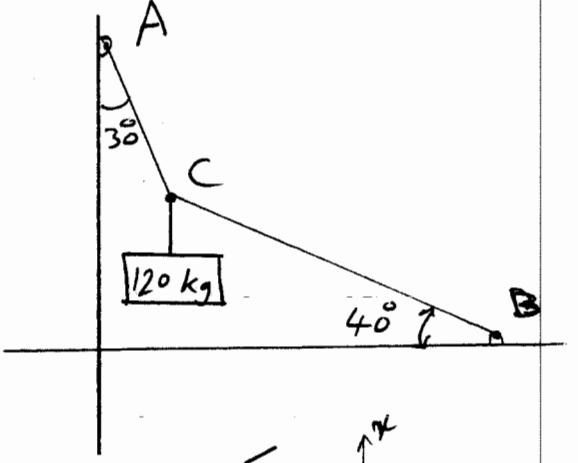
CE 201-9 (061)

Solution of HW # 3

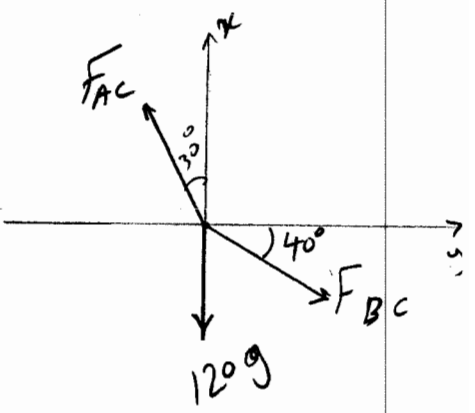
Problem # 1



Data: The system in the figure

Required: The tension in AC & BC

Solution: Equilibrium for C (FBD)



FBD

$$\sum F_x = 0 \Rightarrow F_{BC}\cos 40 - F_{AC}\sin 30 = 0$$

$$\Rightarrow F_{BC} = 0.6527\, F_{AC}$$

$$\sum F_y = 0 \Rightarrow F_{AC}\cos 30 - F_{BC}\sin 40 - 120g = 0$$

$$\Rightarrow F_{AC}\cos 30 - 0.6527\, F_{AC}\sin 40 - 120g = 0$$

$$\Rightarrow \boxed{F_{AC} = 2636.6 \text{ N}} \quad (\text{with } g = 9.81 \tfrac{m}{s^2})$$

$$\Rightarrow \boxed{F_{BC} = 1720.9 \text{ N}}$$

Note: $F_{AC} = T_{CA}$

$F_{BC} = T_{CB}$

Problem # 2

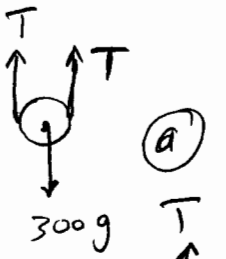
Given: The arrangement shown in Figure P2.

Required: The tension in the rope for each arrangement.

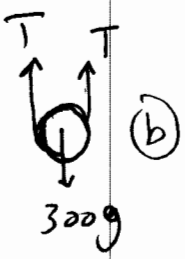
Solution:

a) $\Sigma F_y = 0 \Rightarrow 2T = 300g$

$\Rightarrow T = 150g \Rightarrow \boxed{T = 1471.5\ N}$

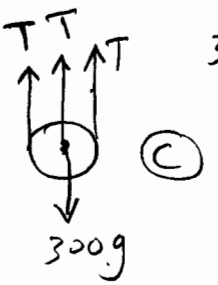


b) $\Sigma F_y = 0 \Rightarrow \boxed{T = 1471.5\ N}$

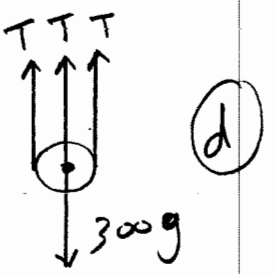


c) $\Sigma F_y = 0 \Rightarrow 3T = 300g =$

$\Rightarrow T = 100g = 100 \times 9.81 \Rightarrow \boxed{T = 981\ N}$

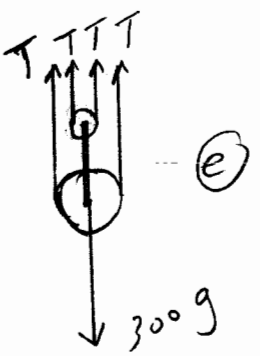


d) $\Sigma F_y = 0 \Rightarrow \boxed{T = 981\ N}$



e) $\Sigma F_y = 0 \Rightarrow 4T = 300g$

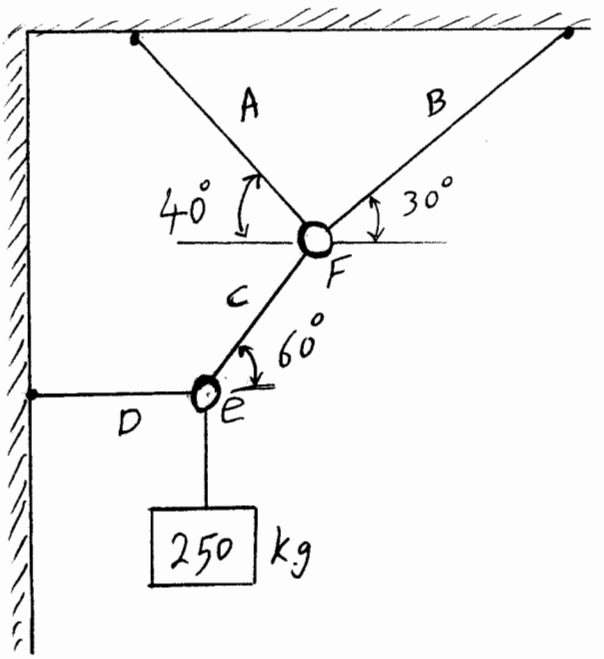
$\Rightarrow \boxed{T = 735.75\ N}$



FBDs

Conclusion: With increasing the rope-and-pulley arrangement, one can decrease the tension in the rope $\Rightarrow$ use smaller rope $\Rightarrow$ less cost. [or it will be safer w/ some rope]

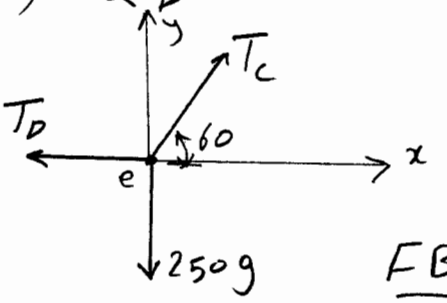
Problem # 3



Given: The system shown in the figure

Required: The tensions in cables A, B, C & D.

Solution: Equilibrium for e (Why start with e?!)



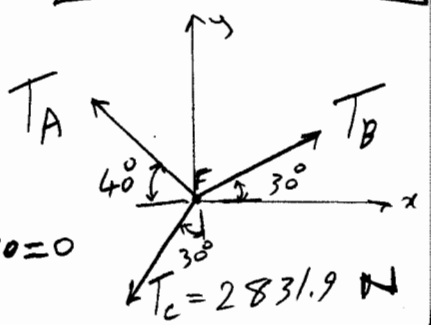
FBD

$\Sigma F_y = 0 \Rightarrow T_C \sin 60 = 250 \times 9.81$

$\Rightarrow \boxed{T_C = 2831.9\ N}$

$\Sigma F_x = 0 \Rightarrow -T_D + T_C \cos 60 = 0 \Rightarrow \boxed{T_D = 1415.95\ N}$

Equilibrium for F



FBD

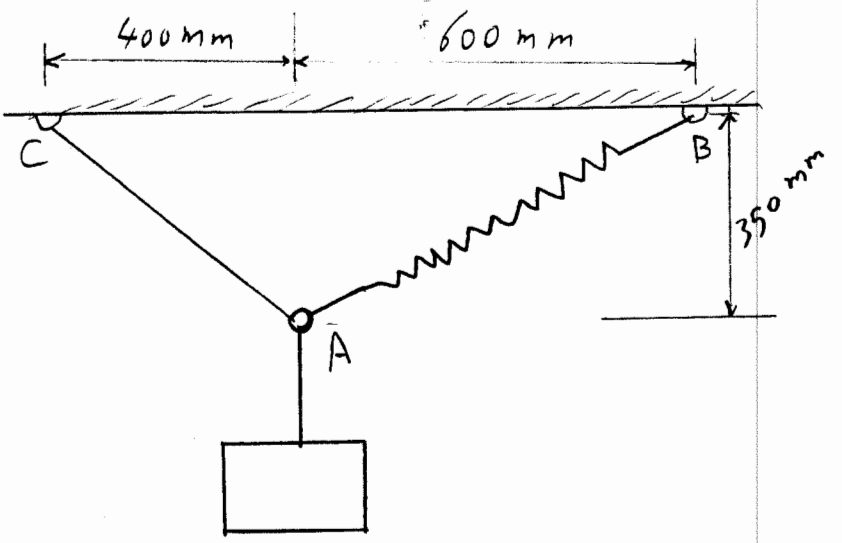
$\Sigma F_x = 0 \Rightarrow T_B \cos 30 - T_A \cos 40 - 2831.9 \sin 30 = 0$

$\Sigma F_y = 0 \Rightarrow T_B \sin 30 + T_A \sin 40 - 2831.9 \cos 30 = 0$

Solving these two equation gives $\boxed{T_A = 1506.8\ N}$

$\boxed{T_B = 2967.8\ N}$

Problem # 4



Given: The arrangement in the figure with the unstretched length of the spring AB is 600 mm & $k_{AB} = 1000$ N/m

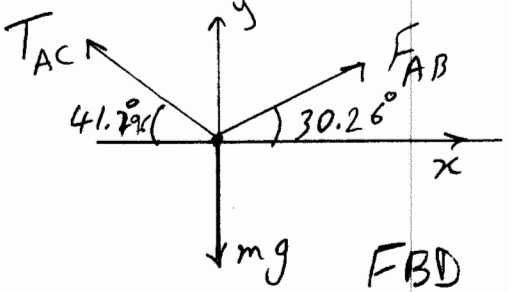
Required: The mass of the suspended object.

Solution: The equilibrium length for spring AB is

$$l = \sqrt{600^2 + 350^2} = 694.62 \text{ mm} \Rightarrow$$

$$S = 694.62 - 600 = 94.62 \text{ mm} \Rightarrow S = 0.09462 \text{ m}$$

$$\therefore F_{AB} = S\,k = 0.09462 * 1000 = 94.62 \text{ N}$$



FBD

$$\sum F_x = 0 \Rightarrow T_{AC}\cos 41.196 = F_{AB}\cos 30.26$$

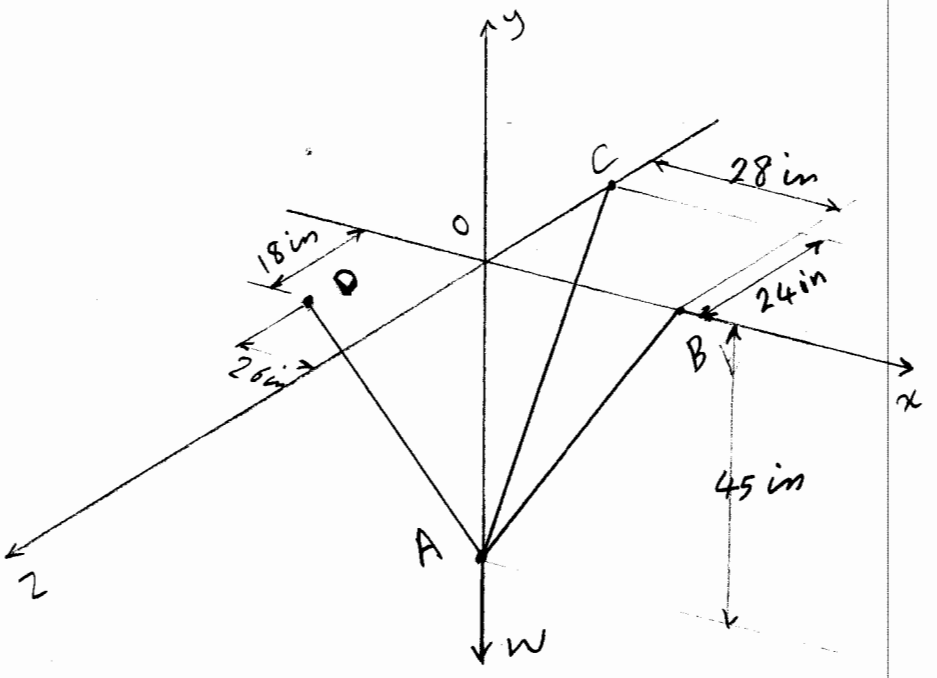
$$\Rightarrow T_{AC} = 108.6 \text{ N}$$

$$\sum F_y = 0 \Rightarrow F_{AC}\sin 41.196 + F_{AB}\sin 30.26 - mg = 0$$

$$\Rightarrow mg = 119.2 \text{ N} \Rightarrow m = \frac{119.2}{9.81} = 12.15 \text{ kg}$$

$$\boxed{m = 12.15 \text{ kg}}$$

Problem # 5



Given: The three cable shown in the figure with $T_{AD} = 924$ lb

Required: The weight W.

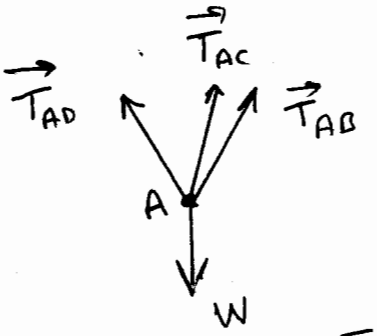
Solution:

$A(0, -45, 0)$

$B(28, 0, 0)$

$C(0, 0, -24)$

$D(-26, 0, 18)$



FBD

$\vec{AD} = -26\vec{i} + 45\vec{j} + 18\vec{k} \Rightarrow AD = 55$ in

$\vec{AB} = 28\vec{i} + 45\vec{j} \Rightarrow AB = 53$ in

$\vec{AC} = +45\vec{j} - 24\vec{k} \Rightarrow AC = 51$ in

$\therefore \vec{T}_{AD} = \frac{924}{55}(-26\vec{i} + 45\vec{j} + 18\vec{k}) = -436.8\vec{i} + 756\vec{j} + 302.4\vec{k}$

$\vec{T}_{AB} = \frac{T_{AB}}{53}(28\vec{i} + 45\vec{j}) = 0.5283\,T_{AB}\,\vec{i} + 0.8491\,T_{AB}\,\vec{j}$

$\vec{T}_{AC} = \frac{T_{AC}}{51}(45\vec{j} - 24\vec{k}) = 0.8824\,T_{AC}\,\vec{j} - 0.4706\,T_{AC}\,\vec{k}$

Continue problem # 5

Equilibrium for A gives

$\sum F_x = 0 \Rightarrow -436.8 + 0.5283 T_{AB} = 0 \Rightarrow T_{AB} = 826.8 \text{ lb}$

$\sum F_z = 0 \Rightarrow 302.4 - 0.4706 T_{AC} = 0 \Rightarrow T_{AC} = 642.6 \text{ lb}$

$\sum F_y = 0 \Rightarrow 756 + 0.8491 T_{AB} + 0.8824 T_{AC} - W = 0$

$\Rightarrow W = 756 + 0.8491(826.8) + 0.8824(642.6)$

$\therefore \boxed{W = 2025.1 \text{ lb}}$ //