Civil Engineering Department
S. V. National Institute of Technology, Surat

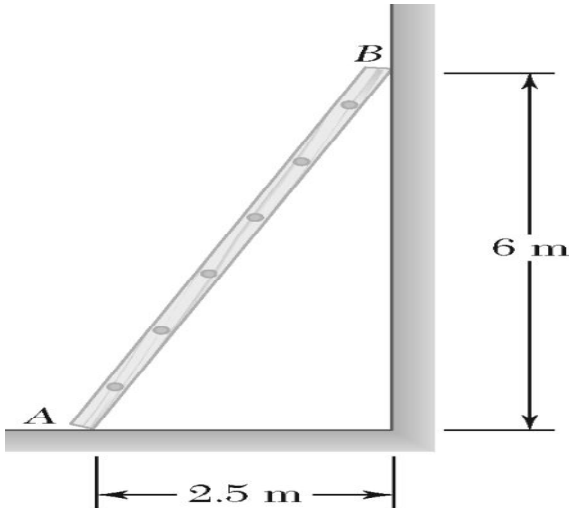
Engineering Mechanics Tutorial : Friction

01 A wooden block of weight 50N rests on a horizontal plane. Determine the force required which is acted at an angle of 15˚ to just (a) Pull it, and (b) Push it. Take coefficient friction 0.4 between the mating surfaces. Comment on the result.
[Answer: 18.7N & 23.17N, Comment: it is easier to pull the block than push it]

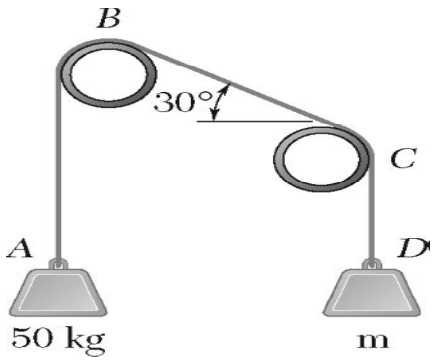
02 A body resting on a rough horizontal plane required a pull of 24N inclined at 30º to the plane just to move it. It was also found that a push of 30N at 30º to the plane was just enough to cause motion to impend. Make calculations for the weight of body and the coefficient of friction.
[Answer: μ=0.192, W = 120.25N]

03 A uniform ladder of 10 m length rests against a rough vertical wall with its lower end on a rough horizontal floor, the ladder being inclined at 45^0 to the horizontal. The coefficient of friction between ladder and the wall is 0.33 and that between ladder and floor is 0.5.
A man whose weight equals one half of that of the ladder ascends up the ladder till the ladder slips. Determine at what length of the ladder the man will be able to ascend, before the ladder commences to slip.
[Answer : 7.14 m]

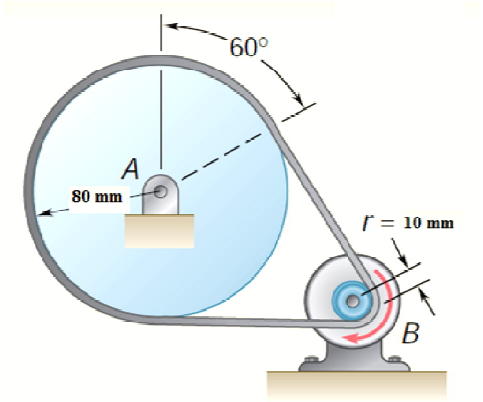
04 A 6.5-m ladder *AB* leans against a wall as shown. Assuming that the coefficient of static friction μ_s is the same at *A* and *B*, determine the smallest value of μ_s for which equilibrium is maintained.
[Answer: $\mu_s = 0.2$]



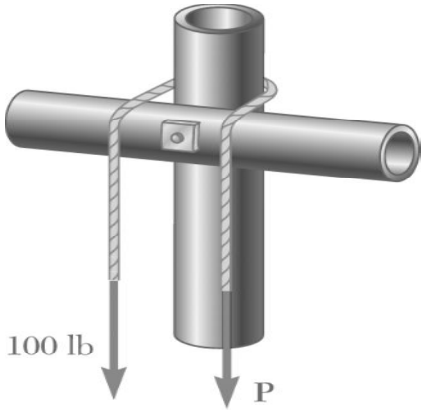
05 A rope *ABCD* is looped over two pipes as shown. Knowing that the coefficient of static friction is 0.25, determine (*a*) the smallest value of the mass *m* for which equilibrium is possible, (*b*) the corresponding tension in portion *BC* of the rope.
[Answer: (a) m = 22.8kg; T_{BC} =291N]



06 A flat belt connects pulley A, which drives a machine tool, to pulley B, which is attached to the shaft of an electric motor. The coefficients of friction are $\mu_s = 0.25$ and $\mu_k = 0.20$ between both pulleys and the belt. Knowing that the maximum allowable tension in the belt is 600 N, determine the largest torque which can be exerted by the belt on pulley A.
[Answer: 19.57 Nm]

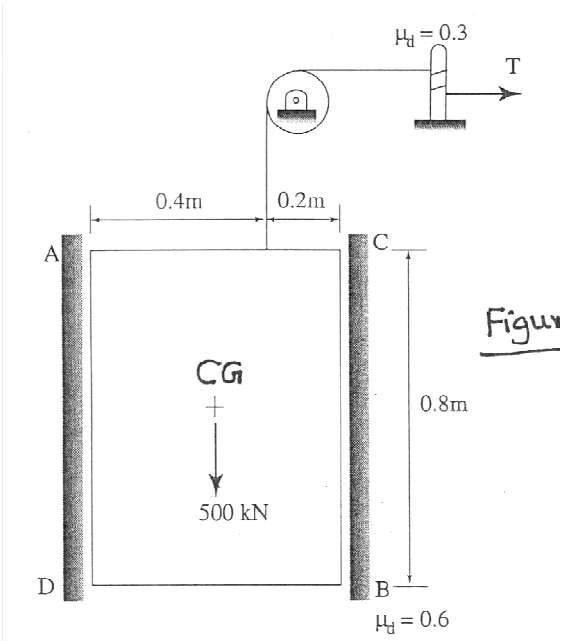


07 Knowing that the coefficient of static friction is 0.25 between the rope and the horizontal pipe and 0.20 between the rope and the vertical pipe, determine the range of values of P for which equilibrium is maintained. [Ans. $24.3 \leq P \leq 411$ lb]



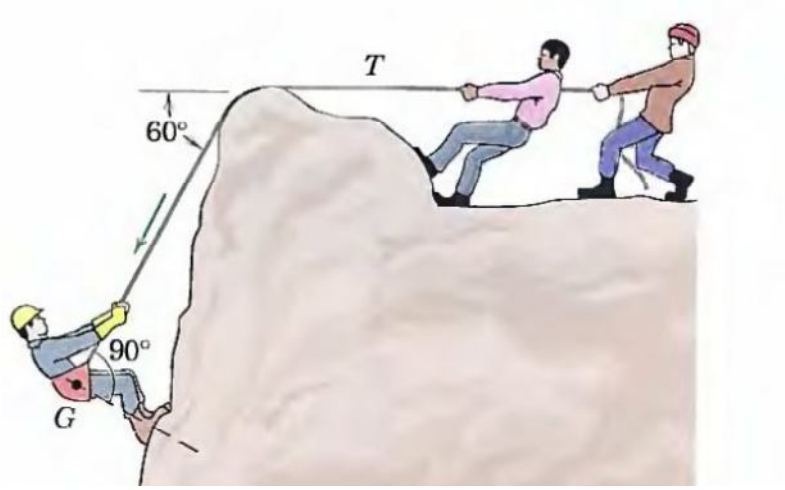
08 A 500 kN crate is being lowered very slowly at a constant speed down an elevator shaft, which as shown is slightly wider that the crate. The cord wraps around a freely turning pulley and then has 2 rotations around a capstan. Find the tension T needed for the operation. The centre of gravity of the crate is at its geometric center. Note that the coefficient of kinetic friction is μd = 0.3 between the rope and the capstan, and μd = 0.6, between the crate and the elevator shaft, as shown in the figure below.

[Ans T=10.02 kN]

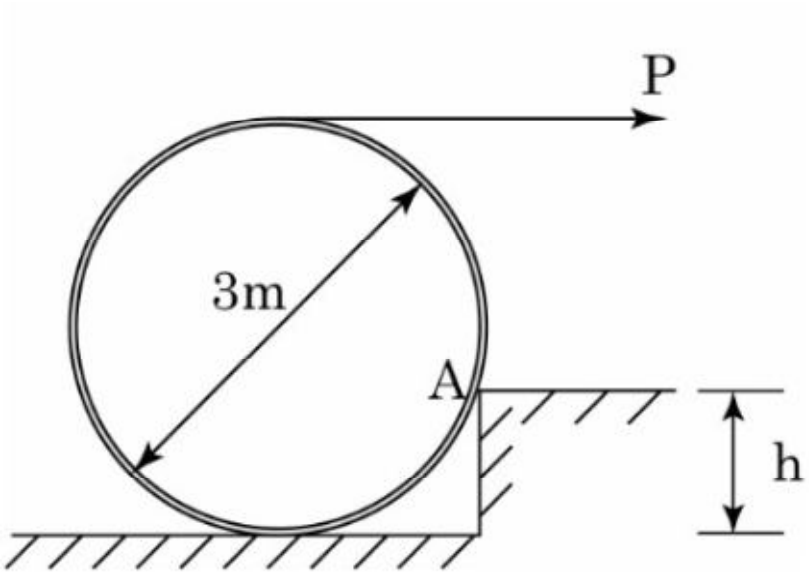


Figure

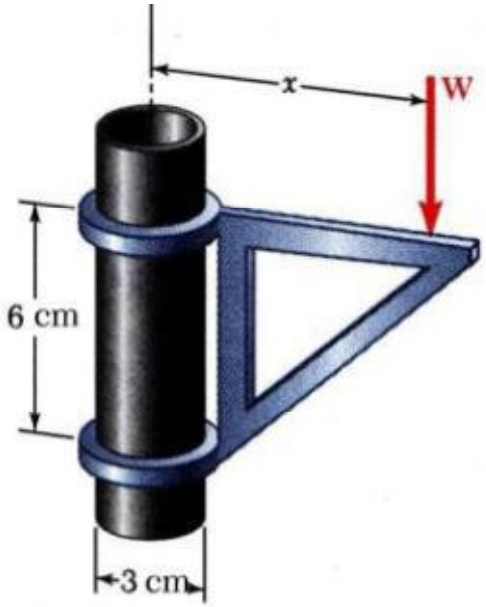
09 The 900 N rock climber is lowered over the edge of cliff by his two companions, who together exert a horizontal pull T of 375 lb on the rope. Compute the coefficient of friction between the rope and the rock. [Ans. μ=0.699]



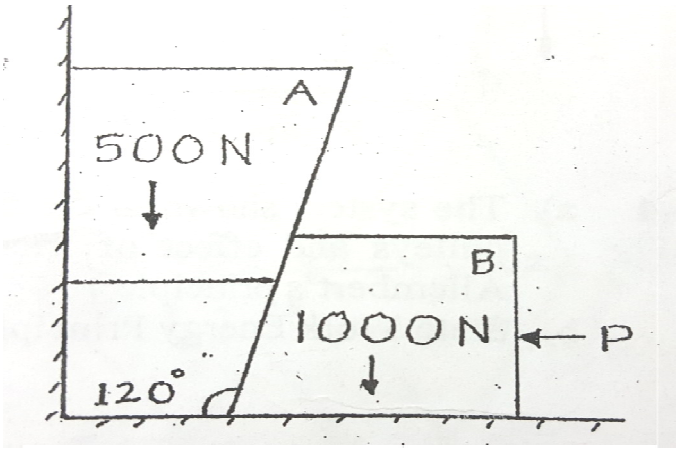
10 What is the maximum height *h* of the step so that the force *P* will roll the cylinder of weight 25kg over the step without impending slippage at the point of contact *A*. Take the coefficient of friction to be equal to 0.3. [Ans. h_{max}= 0.248 m]



11 The moveable bracket shown may be placed at any height on the 3-cm diameter pipe. If the coefficient of static friction between the pipe and bracket is 0.25, determine the minimum distance x at which the load W can be supported. Neglect the weight of the bracket. [Ans. X = 12 cm]



12 Two blocks A and B are resting against a wall and the floor as shown in figure below. Find horizontal force P applied to the lower block that will hold the system in equilibrium. Take is $\mu = 0.25$ at floor, $\mu = 0.3$ at wall and $\mu = 0.2$ between blocks. [Ans: P = 81 N]

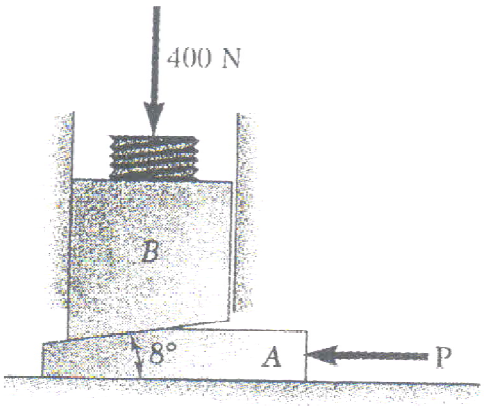


13 The position of the machine block B is adjusted by moving the wedge A. Knowing that the coefficient of friction is 0.35 between all surfaces of contact, determine the force P required

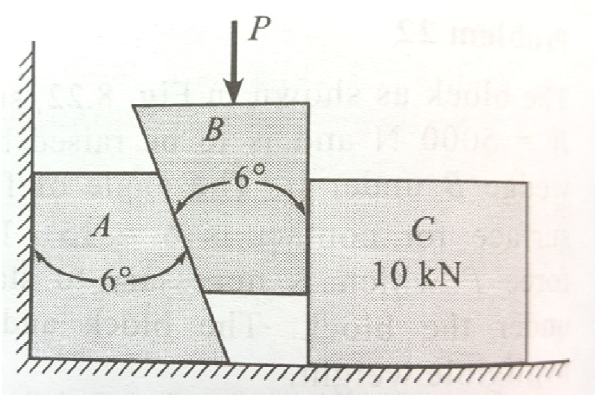
(a) To raise block B

(b) To lower block B

[Ans: (a) P =423 N (←) (b) P =206 N (→)]



14 Two 6^0 wedges are used to push a block horizontally as shown in figure below. Calculate the minimum force required to push the block of weight 10 kN. Take $\mu = 0.25$ for all contact surfaces.
[Ans: P =1.639 kN]



15 Determine the force P required to move the block A of weight 5000 N up the inclined plane. Coefficient of friction between all contact surfaces is 0.25. Wedge angle is 15^0.
[Ans: P = 3462.84 N]