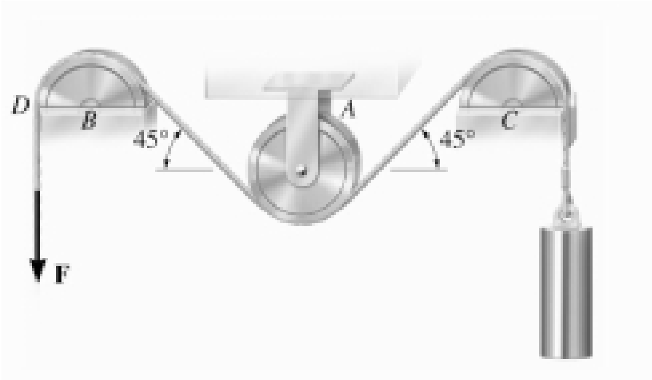
Problem 1:

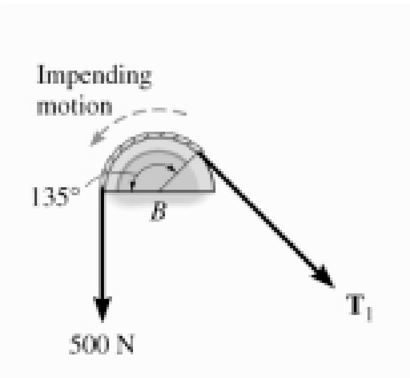
The maximum tension that can be developed in the cord shown below is 500 N. If the pulley at *A* is free to rotate and the coefficient of static friction at the fixed drums *B* and *C* is $\mu_s = 0.25$, determine the largest mass of the cylinder that can be lifted by the cord. Assume that the force ***F*** applied at the end of the cord is directly vertically downward, as shown.



Solution:

Lifting the cylinder, which has a weight $W=mg$, causes the cord to move counter clockwise over the drum at *B* and *C*; hence, the maximum tension T_2 in the cord occurs at *D*. Thus, $T_2=500N$.

A section of the cord passing over the drum at B is shown below. Since $180^o = \pi$ rad, the angle of contact between the drum and the cord is $\beta = (135^o/180^o)\pi = 3\pi/4$ rad.



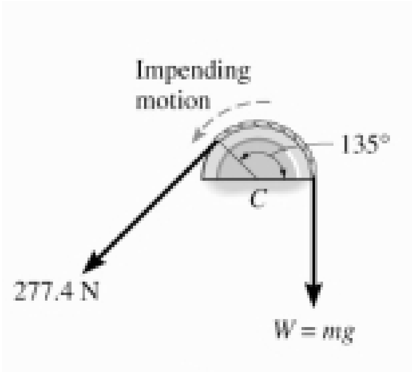
Using the equation for belts

$$\frac{T_2}{T_1} = e^{\mu_s \beta}$$

$$500N = T_1 e^{0.25[(3/4)\pi]}$$

$$T_1 = \frac{500N}{1.8} = 277.4N$$

Since the pulley at A is free to rotate, equilibrium requires that the tension in the cord remains the same on both sides of the pulley. The section of the cord passing over the drum at *C* is shown below.



The weight $W < 277.4\ N$. Why?

$$\frac{T_2}{T_1} = e^{\mu_s \beta}$$

$$277.4N = We^{0.25[(3/4)\pi]}$$

$$W = 153.9N$$

$$m = \frac{W}{g} = \frac{153.9N}{9.81\ m/s^2} = 15.7kg$$