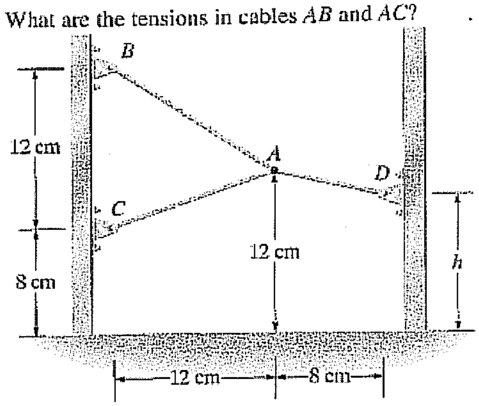
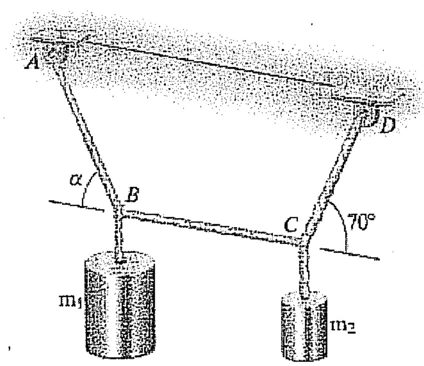
Engineering Statics Assignment #3 Name: ---------------------------------

Group:----------------

3.41 The distance $h = 12$ cm, and the tension in cable AD is 200 N. What are the tensions in cables AB and AC?

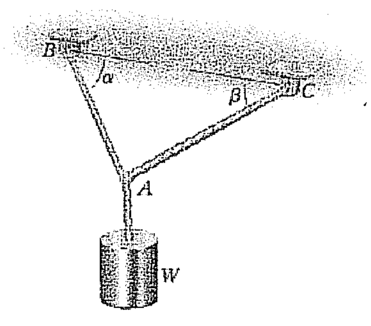


3.44 The masses $m_1 = 12$ kg and $m_2 = 6$ kg are suspended by the cable system shown. The cable BC is horizontal. Determine the angle α and the tensions in the cables AB, BC, and CD.

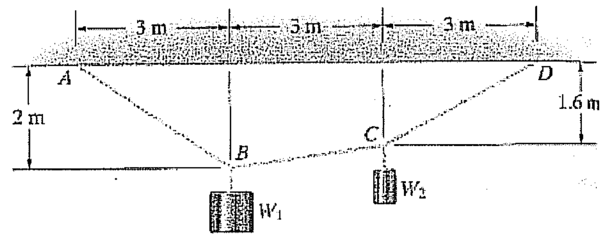


3.42 You are designing a cable system to support a suspended object of weight W. Because your design requires points A and B to be placed as shown, you have no control over the angle α, but you can choose the angle β by placing point C wherever you wish. Show that to minimize the tensions in cables AB and AC, you must choose $\beta = \alpha$ if the angle $\alpha \geq 45°$.

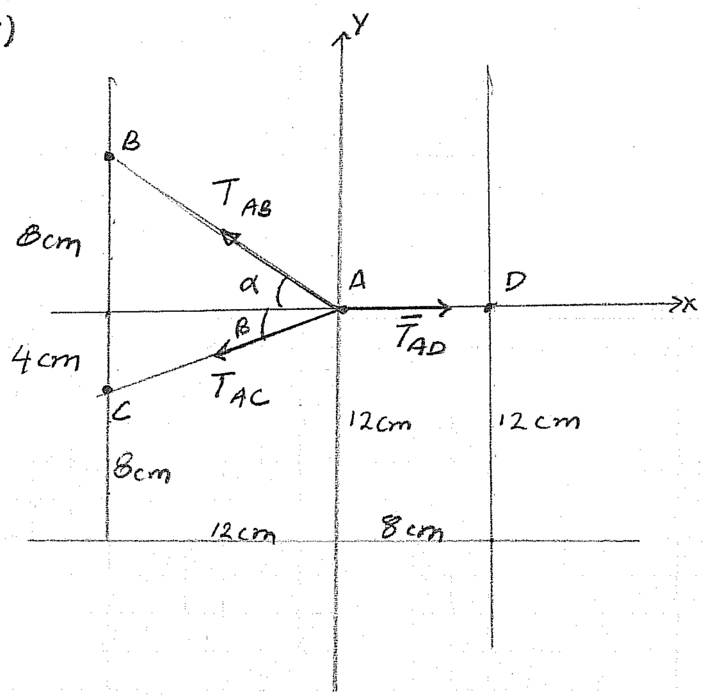
Strategy: Draw a diagram of the sum of the forces exerted by the three cables at A.



3.46 Assume that $W_2 = W_1/2$. If you don't want the tension anywhere in the supporting cable to exceed 200 N, what is the largest acceptable value of W_1?



3.41)



$T_{AD} = 200\ N$

$$\alpha = \tan^{-1}\left(\frac{8}{12}\right) = 36.7^\circ \quad \beta = \tan^{-1}\left(\frac{4}{12}\right) = 18.4^\circ$$

$[\Sigma F_x = 0]$ $\quad -T_{AB}\cos\alpha - T_{AC}\cos\beta + T_{AD} = 0$

$$-0.8018\, T_{AB} - 0.9489\, T_{AC} + 200 = 0 \qquad (1)$$

$[\Sigma F_y = 0]$ $\quad T_{AB}\sin\alpha - T_{AC}\sin\beta = 0$

$$0.5976\, T_{AB} - 0.3156\, T_{AC} = 0 \qquad (2)$$

From (2) $\quad T_{AB} = 0.5281\, T_{AC} \qquad (3)$

Sub(3) into(1) $\quad -0.8018\,[0.5281\, T_{AC}] - 0.9489\, T_{AC} + 200 = 0$

$$T_{AC} = 145.74\,N \qquad (4)$$

Sub(4) into(3) $\quad T_{AB} = 76.94\,N$

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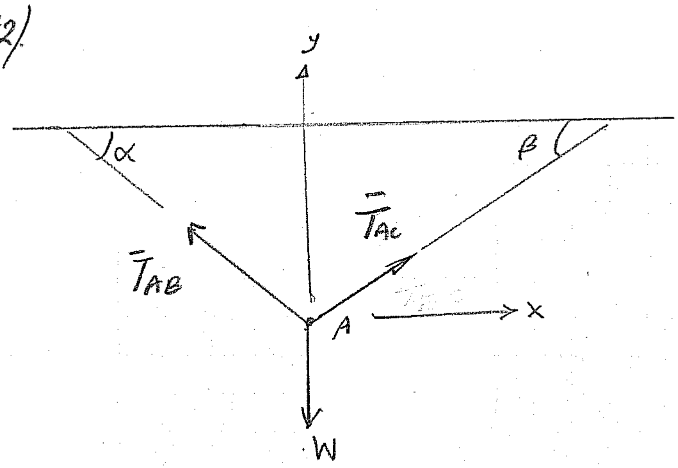

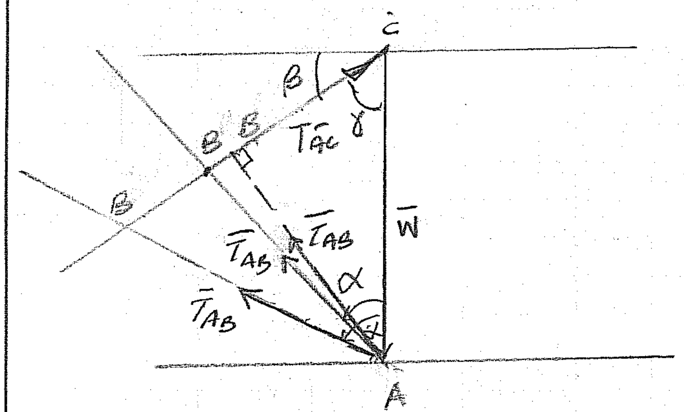

β is fixed

α = variable

case 1) $\alpha \geq 45^\circ$ The smallest force T_{AB} is one whose direction is normal to force T_{BC} (smallest length AB)

In this case,

$$\alpha + \gamma = 90^\circ$$

also $\beta + \gamma = 90$

$$\therefore \quad \alpha = \beta$$

case 2) $\alpha < 45^\circ$ The smallest force in this case will be in cable BC ($\overline{BC}$ smaller than $\overline{AB}$)

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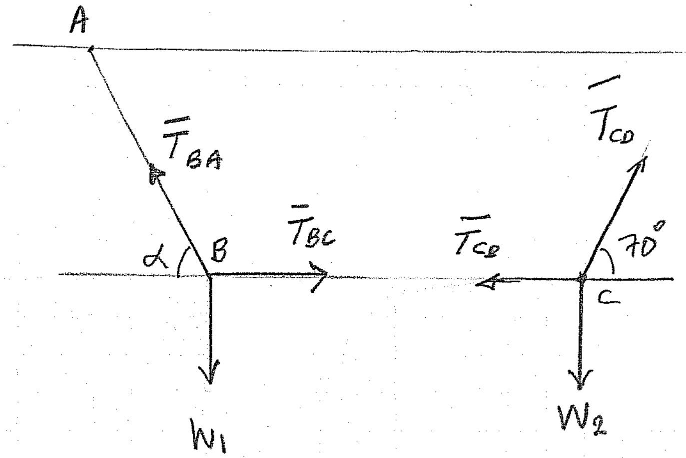
3.44)



$W_1 = m_1 g = 12(9.81)$
$= 117.72^N$

$W_2 = M_2 g = 6(9.81)$
$= 58.86^N$

@ B $[\Sigma F_x = 0]$ $-T_{BA}\cos\alpha + T_{BC} = 0$ (1)

$[\Sigma F_y = 0]$ $T_{BA}\sin\alpha - W_1 = 0$ (2)

@ C $[\Sigma F_x = 0]$ $-T_{CB} + T_{CD}\cos 70° = 0$ (3)

$[\Sigma F_y = 0]$ $T_{CD}\sin 70° - W_2 = 0$ (4)

from (4): $T_{CD}\sin 70° - 58.86 = 0$ $T_{CD} = 62.64$ (N) (5)

Subs (5) into (3) $-T_{CB} + (62.64)\cos 70 = 0$ $T_{CB} = 21.42^N$ (6)

Subs (6) into (1) $-T_{BA}\cos\alpha + 21.42 = 0$

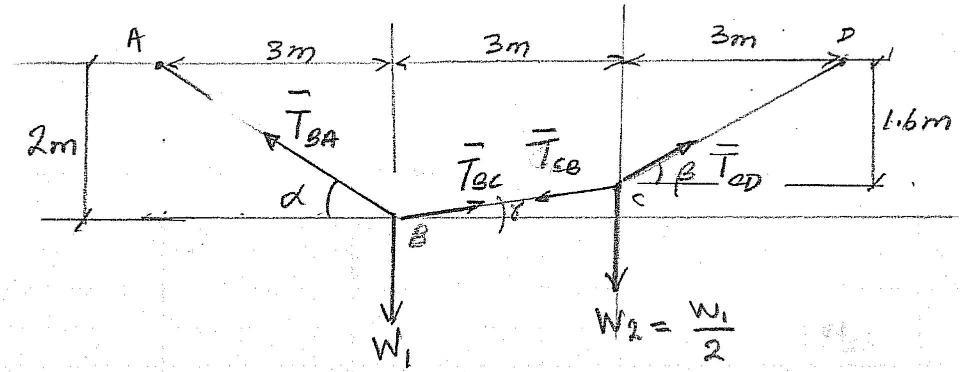
$$T_{BA} = \frac{21.42}{\cos\alpha} \quad (7)$$

Subs (7) into (2) $\frac{21.42}{\cos\alpha}\sin\alpha - 117.72 = 0$

$$\frac{\sin\alpha}{\cos\alpha} = \tan\alpha = \frac{117.72}{21.42} \quad \therefore \alpha = 79.7°$$

from (7) $T_{BA} = 119.80\,N$

3.46)



$\tan\alpha = \frac{2}{3}$ $\quad$ $\tan\gamma = \frac{0.4}{3}$ $\quad$ $\tan\beta = \frac{1.6}{3}$

$\alpha = 33.7^\circ$ $\quad$ $\gamma = 7.6^\circ$ $\quad$ $\beta = 28.1^\circ$

Max force in cables 200^N

@ B $\quad [\Sigma F_x = 0] \quad -T_{BA}\cos\alpha + T_{BC}\cos\gamma = 0 \quad (1)$

$[\Sigma F_y = 0] \quad T_{BA}\sin\alpha + T_{BC}\sin\gamma - W_1 = 0 \quad (2)$

@ C $\quad [\Sigma F_x = 0] \quad -T_{CB}\cos\gamma + T_{CD}\cos\beta = 0 \quad (3)$

$[\Sigma F_y = 0] \quad -T_{CB}\sin\gamma + T_{CD}\sin\beta - \frac{W_1}{2} = 0 \quad (4)$

from (1) $\quad -T_{BA}(0.8319) + T_{BC}(0.9912) = 0$

$T_{BC} = 0.8393\,T_{BA} \quad [\therefore T_{BC} < T_{BA}] \quad (5)$

from (3) $\quad -T_{CB}(0.9912) + T_{CD}(0.8821) = 0$

$T_{CB} = 0.8899\,T_{CD} \quad [\therefore T_{CB} < T_{CD}] \quad (6)$

Since $T_{BC} = T_{CB}$ $\quad 0.8393\,T_{BA} = 0.8899\,T_{CD}$

$T_{BA} = 1.0603\,T_{CD} \quad (7)$

$\therefore [T_{BA} > T_{CD}]$

$\therefore T_{BC} < T_{CD} < T_{BA}$

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$\therefore$ Set $T_{BA} = 200^N$ (cable with max tension)

$\therefore$ from (5) $T_{BC} = 167.86^N$

from (6) $T_{CD} = 188.62^N$

from (2) $200 \sin\alpha + 167.86 \sin\gamma - W_1 = 0$

$\therefore W_1 = 133.17\ N$