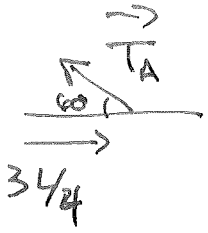
Physics 160

Extra Credit #24

Balancing Torques Ranking → Actually Ranking Tensions

In each case the torque must be the same since the pole does not rotate ⇒ Net torque = 0 so $\tau_{cable} = \tau_{sign}$. Same sign at same place in each ⇒ τ_{sign} same ⇒ τ_{cable} the same.

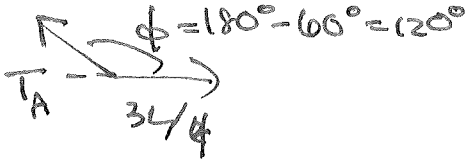
A: 

So either find perpendicular component of $\vec{T}$ ⇒ 

$T_\perp = T\sin 60° = T_A(\sqrt{3}/2)$ ⇒ $\tau_A = (3/4)T(\sqrt{3}/2)$

$= \frac{3\sqrt{3}}{8} T_A L$

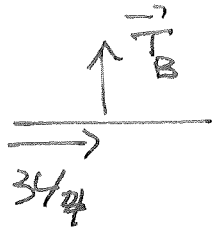
Or use $\tau = rF\sin\phi$



$\tau_A = 3/4\, T \sin 120° = \frac{3\sqrt{3}}{8} T_A L =$

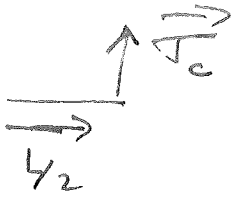
$0.433 T_A L$

$\tau_{cable} = \tau_{sign}$ ⇒ $\frac{3\sqrt{3}}{8} T_A L = \tau_{sign}$ ⇒ $T_A = \left(\frac{\tau_{sign}}{L}\right)\frac{8}{3\sqrt{3}} = 1.54\frac{\tau_{sign}}{L}$

B: 

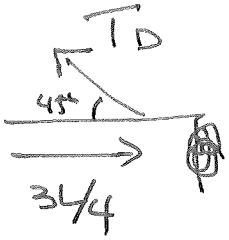
$\vec{T}$ is Perpendicular $\Rightarrow \tau_B = \frac{3L}{4} T_B = \frac{3}{4} L T_B$ 8.25

$\Rightarrow \frac{3}{4} L T_B = \tau_{sign} \Rightarrow T_B = \frac{4}{3} \frac{\tau_{sign}}{L} = 1.33 \frac{\tau_{sign}}{L}$

C: 

$\tau_C = \frac{L}{2} T = \frac{1}{2} L T_C$

$\Rightarrow \frac{1}{2} L T_C = \tau_{sign} \Rightarrow T_C = 2 \frac{\tau_{sign}}{L}$

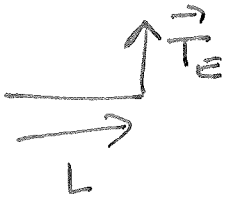
D: 

Similar to A $\Rightarrow \tau = \frac{3L}{4} T_D \sin 45° = \frac{3}{4\sqrt{2}} L T_D$

$= 0.53 L T_D$

$\Rightarrow \frac{3}{4\sqrt{2}} L T_D = \tau_{sign} \Rightarrow T_D = \frac{4\sqrt{2}}{3} \frac{\tau_{sign}}{L}$

$= 1.886 \frac{\tau_{sign}}{L}$

E: 

$\tau = T_E L \Rightarrow T_E L = \tau_{sign} \Rightarrow T_E = 1 \frac{\tau_{sign}}{L}$

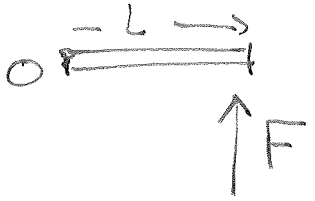
F: 

$\tau = T_F L \sin 30° = T_F L (\frac{1}{2}) \Rightarrow T_F = 2 \frac{\tau_{sign}}{L}$

So T_C, T_F (largest) $> T_D > T_A > T_B > T_E$ (smallest)

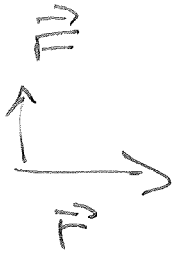
10.1 $L = 4m$, $F = 20N$

(a)



F at $90° \Rightarrow \tau_A = LF = (4m)(20N)$

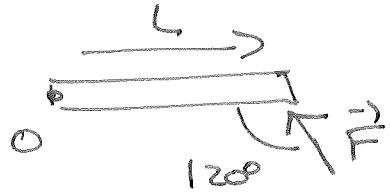
$= 80 N \cdot m$



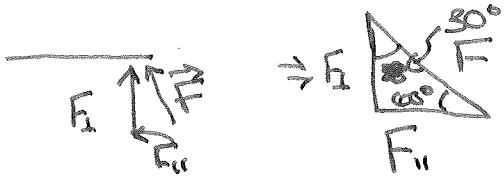
$\vec{\tau} = \vec{r} \times \vec{F}$ so RHR $\Rightarrow$

$\vec{\tau} = 80 N \cdot m, \odot$

(b)



So EITHER Find Perp. Component of $\vec{F}$



$F_\perp = F \sin 60°$

$\Rightarrow \tau = LF \sin 60° = (4m)(20N) \sin 60° = 69.282 N \cdot m$

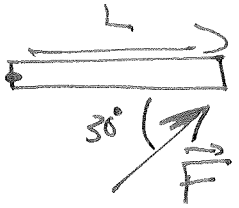
OR USE $\tau = rF \sin\phi$

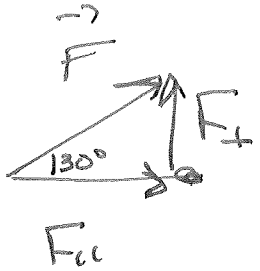
$\tau = LF \sin 120°$

$= 69.282 N \cdot m$

RHR $\Rightarrow \vec{\tau} = 69.3 N \cdot m, \odot$

C.

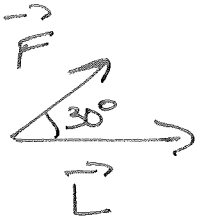




$F_\perp = F\sin 30°$

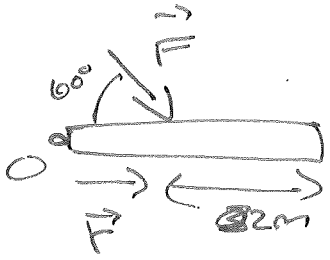
$\tau = LF\sin 30° = (4m)(20N)\sin 30° = 40N\cdot m$

OR



RHR $\Rightarrow$ $\vec{\tau} = 40N\cdot m$, ⊙

a)

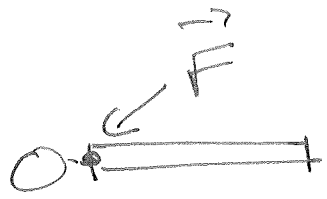


r = Distance from Axis so $r = 2m$ but Because $\vec{F}$ is 2m to RIGHT of O

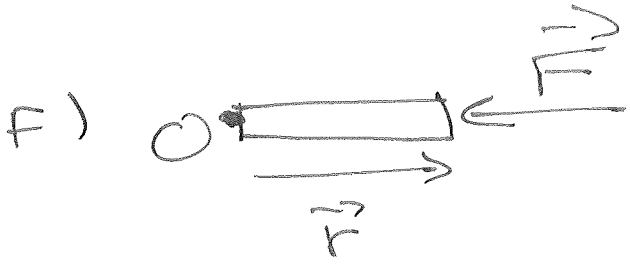
$\tau = rF\sin\phi = (2m)(20N)\sin 60°$

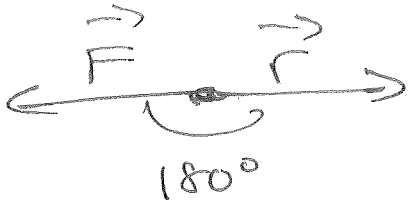
$= 34.64N\cdot m$

RHR $\Rightarrow$ $\vec{\tau} = 34.6N\cdot m$, ⊗

e) 

Here $\vec{F}$ is zero distance from O $\Rightarrow \tau = 0$

f) 



$\sin 180° = 0 \Rightarrow \tau = 0$

If you prefer, this $\vec{F}$ had no perp. Component.

It was all parallel.