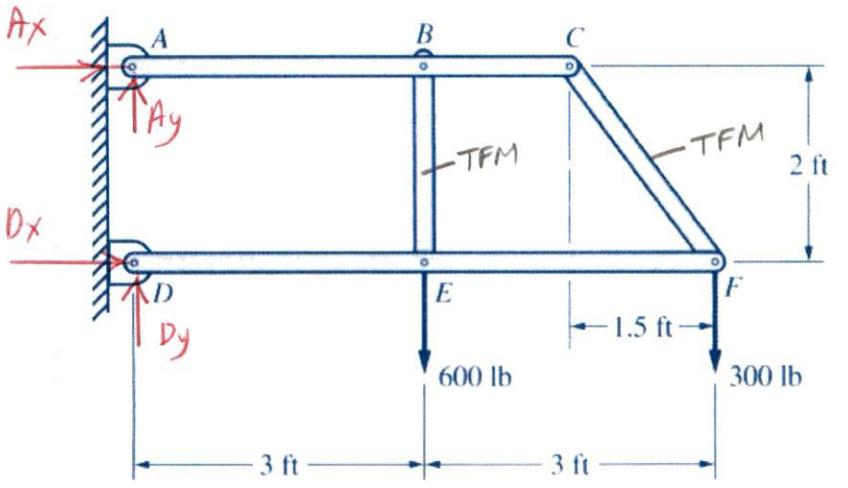
4-30 See Fig. P4-30. Determine the forces in each member of the frame subjected to the loads shown.
Solution.



FBD- Entire Frame

ccw +M ↺
cw −M ↻

Equilibrium Equations

$[\Sigma M_D = 0]$ $-600\,lb(3ft) - 300\,lb(6ft) - A_x(2ft) = 0$

$$A_x = \frac{-3600\ lb \cdot ft}{2\ ft} = -1800\ lb \rightarrow$$

and $\boxed{A_x = 1800\ lb \leftarrow}$

$[\Sigma F_x = 0]$ $D_x + A_x = 0$

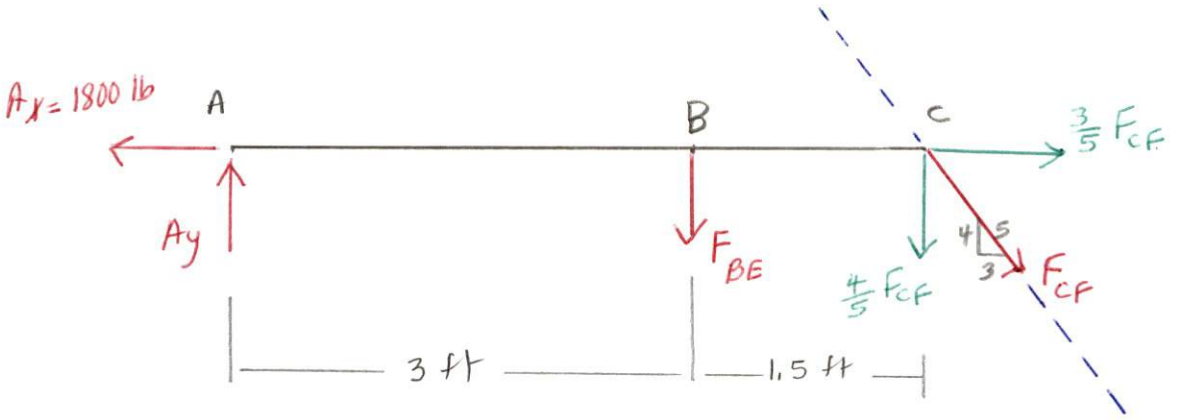
$$D_x = -(-1800\ lb) = \underline{1800\ lb \rightarrow}$$

$[\Sigma F_y = 0]$ $A_y + D_y - 600\,lb - 300\,lb = 0$

$A_y + D_y = 900\ lb$ (eqn 1)

can't solve yet!

Member ABC



FBD – member ABC

Equilibrium Equations

$[\Sigma F_x = 0]$ $\quad -1800\text{ lb} + \frac{3}{5} F_{CF} = 0$

$$F_{CF} = \frac{5}{3}(1800\text{ lb}) = 3000\text{ lb (T)} \qquad \text{(TFM)}$$

$[\Sigma M_A = 0]$ $\quad -F_{BE}(3\text{ ft}) - \frac{4}{5} F_{CF}(4.5\text{ ft}) = 0$

$$F_{BE} = -\frac{4}{5}\frac{(3000\text{ lb})(4.5\text{ ft})}{3\text{ ft}} = -3600\text{ lb (T)} \quad \text{(TFM)}$$

and $\boxed{F_{BE} = 3600\text{ lb (C)}}$

$[\Sigma F_y = 0]$ $\quad A_y - F_{BE} - \frac{4}{5} F_{CF} = 0$

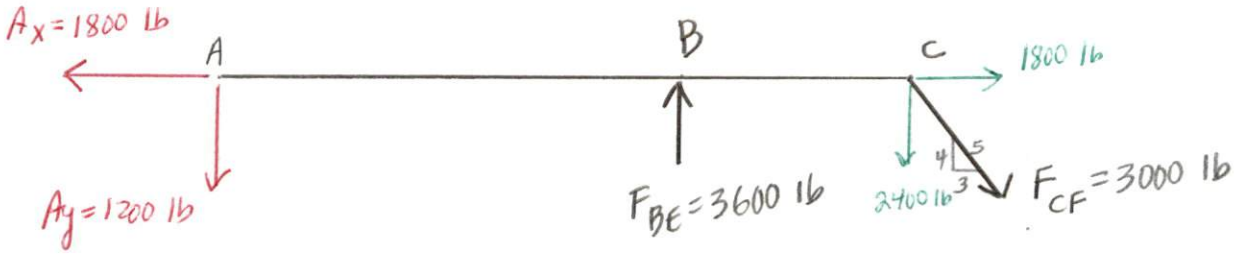
$$A_y = F_{BE} + \frac{4}{5} F_{CF} = -3600\text{ lb} + \frac{4}{5}(3000\text{ lb})$$
$$= -1200\text{ lb} \uparrow$$

and $\boxed{A_y = 1200\text{ lb} \downarrow}$

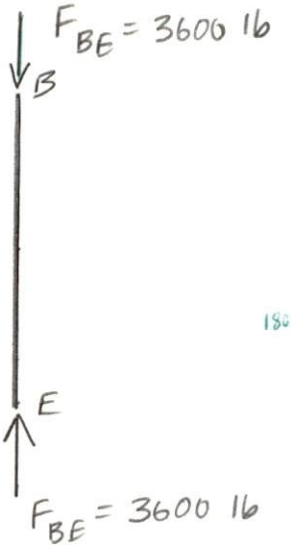
From Eqn 1,

$$D_y = 900\text{ lb} - A_y = 900\text{ lb} - (-1200\text{ lb})$$
$$= \underline{\underline{2100\text{ lb} \uparrow}}$$

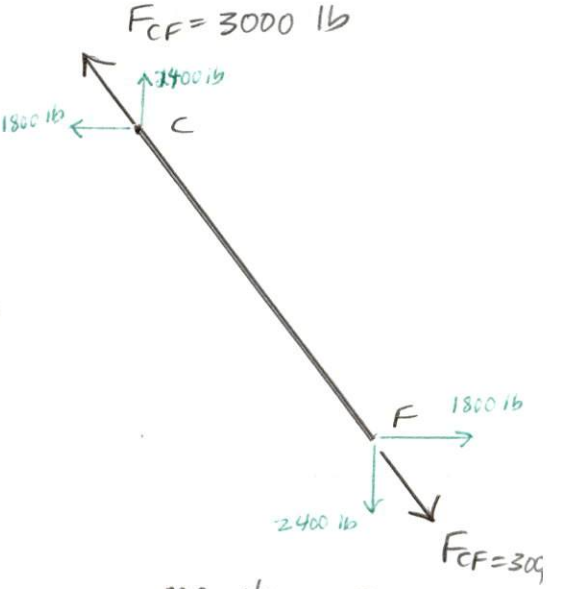
Summarize Results



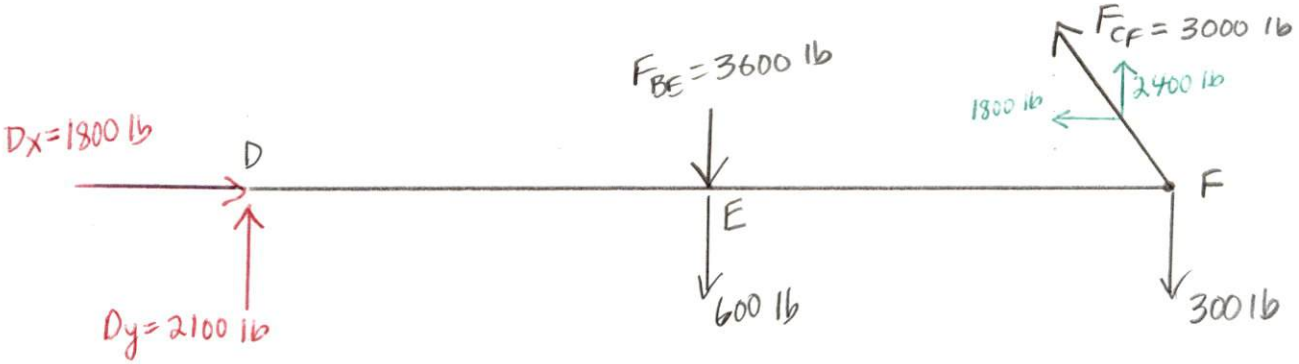
Member ABC



Member BE



Member CF



Member DEF

All members are in equilibrium ✓