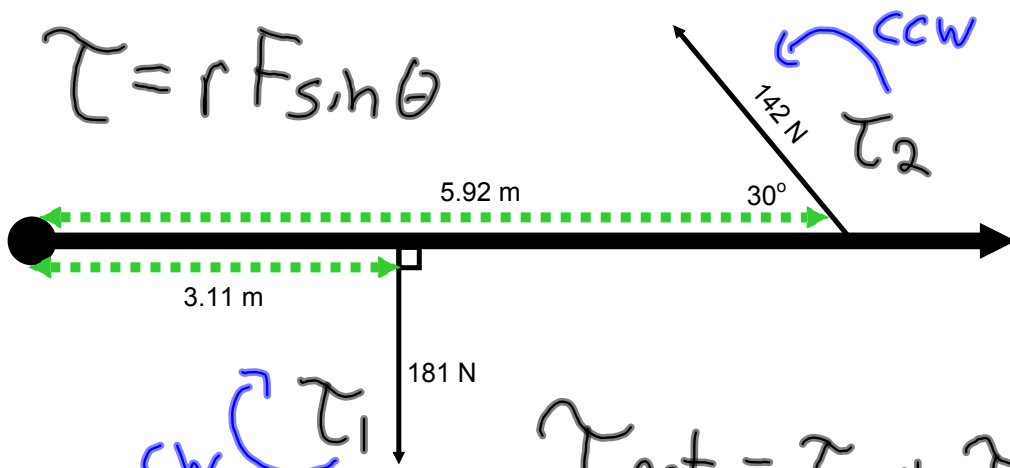


### Net Torque Practice - Solutions

#1)

$$\tau = r F \sin \theta$$



$$\tau_{net} = \tau_1 + \tau_2$$

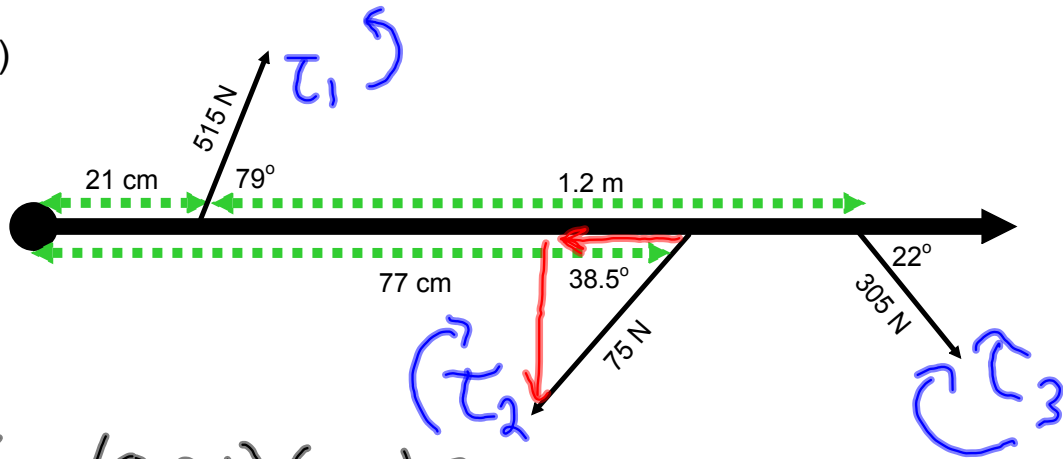
$$\begin{aligned}\tau_1 &= -(3.11 \text{ m})(181) \sin 90^\circ \\ &= \underline{\underline{-563 \text{ Nm}}}\end{aligned}$$

$$\tau_2 = \underline{\underline{420 \text{ Nm}}} \leftarrow (5.92 \text{ m})(142) \sin 30^\circ$$

$$\tau_{net} = -563 \text{ Nm} + 420 \text{ Nm}$$

$$\boxed{= -143 \text{ Nm or } 143 \text{ Nm [cw]}}$$

#2)



$$\tau_1 = (0.21)(515)\sin 79^\circ$$
$$= \underline{\underline{106 \text{ Nm}}}$$

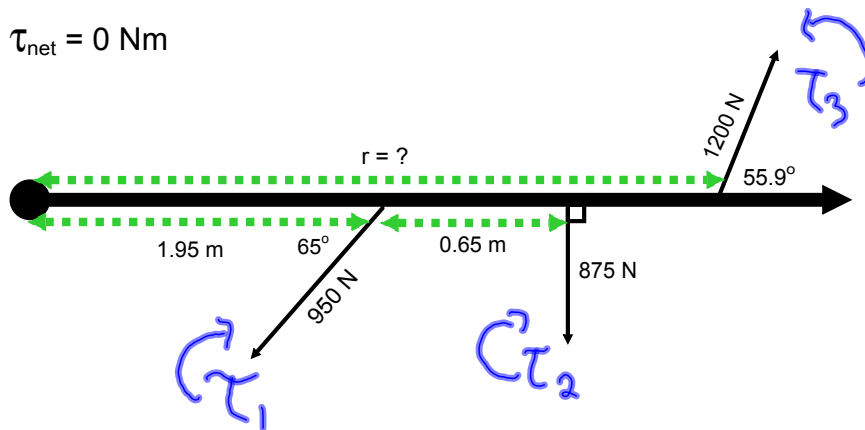
$$\tau_2 = -(0.77)(75)\sin 38.5^\circ$$
$$= \underline{\underline{-35.9 \text{ Nm}}}$$

$$\tau_3 = -(1.2 + 0.21)(305)(\sin 22^\circ)$$
$$= \underline{\underline{-161 \text{ Nm}}}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 + \tau_3 = 106 \text{ Nm} - 35.9 \text{ Nm} - 161 \text{ Nm}$$

$$\tau_{\text{net}} = -90.9 \text{ Nm or } 90.9 \text{ Nm [cw]}$$

#3)  $\tau_{\text{net}} = 0 \text{ Nm}$



$$\tau_1 = -(1.95)(950)\sin 65^\circ$$
$$= \underline{\underline{-1679 \text{ Nm}}}$$

$$\tau_2 = -(1.95 + 0.65)(875)\sin 90^\circ$$
$$= \underline{\underline{-2275 \text{ Nm}}}$$

$$\tau_3 = +r(1200)\sin 55.9^\circ$$
$$= \underline{\underline{994r}}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 + \tau_3$$

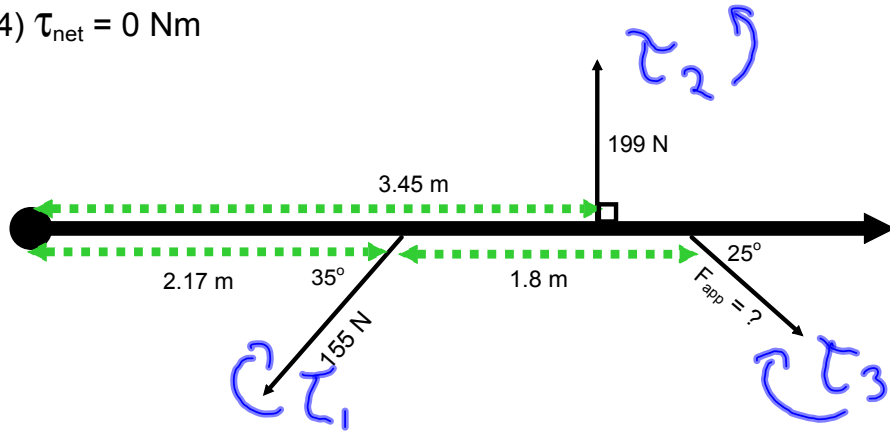
$$0 = -1679 \text{ Nm} - 2275 \text{ Nm} + (994 \text{ N})r$$

$$3954 \text{ Nm} = (994 \text{ N})r$$

$$\frac{3954 \cancel{\text{ Nm}}}{994 \cancel{\text{ N}}} = r$$

$$\boxed{3.98 \text{ m} = r}$$

#4)  $\tau_{\text{net}} = 0 \text{ Nm}$



$$\tau_1 = (2.17)(155)\sin 35^\circ$$
$$= \underline{\underline{-193 \text{ Nm}}}$$

$$\tau_2 = (3.45)(199)\sin 90^\circ$$
$$= \underline{\underline{687 \text{ Nm}}}$$

$$\tau_3 = -(2.17 + 1.8)F \sin 25^\circ$$
$$= \underline{\underline{-1.68F}}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 + \tau_3$$

$$0 = -193 \text{ Nm} + 687 \text{ Nm} - 1.68F$$

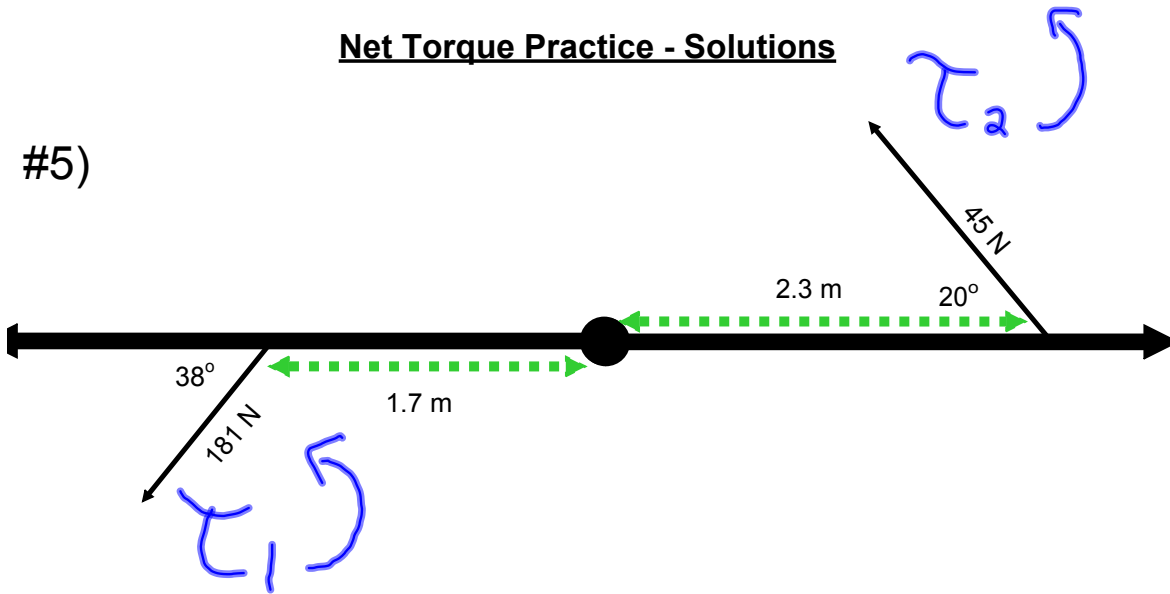
$$-494 = -1.68F$$

$$\frac{-494 \text{ Nm}}{-1.68} = F$$

$$\boxed{294 \text{ N} = F}$$

Net Torque Practice - Solutions

#5)



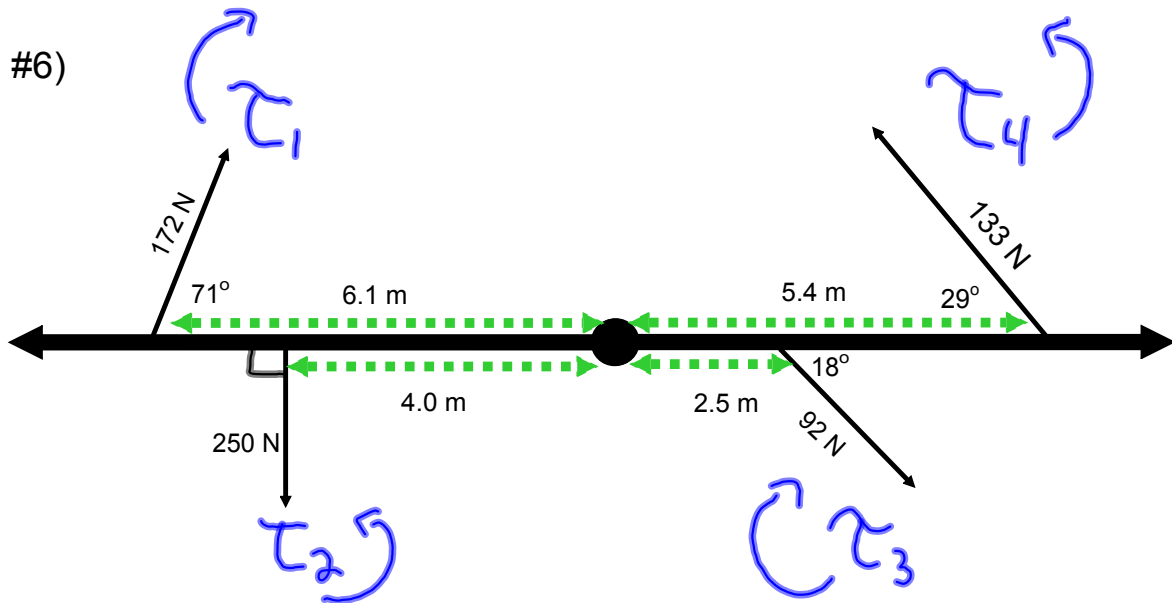
$$\begin{aligned}\tau_1 &= (1.7)(181)\sin 38^\circ \\ &= \underline{\underline{189 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_2 &= (2.3)(45)\sin 20^\circ \\ &= \underline{\underline{35.4 \text{ Nm}}}\end{aligned}$$

$$\tau_{\text{net}} = 189 \text{ Nm} + 35.4 \text{ Nm}$$

$$= 224 \text{ Nm [ccw]}$$

#6)



$$\begin{aligned}\tau_1 &= -(6.1)(172)\sin 71^\circ \\ &= \underline{\underline{-992 \text{ Nm}}}\end{aligned}$$

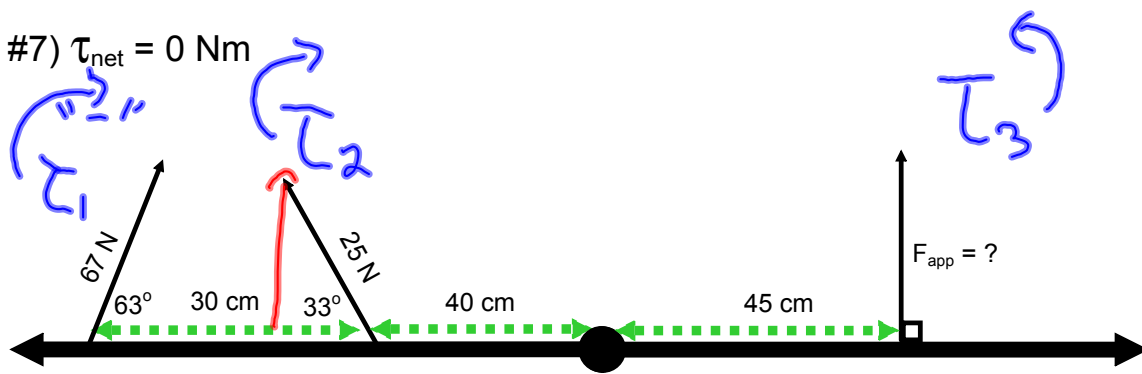
$$\begin{aligned}\tau_2 &= (4.0)(250)\sin 90^\circ \\ &= \underline{\underline{1000 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_3 &= -(2.5)(92)\sin 18^\circ \\ &= \underline{\underline{-71.1 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_4 &= (5.4)(133)\sin 29^\circ \\ &= \underline{\underline{348 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_{\text{net}} &= -992 \text{ Nm} + 1000 \text{ Nm} - 71 \text{ Nm} + 348 \text{ Nm} \\ &= \underline{\underline{285 \text{ Nm or } 285 \text{ Nm [ccw]}}}\end{aligned}$$

#7)  $\tau_{\text{net}} = 0 \text{ Nm}$



$$\begin{aligned}\tau_1 &= -(0.30 + 0.40)(67) \sin 63^\circ \\ &= \underline{\underline{-41.8 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_2 &= -(0.40)(25) \sin 33^\circ \\ &= \underline{\underline{-5.45 \text{ Nm}}}\end{aligned}$$

$$\begin{aligned}\tau_3 &= (0.45 \text{ m})(F) \sin 90^\circ \\ &= \underline{\underline{0.45 F}}\end{aligned}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 + \tau_3$$

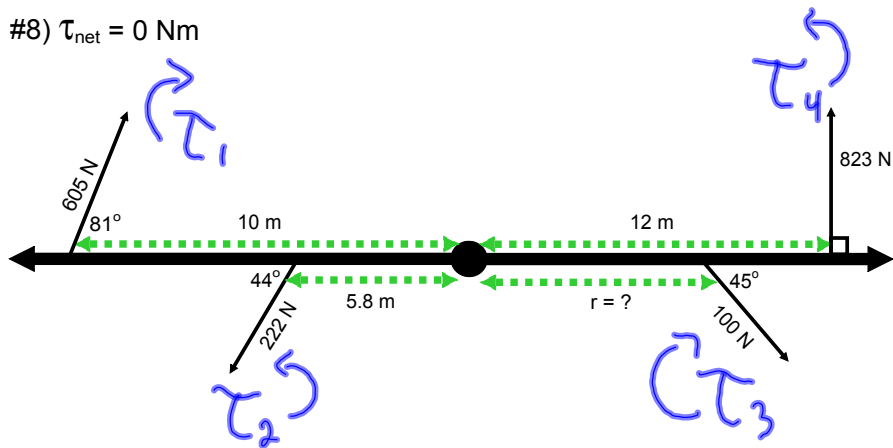
$$0 = -41.8 \text{ Nm} - 5.45 \text{ Nm} + 0.45 F$$

$$47.25 \text{ Nm} = 0.45 F$$

$$\frac{47.25 \text{ Nm}}{0.45 \text{ m}} = F$$

$$\boxed{105 \text{ N} = F}$$

#8)  $\tau_{\text{net}} = 0 \text{ Nm}$



$$\tau_1 = -(10)(605)\sin 81^\circ$$
$$= \underline{\underline{-5976 \text{ Nm}}}$$

$$\tau_2 = (5.8)(222)\sin 44^\circ$$
$$= \underline{\underline{894 \text{ Nm}}}$$

$$\tau_3 = -r(100)\sin 45^\circ$$
$$= \underline{\underline{-70.7r}}$$

$$\tau_4 = (12)(823)\sin 90^\circ$$
$$= \underline{\underline{9876 \text{ Nm}}}$$

$$\tau_{\text{net}} = \tau_1 + \tau_2 + \tau_3 + \tau_4$$

$$0 = -5976 \text{ Nm} + 894 \text{ Nm} - 70.7r + 9876 \text{ Nm}$$

$$0 = 4794 \text{ Nm} - 70.7r$$

$$-4794 \text{ Nm} = -70.7r$$

$$\frac{-4794 \cancel{\text{ Nm}}}{-70.7 \cancel{\text{ N}}} = r$$

$$\boxed{67.8 \text{ m} = r}$$