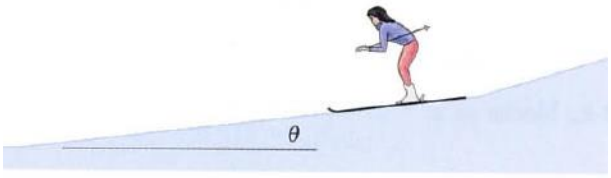
New Problem Sheet No. 2

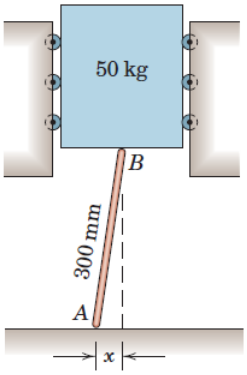
(Friction)

12. The designer of a ski resort wishes to have a portion of a beginner's slope on which the skier's speed will remain fairly constant. Tests indicate the average coefficients of friction between skis and snow to be $\mu_s = 0.10$ and $\mu_d = 0.08$. What should be the slope angle θ of the constant speed section.

    Ans $\theta = 4.57^0$

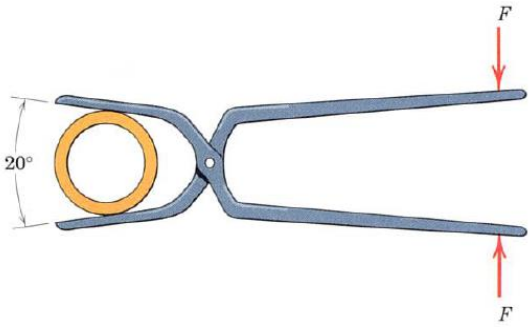


13. The light bar is used to support the 50-kg block in its vertical guides. If the coefficient of static friction is 0.03 at the upper end of the bar and 0.40 at the lower end of the bar, find the friction force acting at each end for x = 75 mm. Also find the maximum value of x for which the bar will not slip.



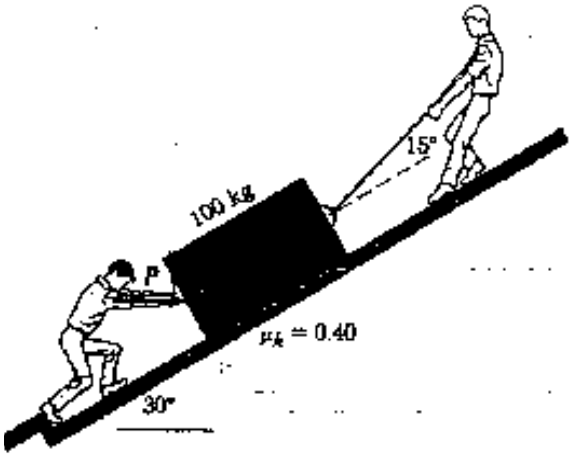
14. The tongs are used to handle hot steel tubes that are being heat-treated in an oil bath. For a 200 jaw opening, what is the minimum coefficient of static friction between the jaws and the tube that will enable the tongs to grip the tube without slipping.

    Ans. $\mu_s = 0.176$



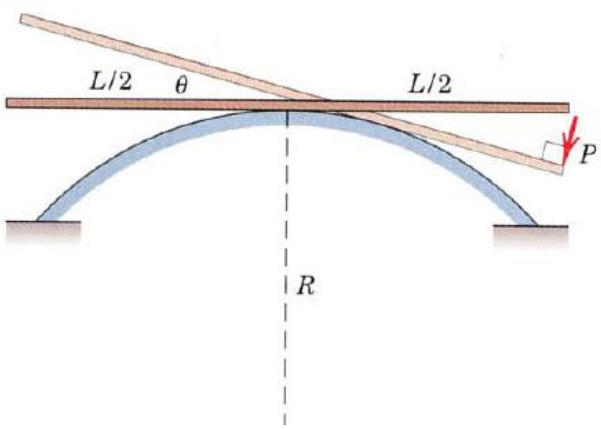
15. Two men are sliding a 100-kg crate up an incline. If the lower man pushes horizontally with a force of 500 N and if the coefficient of kinetic friction is 0.4, determine the tension T which the man must exert in the rope to maintain motion of the crate.

    Ans. T = 465 N



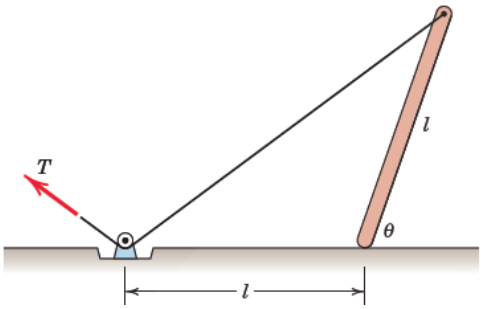
5. The uniform slender rod of mass m and length L is initially at rest in a centered horizontal position on the fixed circular surface of radius R = 0.6L. If a force normal to the bar is gradually applied to its end until the bar begins to slip at the angle θ = 20^0, determine the coefficient of static friction μ_s.

   Ans. $\mu_s = 0.212$



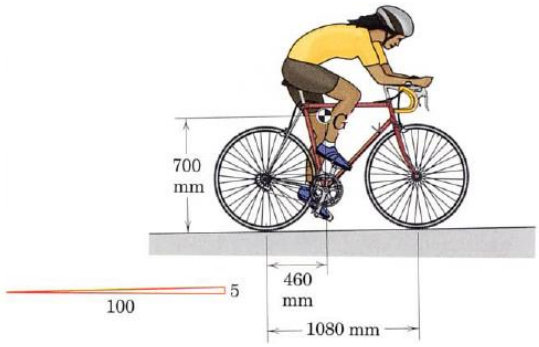
6. The uniform slender rod is slowly lowered from the upright position (θ = 90^0) by means of the cord attached to its upper end and passing over the small fixed pulley. If the rod is observed to slip at its lower end when θ = 40^0, determine the coefficient of static friction at the horizontal surface.

   Ans. $\mu_s = 0.761$



7. A man pedals his bicycle up a 5 percent grade on a slippery road at a steady speed. The man and bicycle have a combined mass of 82 kg with mass center at G. If his rear wheel is on the verge of slipping, determine the coefficient of friction μs between the rear tire and the road. If the coefficient of friction were doubled, what would be the friction force acting on the rear wheel? (why may we neglect friction under the front wheel?)

   Ans. $\mu_s = 0.082$, F = 40.2 N

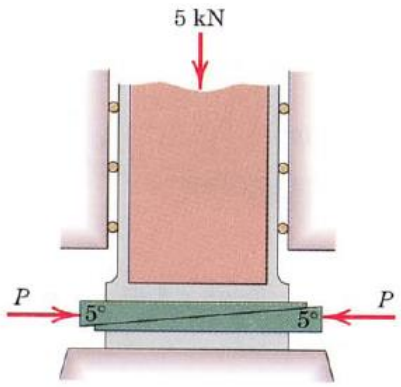


8. The industrial truck is used to move the solid 1200-kg roll of paper up the 300 incline. If the coefficients of static and kinetic friction between the roll and the vertical barrier of the truck and between the roll and the incline are both 0.40, compute the required tractive force P between the tires of the truck and the horizontal surface.

   Ans. P = 22.1 kN

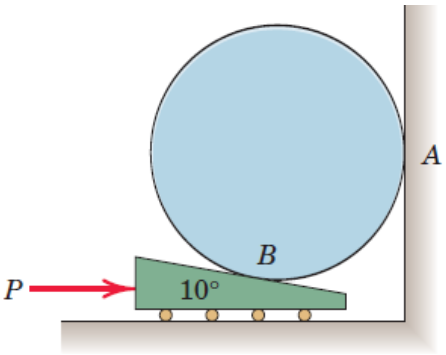
9. The two 5^0 wedges shown are used to adjust the position of the column under a vertical load of 5 kN. Determine the magnitude of forces P required to lower the column if the coefficient of friction for all surfaces is 0.40.

   Ans. P = 3.51 kN



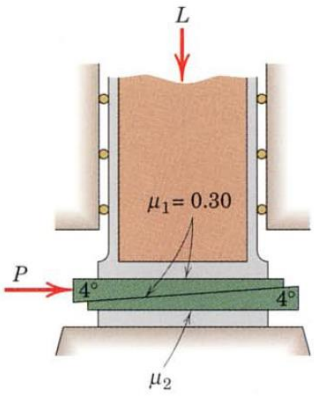
10. Calculate the horizontal force P on the light 10^0 wedge necessary to initiate movement of the 40-kg cylinder. The coefficient of static friction for both pairs of contacting surfaces is 0.25. Also determine the friction force FB at point B.

    Ans. P = 98.6 N, F_B = 24.6 N



11. The two wedges are used to position the vertical column under a load L. What is the least value of the coefficient of friction μ_2 for the bottom pair of surfaces for which the column may be raised by applying a single horizontal force P to the upper wedge?

    Ans. μ_2 = 0.378



12. Calculate the couple M applied to the lower of the two 20-kg cylinders which will allow them to roll slowly down the incline. The coefficients of static and kinetic friction for all contacting surfaces are μ_s = 0.60 and μ_k = 0.50.

    Ans. M = 10.16 N.m