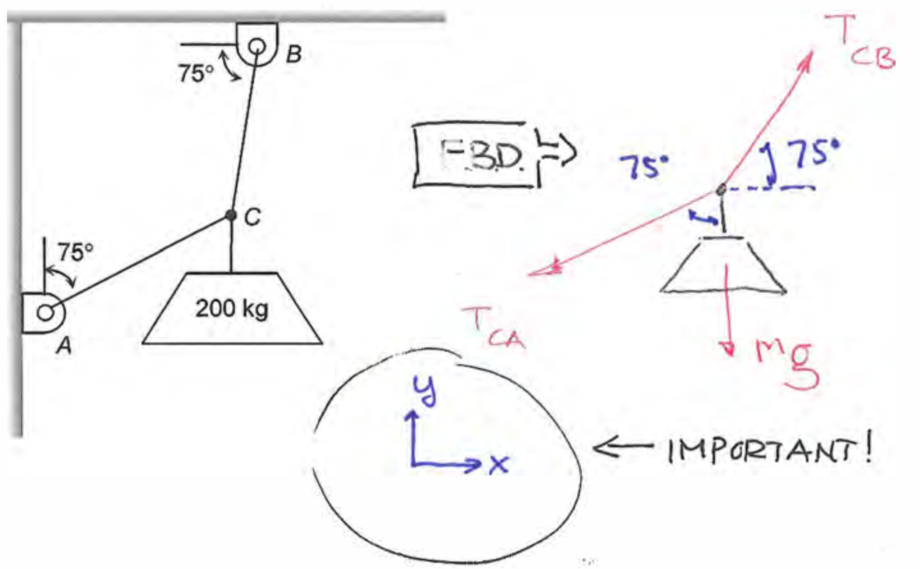
Example

A 200-kg mass is suspended from two light, inextensible cables tied together as shown. Find the tension in cable AC and BC.



$\xrightarrow{+} \sum F_x = 0$

$T_{CB} \cos 75° - T_{CA} \sin 75° = 0$ (1)

$+\uparrow \sum F_y = 0$

$T_{CB} \sin 75° - T_{CA} \cos 75° - mg = 0$ 2 EQ, 2 UNK (2)

$T_{CB} = T_{CA} \tan 75°$

$T_{CA} \tan 75° \cdot \sin 75° - T_{CA} \cos 75° = mg$

$$T_{CA} = \frac{mg}{\tan 75° \cdot \sin 75° - \cos 75°} = \frac{200\ \text{kg} \cdot 9.81\ \text{m/s}^2}{3.605 - 0.2588} \left\langle \frac{\text{N}}{\text{kg}\cdot\text{m/s}^2} \right\rangle$$

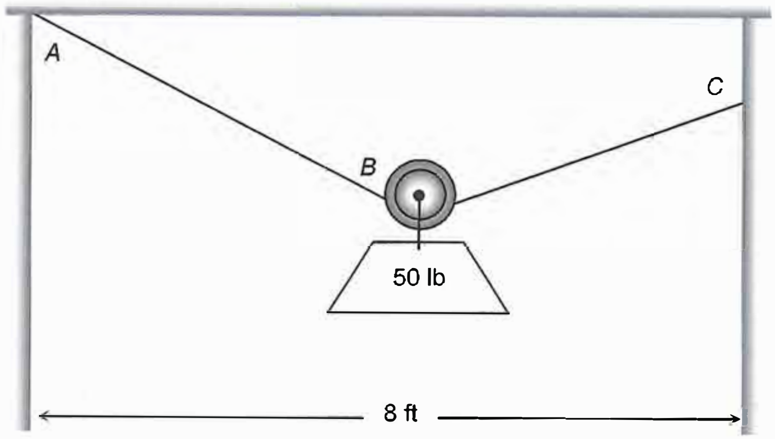
$= \boxed{586\ \text{N}}$

$T_{CB} = (586\ \text{N})(\tan 75°) = \boxed{2190\ \text{N}}$

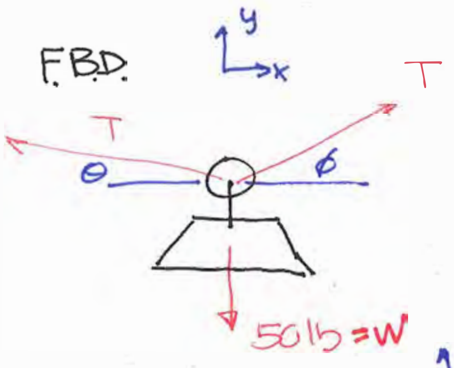
Example

A light inextensible cable of total length 10 ft is stretched between two walls 8 ft apart A 5O-lb weight is suspended from a massless, frictionless pulley on the cable. Find the tension in the cable.

LETS YOU ASSUME T SAME ON BOTH SIDES



F.B.D.



$\rightarrow \sum F_x = 0$

$\frac{T}{T} \cos\phi - \frac{T}{T} \cos\theta = \frac{0}{T}$

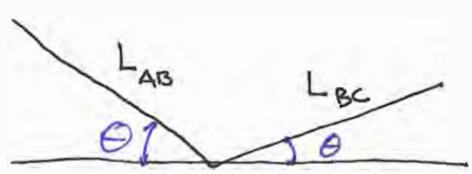
$\cos\phi = \cos\theta \qquad \underline{\phi = \theta}$

$\uparrow \sum F_y = 0$

$\overset{?}{T} \sin\theta + \overset{?}{T} \sin\theta - 50 \text{ lb} = 0 \qquad (1)$

1 EQN, 2 UNKNOWNS.
WHAT TO DO?

GEOMETRY



$\overset{?}{L_{AB}} + \overset{?}{L_{BC}} = 10' \quad (2)$

$\cos\theta \, L_{AB} + \cos\theta \, L_{BC} = 8'$

$\cos\theta (\underbrace{L_{AB} + L_{BC}}_{?\ 10!}) = 8' \qquad (3)$

$\cos\theta = 8' / (L_{AB} + L_{BC}) = 8/10 \qquad \underline{\theta = 36.9°}$

FROM (1)

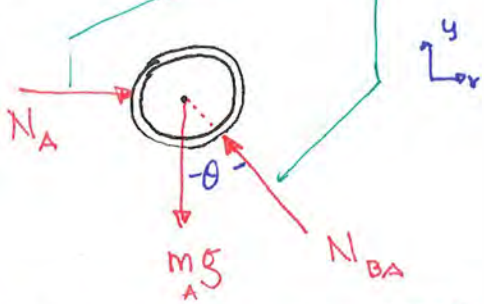
$$T = \frac{50}{2 \sin\theta} = \frac{50\#}{2 \cdot \sin(36.9°)} = \boxed{41.7 \text{ lb}}$$

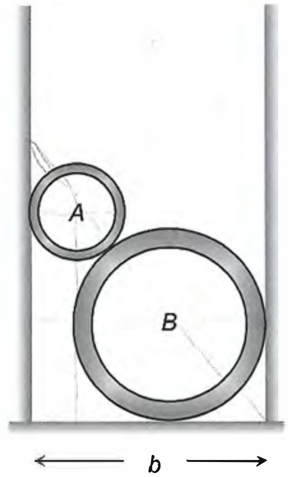
Example — NO FRICTION

Two smooth steel pipes are stacked in a box. The masses and diameters of pipe A and Bare, m_A = 5 kg, m_B = 20 kg, DA = 100 mm and D_B = 200 mm, respectively. If the distance between the walls is b = 250 mm, find

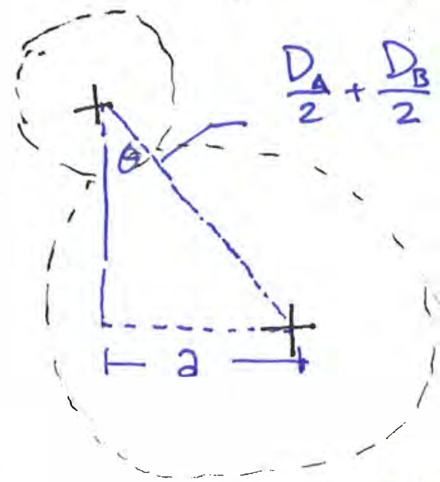
a) the magnitude of the two forces exerted on pipe A, and
b) the force the bottom of the box exerts on pipe B.

a) FBD A — NORMAL TO SURFACES





GEOMETRY



$\uparrow \sum F_y = 0$ (WHY y FIRST?)

$-m_A g + \cos\theta \, N_{BA} = 0$

$N_{BA} = \frac{m_A g}{\cos\theta} = \frac{(5\text{kg} \cdot 9.81 \frac{m}{s^2})}{\cos(41.8°)} = 65.81\text{N}$

$b = \frac{D_A}{2} + a + \frac{D_B}{2}$

$b = \frac{D_A}{2} + \sin\theta\left(\frac{D_A}{2} + \frac{D_B}{2}\right) + \frac{D_B}{2}$

$\rightarrow \sum F_x = 0$

$N_A - N_{BA} \sin\theta = 0$

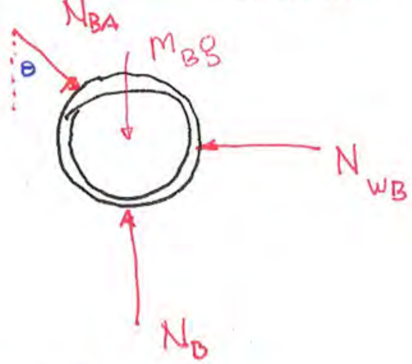
$N_A = N_{BA} \sin\theta = 65.81\text{N} \cdot \sin\theta = 43.87\text{N}$

$\sin\theta = \frac{b - \left(\frac{D_A}{2} + \frac{D_B}{2}\right)}{\frac{D_A}{2} + \frac{D_B}{2}}$

$= \frac{250 - (50 + 100)}{(50 + 100)}$

$= \frac{100}{150} \Rightarrow \theta = 41.8°$

b) FBD B — NOTE REVERSE DIRECTION



$\uparrow \sum F_y = 0$

$N_B - N_{BA}\cos\theta - m_B g = 0$

$N_B = m_B g + N_{BA}\cos\theta$

$= 20\text{kg} \cdot 9.81 \frac{m}{s^2} + 65.81\text{N} \cdot \cos(41.8)$

$= 245.3\text{N}$

DRAW ANOTHER FBD THAT GIVE SAME RESULT!