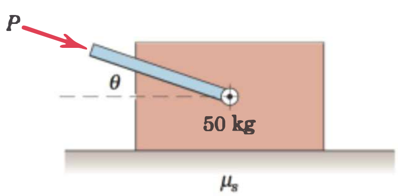
Introductory Problems

6/1 The force P is applied to the 90-kg crate, which is stationary before the force is applied. Determine the magnitude and direction of the friction force F exerted by the horizontal surface on the crate if (*a*) P = 300 N, (*b*) P = 400 N, and (*c*) P = 500 N.



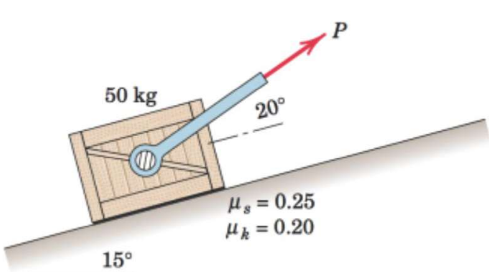
Problem 6/1

6/2 The 50-kg block rests on the horizontal surface, and a force P = 200 N, whose direction can be varied, is applied to the block. (*a*) If the block begins to slip when θ is reduced to 30°, calculate the coefficient of static friction μ_s between the block and the surface. (*b*) If P is applied with θ = 45°, calculate the friction force F.



Problem 6/2

6/3 The force P is applied to the 50-kg block when it is at rest. Determine the magnitude and direction of the friction force exerted by the surface on the block if (*a*) P = 0, (*b*) P = 200 N, and (*c*) P = 250 N. (*d*) What value of P is required to initiate motion up the incline? The coefficients of static and kinetic friction between the block and the incline are μ_s = 0.25 and μ_k = 0.20, respectively.

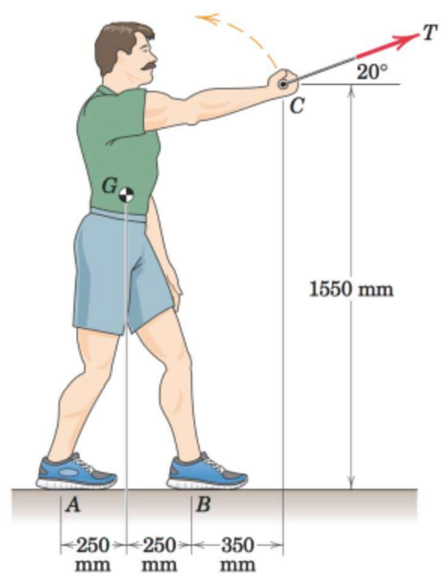


Problem 6/3

6/4 The designer of a ski resort wishes to have a portion of a beginner's slope on which a snowboarder's speed will remain fairly constant. Tests indicate the average coefficients of friction between a snowboard and snow to be μ_s = 0.11 and μ_k = 0.09. What should be the slope angle θ of the constant-speed section?

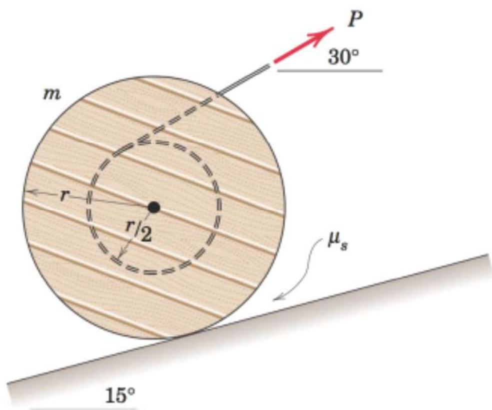
Problem 6/4

6/5 The 80-kg exerciser is repeated from Prob. 3/23. The tension T = 65 N is developed against an exercise machine (not shown) as he is about to begin a biceps curl. Determine the minimum coefficient of static friction which must exist between his shoes and the floor if he is not to slip.



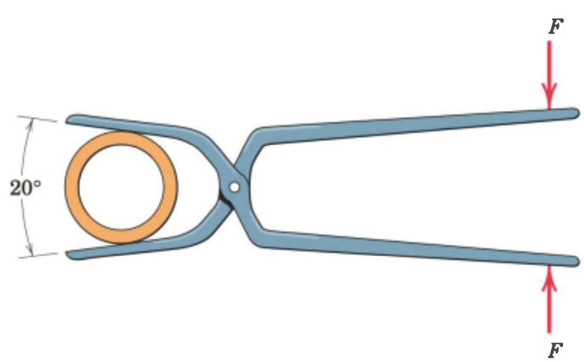
Problem 6/5

6/6 Determine the minimum coefficient of static friction μ_s which will allow the drum with fixed inner hub to be rolled up the 15° incline at a steady speed without slipping. What are the corresponding values of the force P and the friction force F?



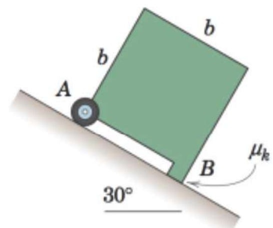
Problem 6/6

6/7 The tongs are designed to handle hot steel tubes which are being heat-treated in an oil bath. For a 20° jaw opening, what is the minimum coefficient of static friction between the jaws and the tube which will enable the tongs to grip the tube without slipping?



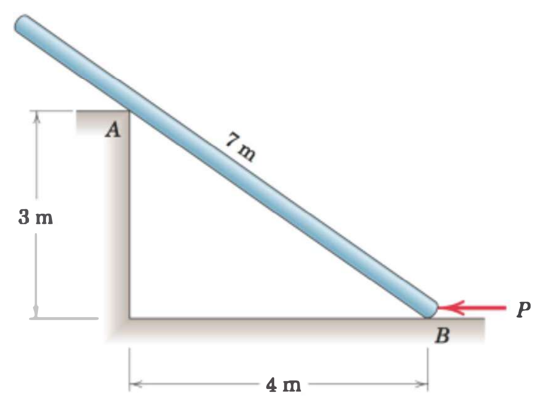
Problem 6/7

6/8 Determine the coefficient μ_k of kinetic friction which allows the homogeneous body to move down the 30° incline at constant speed. Show that this constant-speed motion is unlikely to occur if the ideal roller and small foot were reversed.



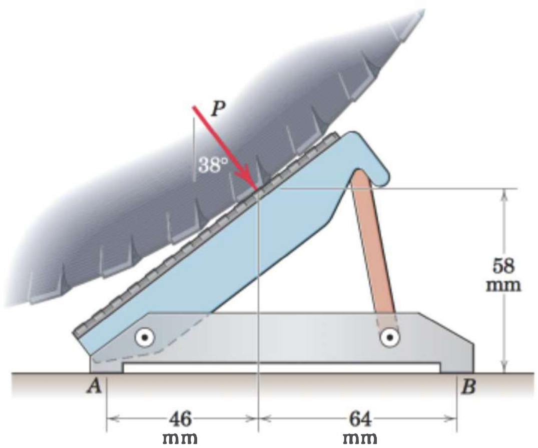
Problem 6/8

6/9 The uniform 7-m pole has a mass of 100 kg and is supported as shown. Calculate the force P required to move the pole if the coefficient of static friction for each contact location is 0.40.



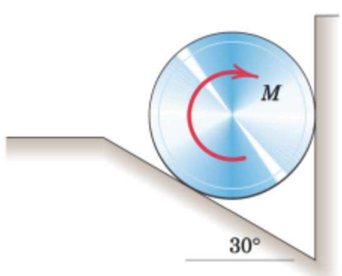
Problem 6/9

6/10 A vehicle tire exerts the force P on the tire chock. (*a*) Determine the minimum coefficient of static friction common to both A and B so that the chock will not slip relative to the horizontal support surface. (*b*) If foot A rests on an oily spot for which the coefficient of static friction is essentially zero, determine the minimum friction coefficient at foot B for static equilibrium. State any assumptions.



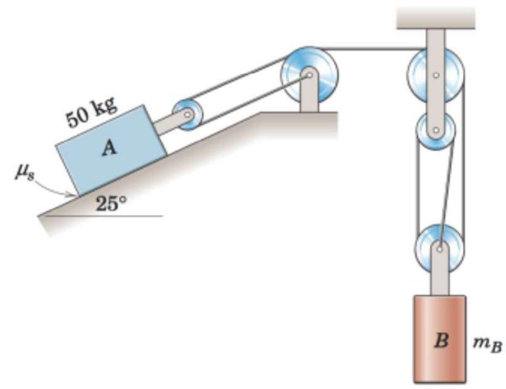
Problem 6/10

6/11 The 30-kg homogeneous cylinder of 400-mm diameter rests against the vertical and inclined surfaces as shown. If the coefficient of static friction between the cylinder and the surfaces is 0.30, calculate the applied clockwise couple M which would cause the cylinder to slip.



Problem 6/11

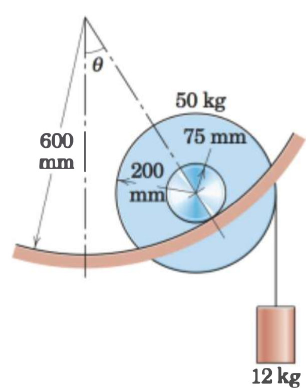
6/12 If the coefficient of static friction between block A and the incline is $\mu_s = 0.30$, determine the range of cylinder masses m_B for which the system will remain in equilibrium. Neglect all pulley friction.



Problem 6/12

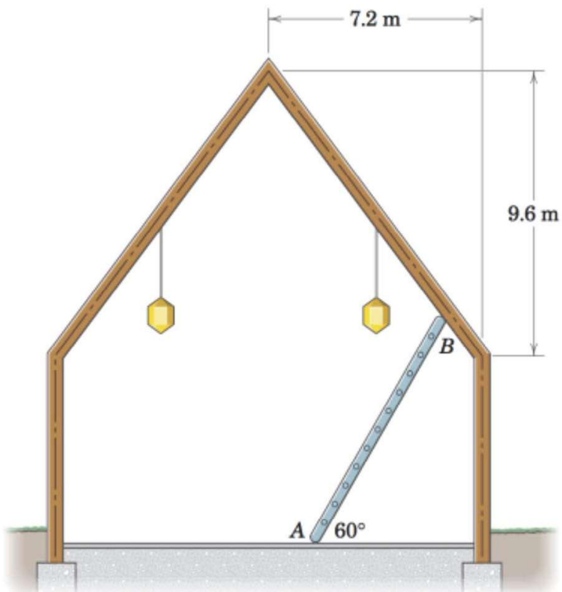
Representative Problems

6/13 The 50-kg wheel rolls on its hub up the circular incline under the action of the 12-kg cylinder attached to a cord around the rim. Determine the angle θ at which the wheel comes to rest, assuming that friction is sufficient to prevent slippage. What is the minimum coefficient of static friction which will permit this position to be reached with no slipping?



Problem 6/13

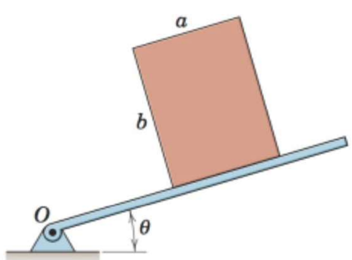
6/14 A uniform ladder is positioned as shown for the purpose of maintaining the light fixture suspended from the cathedral ceiling. Determine the minimum coefficient of static friction required at ends A and B to prevent slipping. Assume that the coefficient is the same at A and B.



Problem 6/14

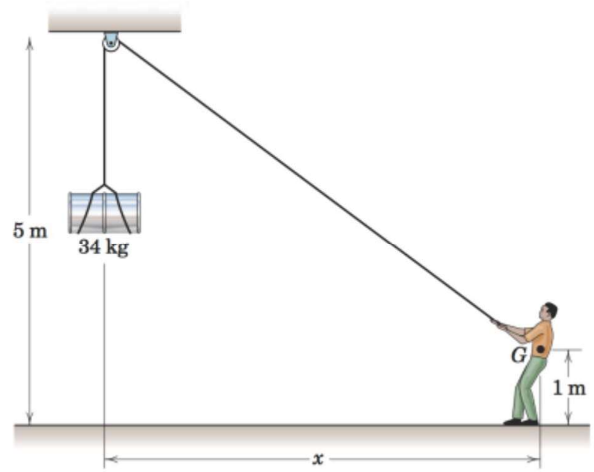
6/15 If there is a small frictionless roller on end B of the ladder of Prob. 6/14, determine the minimum coefficient of static friction required at end A in order to provide equilibrium. Compare with the results of the previous problem.

6/16 The homogeneous rectangular block of mass m rests on the inclined plane which is hinged about a horizontal axis through O. If the coefficient of static friction between the block and the plane is μ, specify the conditions which determine whether the block tips before it slips or slips before it tips as the angle θ is gradually increased.



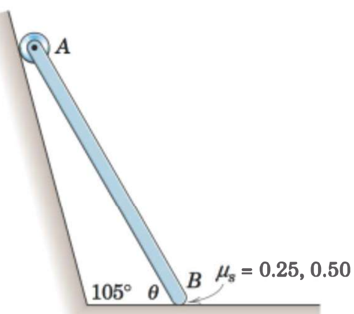
Problem 6/16

6/17 The 80-kg man with center of mass G supports the 34-kg drum as shown. Find the greatest distance x at which the man can position himself without slipping if the coefficient of static friction between his shoes and the ground is 0.40.



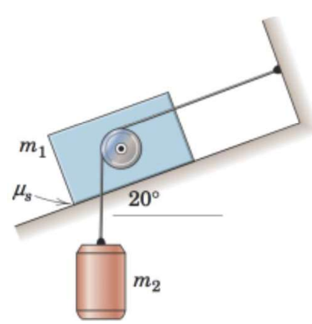
Problem 6/17

6/18 The uniform slender bar has an ideal roller at its upper end A. Determine the minimum value of the angle θ for which equilibrium is possible for $\mu_s = 0.25$ and for $\mu_s = 0.50$.



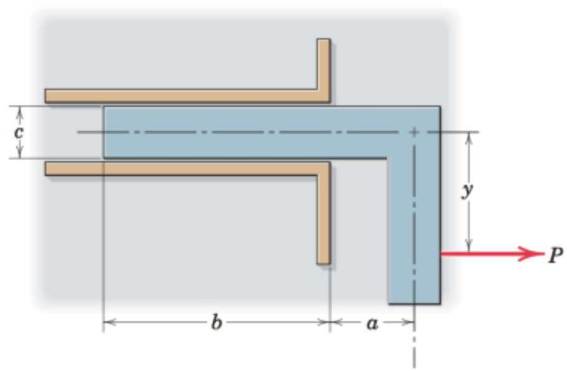
Problem 6/18

6/19 Determine the range of mass m_2 for which the system is in equilibrium. The coefficient of static friction between the block and the incline is $\mu_s = 0.25$. Neglect friction associated with the pulley.



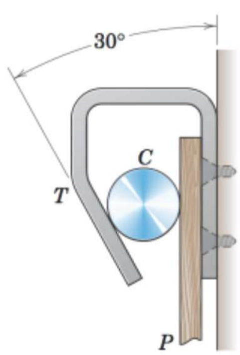
Problem 6/19

6/20 The right-angle body is to be withdrawn from the close-fitting slot by the force P. Find the maximum distance y from the horizontal centerline at which P may be applied without binding. The body lies in a horizontal plane, and friction underneath the body is to be neglected. Take the coefficient of static friction along both sides of the slot to be μ_s.



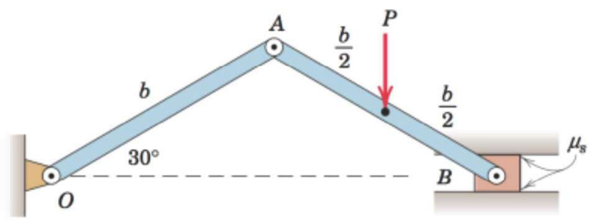
Problem 6/20

6/21 The inverted track T with freely floating cylinder C comprise a system which is designed to hold paper or other thin materials P in place. The coefficient of static friction is μ for all interfaces. What minimum value of μ ensures that the device will work no matter how heavy the supported material P is?



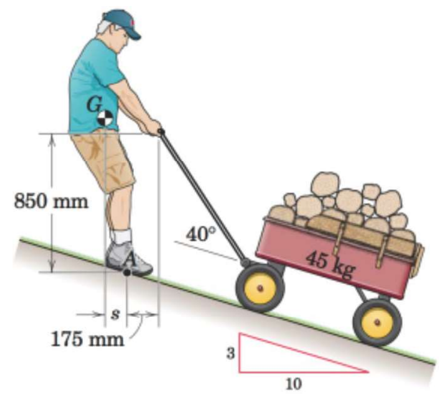
Problem 6/21

6/22 The top view of a bifold door is shown. The designer is considering a slider at B rather than the usual roller. Determine the critical value of the coefficient of static friction below which the door will close from the position shown under the action of the force P.



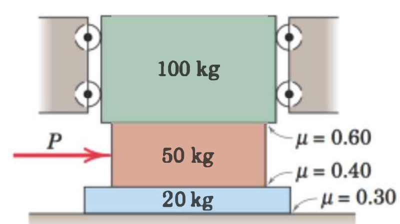
Problem 6/22

6/23 A 82-kg man pulls the 45-kg cart up the incline at steady speed. Determine the minimum coefficient μ_s of static friction for which the man's shoes will not slip. Also determine the distance s required for equilibrium of the man's body.



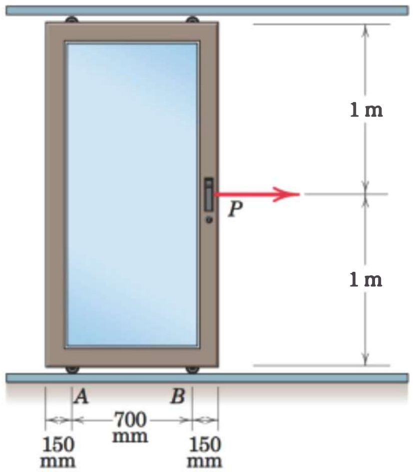
Problem 6/23

6/24 Determine the horizontal force P required to cause slippage to occur. The friction coefficients for the three pairs of mating surfaces are indicated. The top block is free to move vertically.



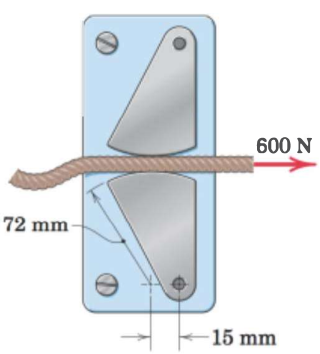
Problem 6/24

6/25 The sliding glass door rolls on the two small lower wheels A and B. Under normal conditions the upper wheels do not touch their horizontal guide. (*a*) Compute the force P required to slide the door at a steady speed if wheel A becomes "frozen" and does not turn in its bearing. (*b*) Rework the problem if wheel B becomes frozen instead of wheel A. The coefficient of kinetic friction between a frozen wheel and the supporting surface is 0.30, and the center of mass of the 64-kg door is at its geometric center. Neglect the small diameter of the wheels.



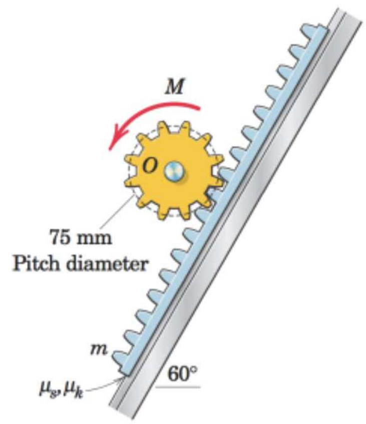
Problem 6/25

6/26 The figure shows a device, called a jam cleat, which secures a rope under tension by reason of large friction forces developed. For the position shown determine the minimum coefficient μ_s of static friction between the rope and the cam surfaces for which the cleat will be self-locking. Also find the magnitude of the total reaction R on each of the cam bearings.



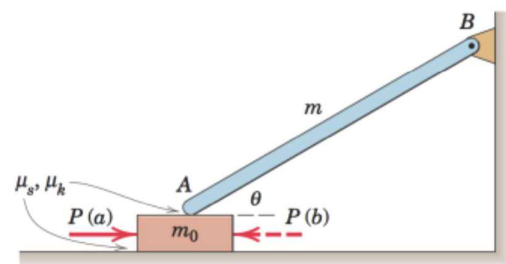
Problem 6/26

6/27 The rack has a mass m = 75 kg. What moment M must be exerted by the gear wheel in order to (*a*) lower and (*b*) raise the rack at a slow steady speed on the greased 60° rail? The coefficients of static and kinetic friction are $\mu_s = 0.10$ and $\mu_k = 0.05$. The fixed motor which drives the gear wheel is not shown.



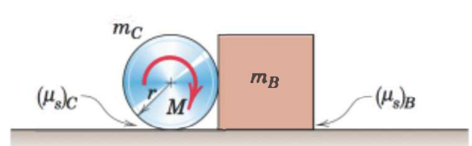
Problem 6/27

6/28 Determine the magnitude P of the horizontal force required to initiate motion of the block of mass m_0 for the cases (*a*) P is applied to the right and (*b*) P is applied to the left. Complete a general solution in each case, and then evaluate your expression for the values $\theta = 30°$, $m = m_0 = 3$ kg, $\mu_s = 0.60$, and $\mu_k = 0.50$.



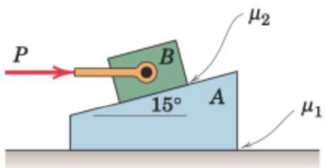
Problem 6/28

6/29 A clockwise couple M is applied to the circular cylinder as shown. Determine the value of M required to initiate motion for the conditions $m_B = 3$ kg, $m_C = 6$ kg, $(\mu_s)_B = 0.50$, $(\mu_s)_C = 0.40$, and $r = 0.2$ m. Friction between the cylinder C and the block B is negligible.



Problem 6/29

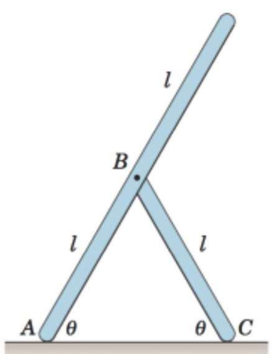
6/30 The horizontal force $P = 50$ N is applied to the upper block with the system initially stationary. The block masses are $m_A = 10$ kg and $m_B = 5$ kg. Determine if and where slippage occurs for the following conditions on the coefficients of static friction: (*a*) $\mu_1 = 0.40$, $\mu_2 = 0.50$ and (*b*) $\mu_1 = 0.30$, $\mu_2 = 0.60$. Assume that the coefficients of kinetic friction are 75 percent of the static values.



Problem 6/30

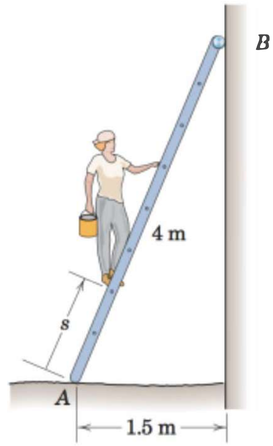
6/31 Reconsider the system of Prob. 6/30. If $P = 40$ N, $\mu_1 = 0.30$, and $\mu_2 = 0.50$, determine the force which block B exerts on block A. Assume that the coefficients of kinetic friction are 75 percent of the static values. The block masses remain $m_A = 10$ kg and $m_B = 5$ kg.

6/32 The two uniform slender bars constructed from the same stock material are freely pinned together at B. Determine the minimum angle θ at which slipping does not occur at either contact point A or C. The coefficient of static friction at both A and C is $\mu_s = 0.50$. Consider only motion in the vertical plane shown.



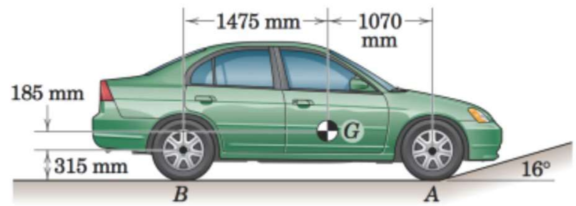
Problem 6/32

6/33 Determine the distance s to which the 90-kg painter can climb without causing the 4-m ladder to slip at its lower end A. The top of the 15-kg ladder has a small roller, and at the ground the coefficient of static friction is 0.25. The mass center of the painter is directly above her feet.



Problem 6/33

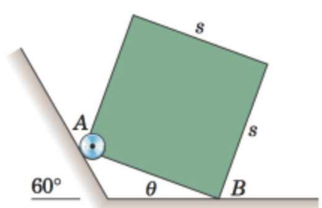
6/34 The 1600-kg car is just beginning to negotiate the 16° ramp. If the car has rear-wheel drive, determine the minimum coefficient of static friction required at B.



Problem 6/34

6/35 Repeat Prob. 6/34, but now the car has all-wheel drive. Assume that slipping occurs at A and B simultaneously.

6/36 The homogeneous square body is positioned as shown. If the coefficient of static friction at B is 0.40, determine the critical value of the angle θ below which slipping will occur. Neglect friction at A.



Problem 6/36