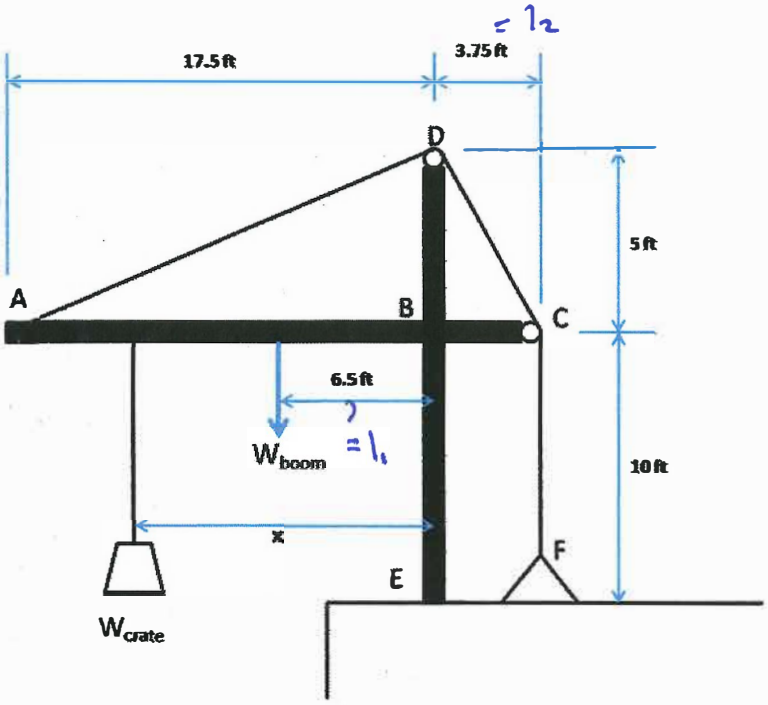
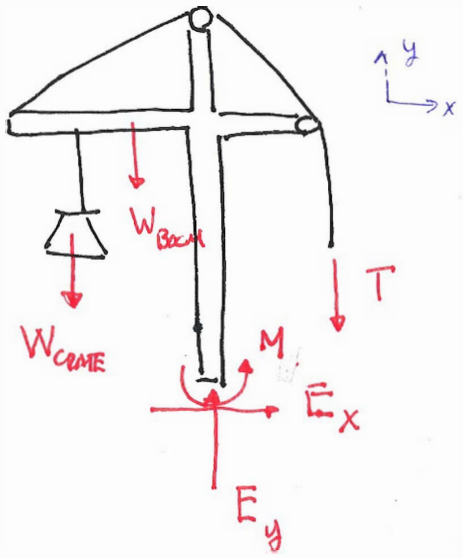
Example

The rig shown below consists of a 1200-lb boom ABC and a vertical member DBE welded together at B. (There are frictionless pulleys at both C and D.) The rig is being used to suspend a 3600-lb crate at a distance $x = 12$ ft from the vertical member. If the tension in the cable is 4 kips, determine the reaction at E.





$\rightarrow \Sigma F_x = 0$

$E_x = 0$

$+\uparrow \Sigma F_y = 0$

$-W_{cr} - W_B - T + E_y = 0$

$E_y = W_{cr} + W_B + T$

$= 3600\text{ lb} + 1200\text{ lb} + 4000\text{ lb}$

$= \boxed{8800\text{ lb}}$

$\circlearrowleft + \Sigma M_E = 0$

$x W_c + l_1 W_B + M - l_2 T = 0$

$M = l_2 T - l_1 W_B - x W_c$

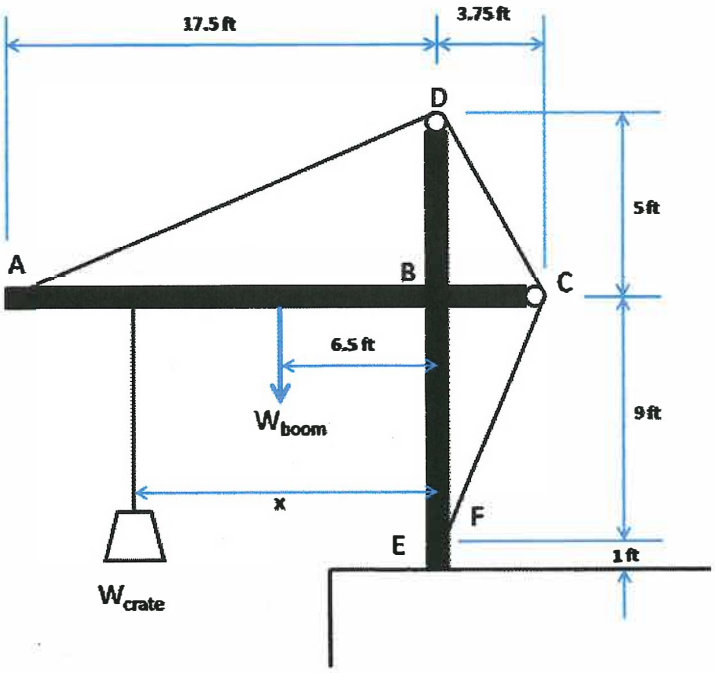
$= (3.75')(4000\text{ lb}) - (6.5')(1200\text{ lb}) - (12')(3600\text{ lb})$

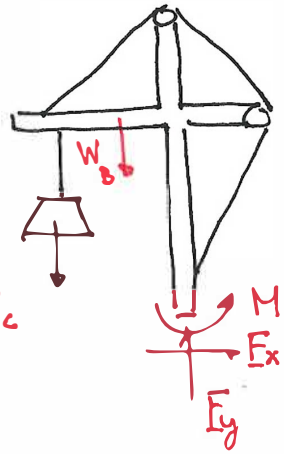
$= \boxed{-36{,}000\text{ ft-lb}}$

GOT DIRECTION BACKWARDS

Example

If the cable attachment point in the last example is changed as shown below, find the new reaction at *E*.





$\Sigma F_x = 0 \quad E_x = 0$

$\Sigma F_y = 0 \quad -W_c - W_B + F_y = 0 \quad E_y = W_c + W_B =$

$= 3600\ lb + 1200\ lb$

$= \boxed{4800\ lb}$

(+) $\Sigma M_E = 0$

$x W_c + 7.5 W_B + M = 0$

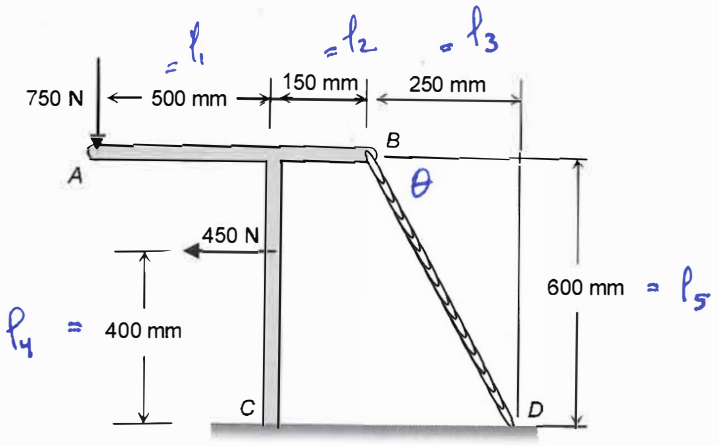
$M = -x W_c - 7.5 W_B = -(12')(3600\#) - (6.5')(1200\ lb)$

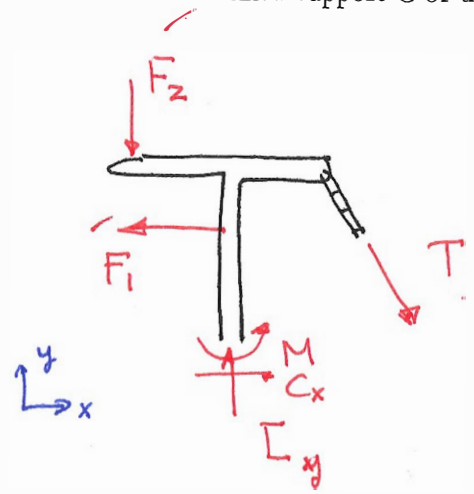
$= \boxed{-51{,}000\ ft\text{-}lb}$

NOTE THAT CABLE TENSION IS COMPLETELY IND. of ALL of THIS!

Example

Knowing that the tension in the wire *BD* is 1300 N, determine the reaction at the fixed support *C* of the structure shown. Assume that the weight of the structure is negligible.





$\rightarrow \sum F_x = 0$

$-F_1 + C_x + T\cos\theta = 0$

$\theta = \tan^{-1}\left(\frac{600\text{ mm}}{250\text{ mm}}\right) = 67.4°$

$C_x = F_1 - T\cos\theta$

$= 450\text{ N} - 1300\cos(67.4°) = \boxed{-50\text{ N}}$

$+\uparrow \sum F_y = 0$

$-F_2 + C_y - T\sin\theta = 0$

$C_y = T\sin\theta + F_2 = (1300\text{ N})(\sin 67.4°) + 750\text{ N}$

$= \boxed{1950\text{ N}}$

$(+\circlearrowleft) \sum M_B = 0$

$(l_1 + l_2)F_2 - (l_5 - l_4)F_1 - l_2 C_y + l_5 C_y + M = 0$

$M = -(l_1 + l_2)F_2 + (l_5 - l_4)F_1 + l_2 C_y - l_5 C_x$

$= -(500 + 150)\text{mm}(750\text{N}) + (600 - 400)\text{mm}(450\text{N})$

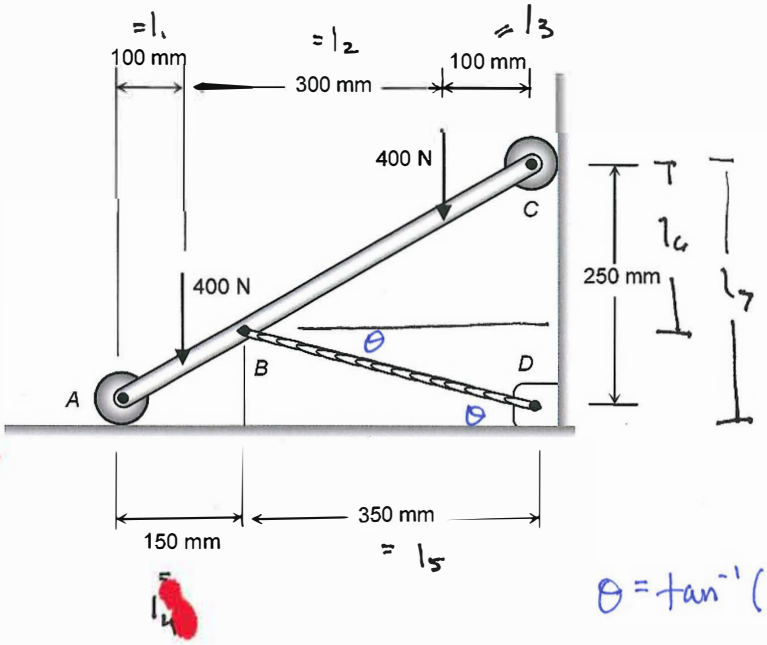
$+ (150\text{ mm})(1950\text{ N}) - (600\text{ mm})(-50\text{ N})$

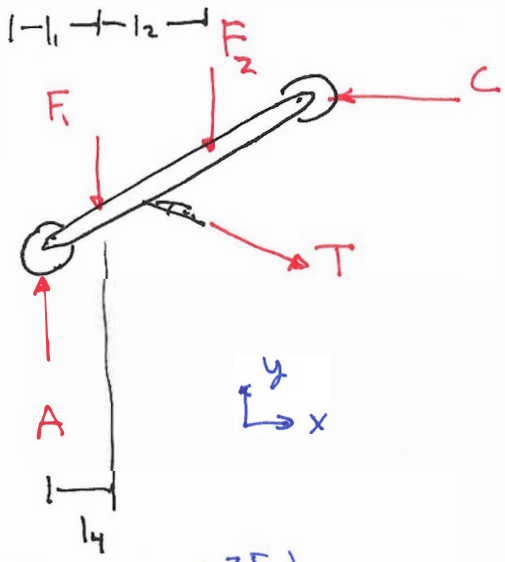
$= \boxed{-75{,}000\text{ N-m}}$

TRY AGAIN @ C & GET SAME ANSWER...

Example

Find the tension in the wire *BD*. Assume that the weight of the structure is negligible.





$$\theta = \tan^{-1}\left(\frac{l_7 - l_6}{l_5}\right) = \tan^{-1}\left(\frac{75}{350}\right) = 12.1^\circ$$

$$\frac{l_5}{l_6} = \frac{l_4 + l_5}{l_7} \qquad l_6 = \frac{l_7 \cdot l_5}{l_4 + l_5} = \frac{(250)(350)\ mm^2}{(150 + 350)\ mm} = 175\ mm$$

$$\Sigma F_x = 0$$

$$-C + T\cos\theta = 0 \quad (1)$$

$$\Sigma F_y = 0$$

$$A - F_1 - F_2 - T\sin\theta = 0 \quad (2)$$

$$\Sigma M_B = 0$$

$$-l_4 A + (l_4 - l_1)F_1 - (l_5 - l_3)F_2 + l_6 C = 0 \quad (3)$$

3 EQNS	3 UNK
(1)-(3)	C, T, A

$\Rightarrow$ SOLVE

$$-C + T \cdot \cos[\theta] = 0$$

$$A - F_1 - F_2 - T \cdot \sin[\theta] = 0$$

$$-l_4 \cdot A + [l_4 - l_1] \cdot F_1 - [l_5 - l_3] \cdot F_2 + l_6 \cdot C = 0$$

$\theta = 12.1$ [deg]

$F_1 = 400$ [lb]

$F_2 = 400$ [lb]

$l_4 = 150$ [mm]

$l_1 = 100$ [mm]

$l_5 = 350$ [mm]

$l_3 = 100$ [mm]

$l_6 = 175$ [mm]

SOLUTION

Unit Settings: [kJ]/[C]/[kPa]/[kg]/[degrees]

A = 1100 [lb]	C = 1400 [lb]	F_1 = 400 [lb]
F_2 = 400 [lb]	l_1 = 100 [mm]	l_3 = 100 [mm]
l_4 = 150 [mm]	l_5 = 350 [mm]	l_6 = 175 [mm]
T = 1432 [lb]	θ = 12.1 [deg]	

5 potential unit problems were detected.