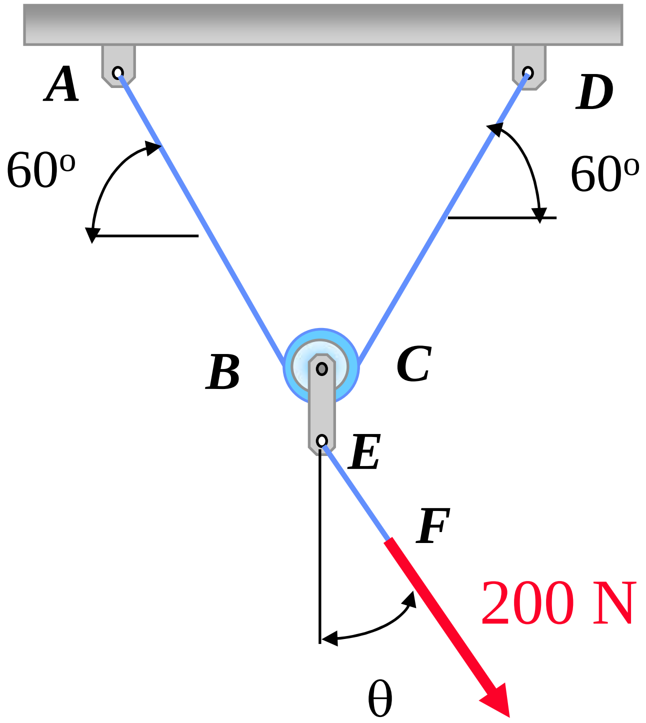
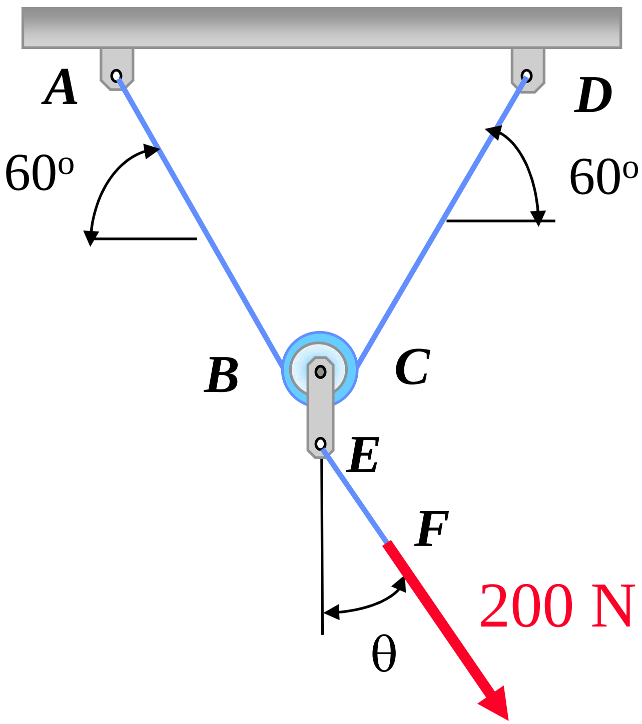
Problem 8.161



The axle of the pulley is frozen and cannot rotate with respect to the block. Knowing that the coefficient of static friction between cable *ABCD* and the pulley is 0.30, determine (a) the maximum allowable value of θ if the system is to remain in equilibrium, (b) the corresponding reactions at *A* and *D*. (Assume that the straight portions of the cable meet at point *E*.)

Solving Problems on Your Own



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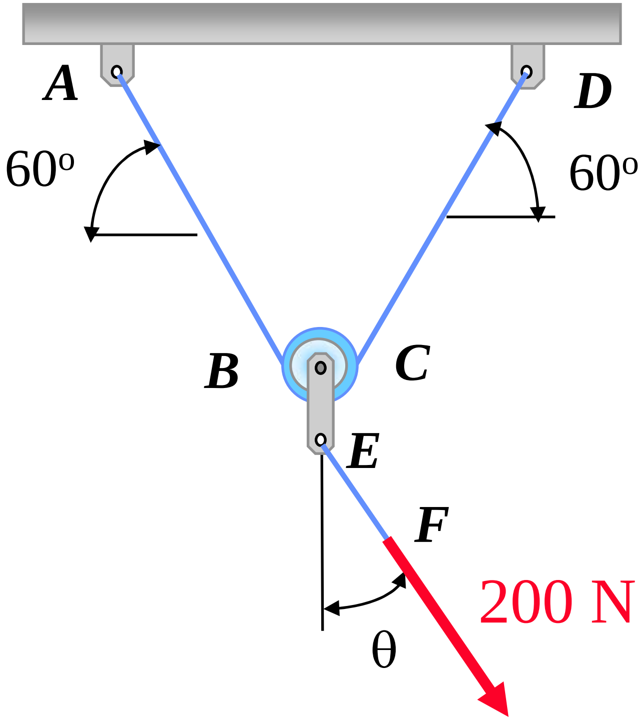
Problems involving belt friction in which slipping is impending will require the use of

$$\ln \frac{T_2}{T_1} = \mu_s \beta \quad \text{or} \quad \frac{T_2}{T_1} = e^{\mu_s \beta} \qquad \text{Eq. (8.14)}$$

where β is in radians, T_2 denotes the largest tension and is at the end of the belt which is in the direction of the motion.

Solving Problems on Your Own



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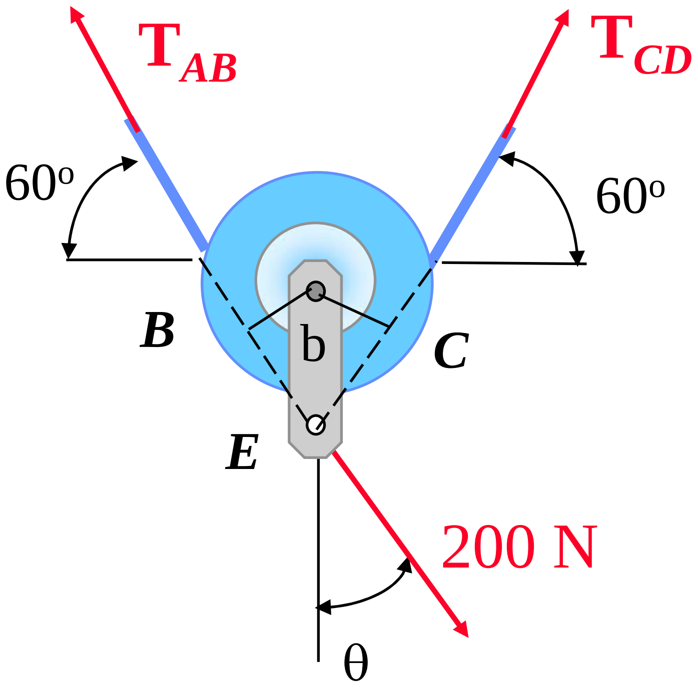
Find the magnitude of the force applied to the belt knowing that slipping is impending. If neither T_1 or T_2 is known, use the free-body diagram of the belt-drum system to write an equilibrium equation that you solve simultaneously with Eq. (8.14) for T_1 and T_2 .



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Since the 200-N force tends to rotate the pulley counterclockwise, the cable tends to slip clockwise relative to the pulley.

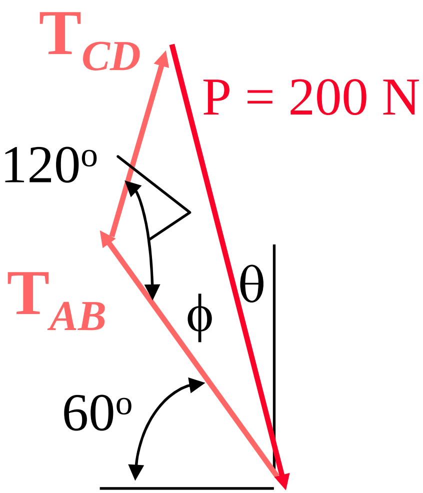
$$T_1 = T_{CD} \qquad T_2 = T_{AB} \qquad \beta = 120^o = 2\pi/3 \text{ rad} \qquad \mu_s = 0.30$$

$$\frac{T_2}{T_1} = \frac{T_{AB}}{T_{CD}} = e^{0.30(2\pi/3)} = e^{0.2\pi} = 1.8745$$

$$T_{AB} = 1.8745\, T_{CD}$$

Force Triangle

Problem 8.161 Solution



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$$T_{AB} = 1.88745\, T_{CD}$$

Law of cosines

$$P^2 = T_{AB}^2 + T_{CD}^2 - 2\,(T_{AB})\,(T_{CD}) \cos 120^{o}$$

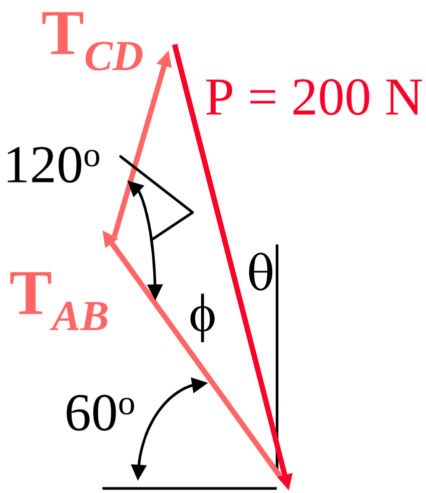
$$= (1.8745\, T_{CD})^2 + T_{CD}^2 - 2(1.8745\, T_{CD})(T_{CD})(-0.5)$$

$$= [(1.8745)^2 + 1 + 1.8745]\, T_{CD}^2$$

$$P^2 = 6.3880\, T_{CD}^2$$

$$T_{CD} = 0.39565\, P$$

Force Triangle



$$T_{AB} = 1.8745\, T_{CD} \qquad T_{CD} = 0.39565\, P$$

(a) Maximum allowable value of θ:

Law of sines

$$\frac{\sin\phi}{T_{CD}} = \frac{\sin 120^{o}}{P}\ ; \qquad \sin\phi = \frac{T_{CD}}{P}\ \sin 120^{o}$$

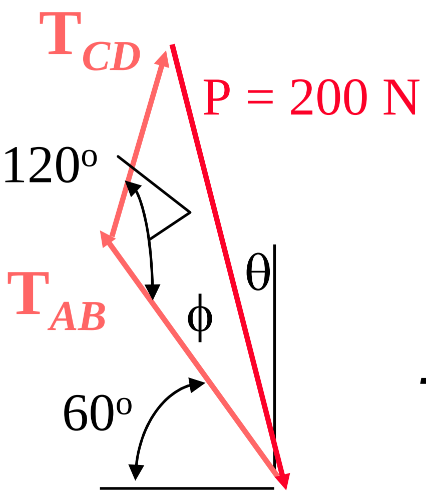
$$\sin\phi = \frac{0.39565\, P}{P}\ \sin 120^{o} = 0.34265$$

$$\phi = 20.04^{o}$$

$$\theta = 90^{o} - (60^{o} + 20.04^{o})$$

$$\boxed{\theta = 9.96^{o}}$$

Force Triangle



$\theta = 9.96^{\circ}$

$$T_{AB} = 1.88745\ T_{CD} \qquad T_{CD} = 0.39565\,P$$

(b) <u>Reactions at *A* and *D* :</u> $P = 200$ N

$$T_{CD} = 0.39565\,(200) = 79.13 \text{ N}$$

$$T_{AB} = 1.8745\ T_{CD} = 1.8745(79.13) = 148.33 \text{ N}$$

Thus

D = 79.1 N $\measuredangle$ 60°

A = 148.3 N 60°