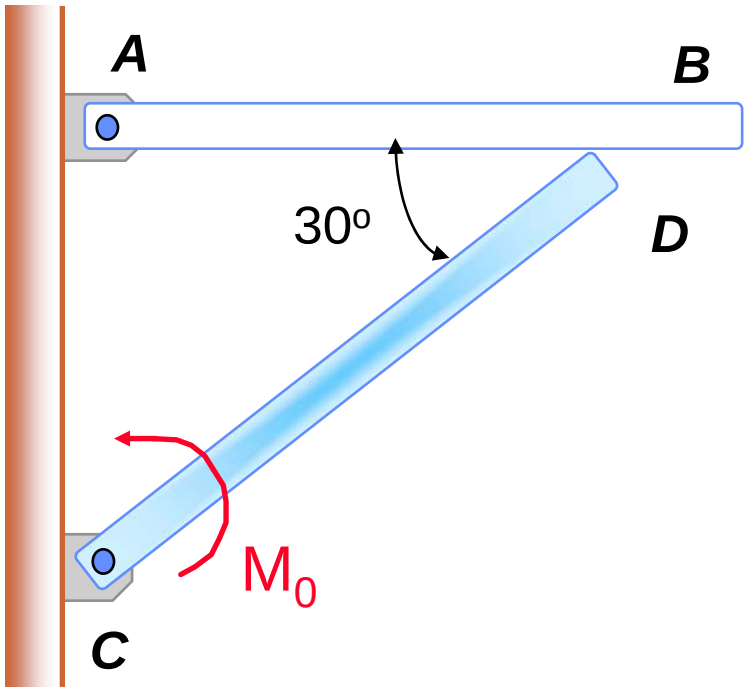
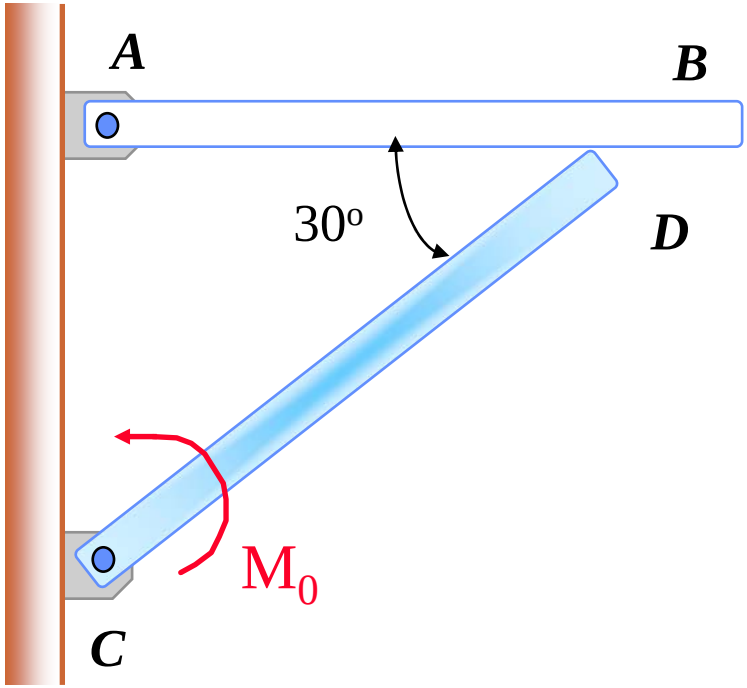
Problem 8.154



Two uniform rods each of weight *W* and length *L* are maintained in the position shown by a couple $\mathbf{M}_0$ applied to rod *CD*. Knowing that the coefficient of static friction between the rods is 0.40, determine the range of values of $\mathbf{M}_0$ for which equilibrium is maintained.

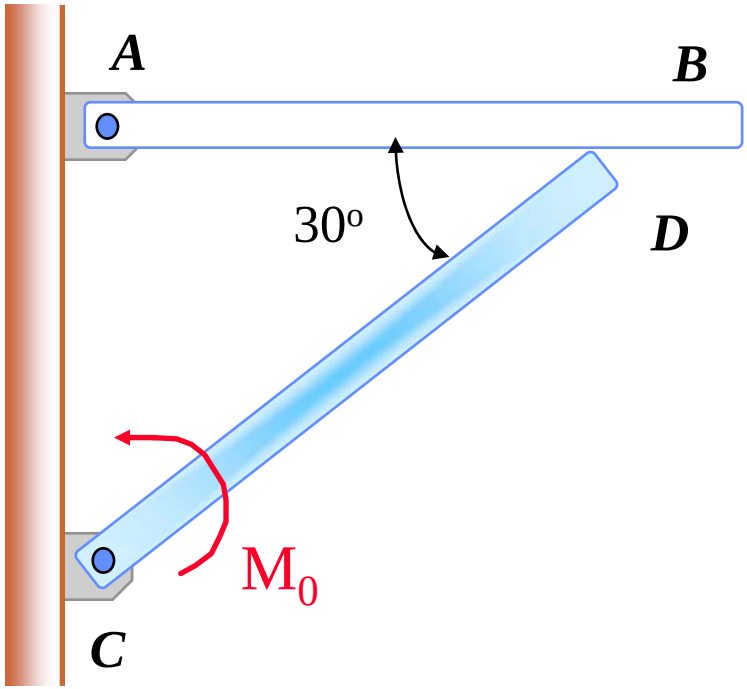


Solving Problems on Your Own

Two uniform rods each of weight *W* and length *L* are maintained in the position shown by a couple $\mathbf{M}_0$ applied to rod *CD*. Knowing that the coefficient of static friction between the rods is 0.40, determine the range of values of $\mathbf{M}_0$ for which equilibrium is maintained.

When the motion is impending and μ_s is known; you must find some unknown quantities, such as a distance, an angle, the magnitude of a force, or the direction of a force.

a. *Assume a possible motion of the body* and, on the free-body diagram, draw the friction force in a direction opposite to that of the assumed motion.



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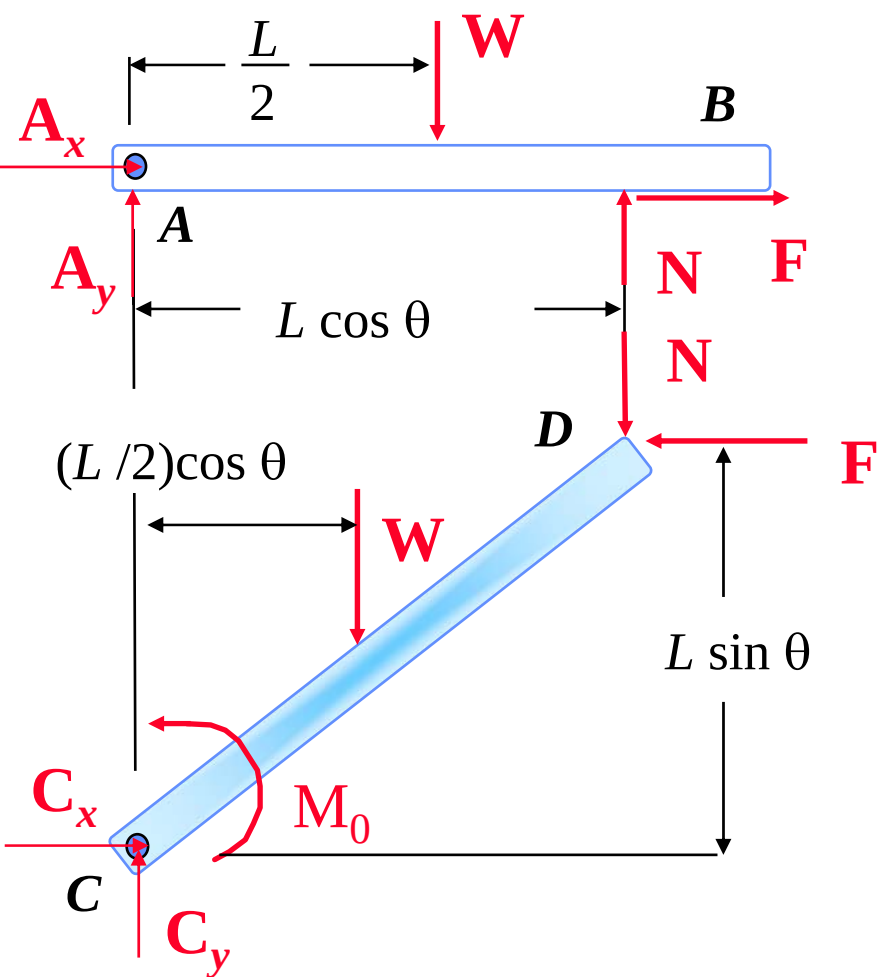
b. *Since motion is impending,* $F = F_m = \mu_s N$. Substituting for μ_s its known value, you can express *F* in terms of *N* on the free-body diagram, thus eliminating one unknown.

c. *Write and solve the equilibrium equations for the unknowns.*

Assume a possible motion of the body and,on the free-body diagram, draw the friction force in a direction opposite to that of the assumed motion.

Impending Motion: Assumed clockwise

Free-Body Diagrams



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Impending Motion: Assumed clockwise

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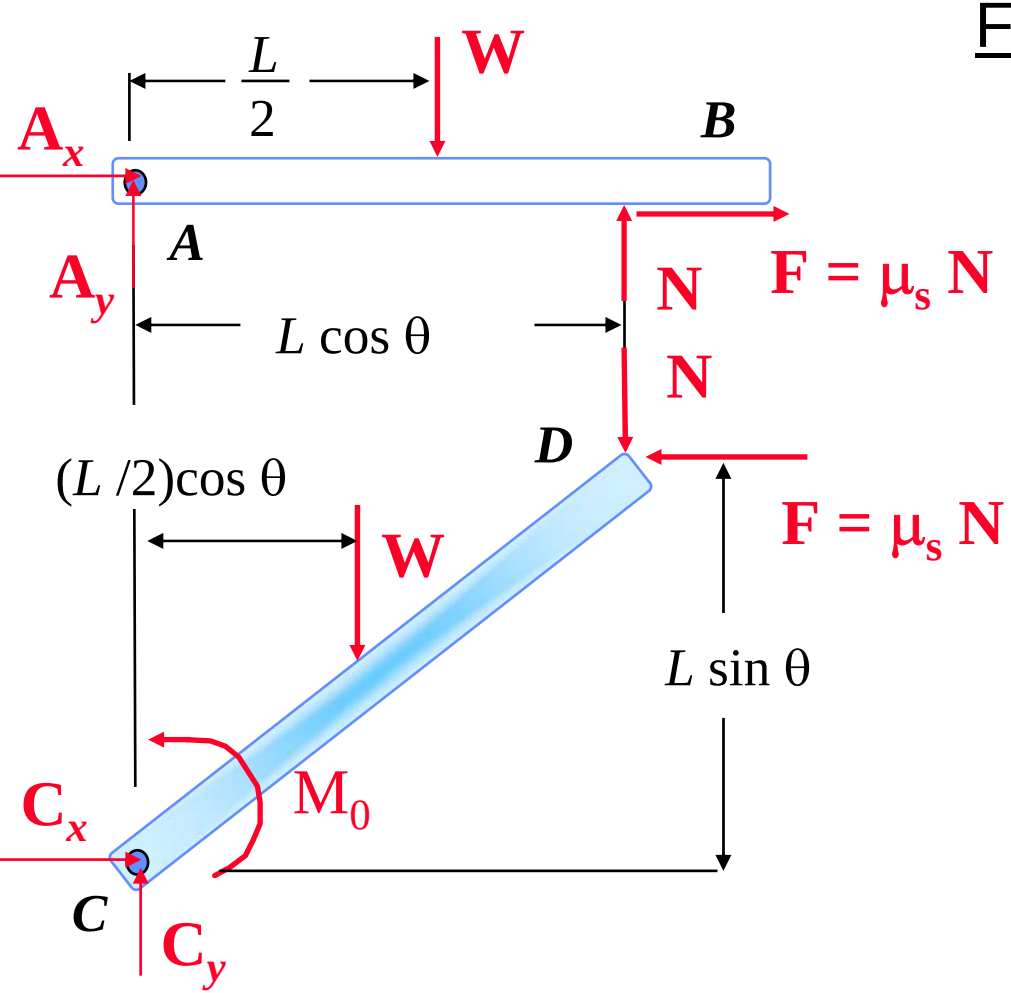
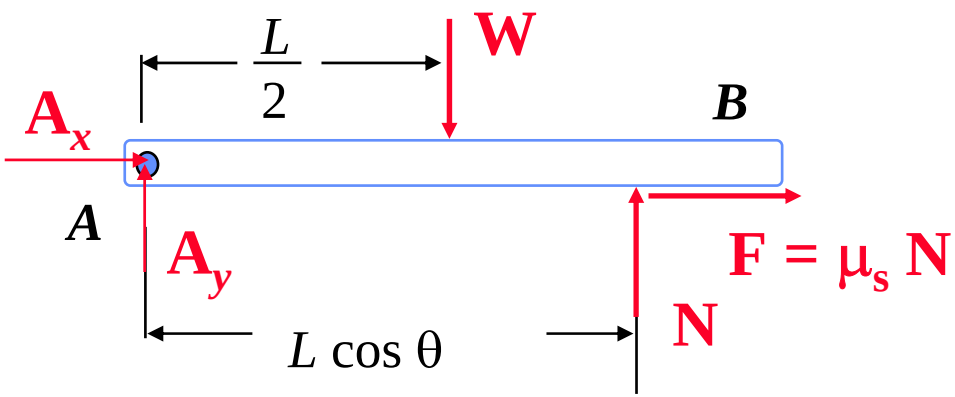


Since motion is impending, $F = F_m = \mu_s N$. Substituting for μ_s its known value, you can express F in terms of N on the free-body diagram, thus eliminating one unknown.

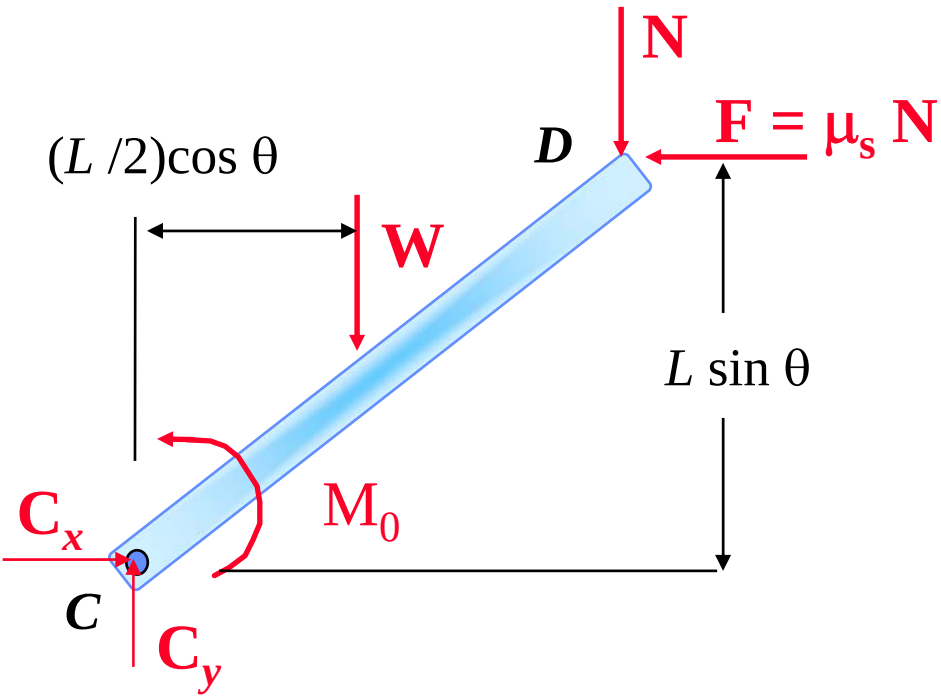
Write and solve the equilibrium equations for the unknown.



$$+\circlearrowleft \Sigma M_A = 0: \qquad N(L\cos\theta) - W(L/2) = 0$$

$$N = \frac{W}{2\cos\theta}$$

$$F = \mu_s N = \frac{\mu_s W}{2\cos\theta}$$



Write and solve the equilibrium equations for the unknown.

$$N = \frac{W}{2\cos\theta}$$

$$F = \mu_s N = \frac{\mu_s W}{2\cos\theta}$$

$$+\circlearrowleft \Sigma M_C = 0: \; M_0 - N(L\cos\theta) + F(L\sin\theta) - W(L/2)(\cos\theta) = 0$$

$$M_0 - \frac{W}{2\cos\theta}(L\cos\theta) + \frac{\mu_s W}{2\cos\theta}(L\sin\theta) - W(L/2)(\cos\theta) = 0$$

$$M_0 = \frac{1}{2} WL(\cos\theta + 1 - \mu_s \tan\theta)$$

$$= (0.5)WL(\cos 30^\circ + 1 - 0.40\tan 30^\circ)$$

$$M_0 = 0.818WL$$

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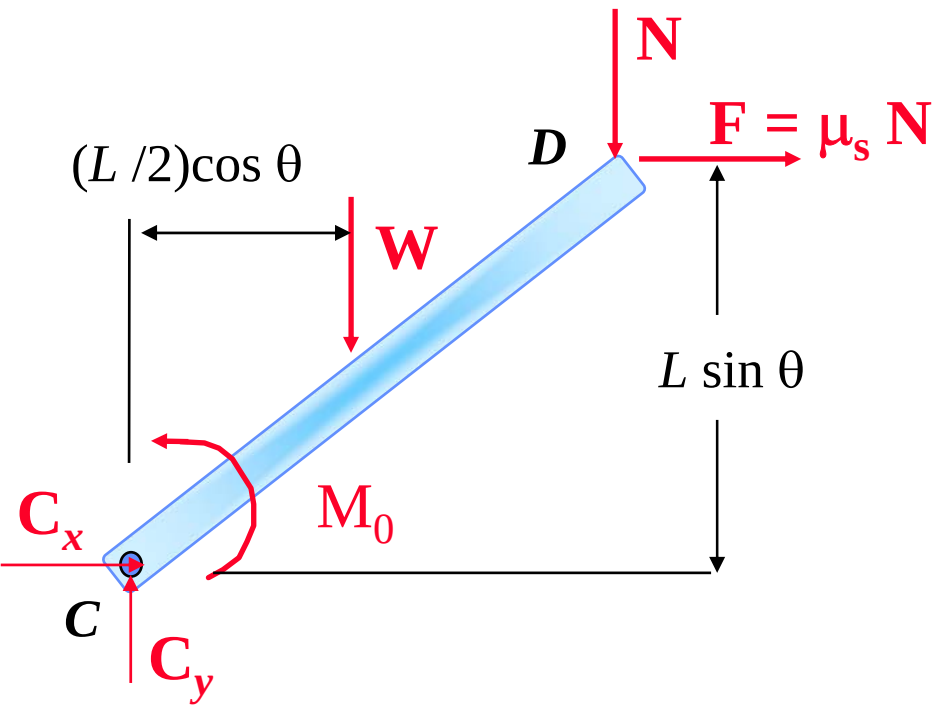
Problem 8.154 Solution

For Impending Counterclockwise Motion of the rods, we change the sign of μ_s. Therefore, M_0 is

$$M_0 = \frac{1}{2} WL\,(\cos\theta + 1 + \mu_s \tan\theta)$$

$$= (0.5)WL\,(\cos 30^o + 1 + 0.40 \tan 30^o)$$

$$M_0 = 1.0484\ WL$$



Range of M_0 for Equilibrium:

$$0.818WL \le M_0 \le 1.048WL$$