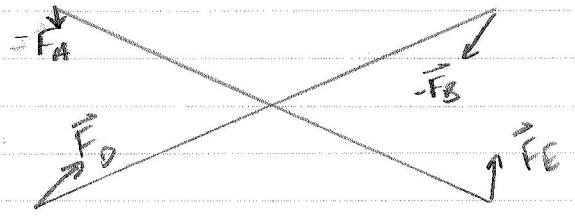
16.12

Find $\bar{a}$ and $\vec{F}_{By}$

Use Newton's Laws

FBD Linkage



Positions (ft)	Forces
$\vec{r}_{E/D} = 2.5\frac{\sqrt{3}}{2}\hat{i}$	$\vec{F}_E = F_E\hat{j}$
$\vec{r}_{A/D} = 1.25\hat{j}$	$-\vec{F}_A = -F_A\hat{j}$
$\vec{r}_{B/D} = 2.5\frac{\sqrt{3}}{2}\hat{i} + 1.25\hat{j}$	$-\vec{F}_B = -F_{Bx}\hat{i} - F_{By}\hat{j}$
	$\vec{F}_D = F_{Dx}\hat{i} + F_{Dy}\hat{j}$

$$\Sigma \vec{M}_D = \vec{0} = \vec{r}_{E/D} \times \vec{F}_E + \vec{r}_{A/D} \times -\vec{F}_A + \vec{r}_{B/D} \times -\vec{F}_B = \vec{0}$$

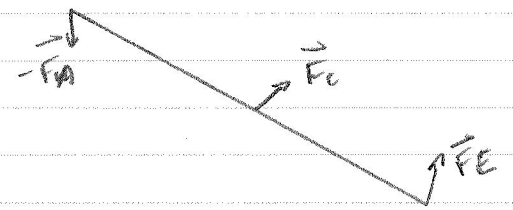
$$1.25\sqrt{3}\,F_E\hat{k} - 1.25\sqrt{3}\,F_{By}\hat{k} + 1.25\,F_{Bx}\hat{k} = \vec{0}$$

$$\sqrt{3}\,F_E - \sqrt{3}\,F_{By} + F_{Bx} = 0 \qquad (1)$$

$$\Sigma F_x = 0 = -F_{Bx} + F_{Dx} \qquad F_{Bx} = -F_{Dx}$$

$$\Sigma F_y = 0 = F_E - F_A - F_{By} + F_{Dy}$$

FBD BCE



Position	Force
$\vec{r}_{E/C} = 1.08\hat{i} - 0.625\hat{j}$	$\vec{F}_E = F_E\hat{j}$
$\vec{r}_{A/C} = -1.08\hat{i} + 0.625\hat{j}$	$-\vec{F}_A = -F_A\hat{j}$
	$\vec{F}_C = F_{Cx}\hat{i} + F_{Cy}\hat{j}$

$$\Sigma \vec{M}_C = \vec{0} = 1.08\,F_E\hat{k} + 1.08\,F_A\hat{k}$$

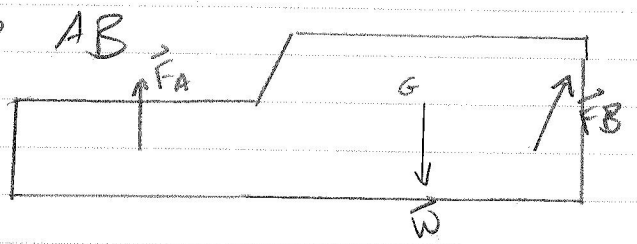
$$F_E = -F_A \qquad (2)$$

$$-\sqrt{3}\,F_A - \sqrt{3}\,F_{By} + F_{Bx} = 0 \qquad (3)$$

$$F_A + F_{By} = 0.577\,F_{Bx} \qquad (3')$$

(3'')

FBD AB



Positions (ft)	Forces
$\vec{r}_{A/G} = -1.54\,\hat{i}$	$\vec{F}_A = F_A\,\hat{j}$
$\vec{r}_{B/G} = 0.625\,\hat{i} - 0.208\,\hat{j}$	$\vec{F}_B = F_{Bx}\,\hat{i} + F_{By}\,\hat{j}$
	$\vec{W} = -20\,\hat{j}$

$\vec{a} = a\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$

$\Sigma \vec{F} = m\,\vec{a}$

$$F_{Bx}\,\hat{i} + (F_A + F_{By} - 20)\,\hat{j} = \frac{20}{32.2}\,a\left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right)$$

$$F_{Bx} = 0.3106\,a \qquad (4)$$

$$(F_A + F_{By} - 20) = -0.558\,a \qquad (5)$$

From (3) and (4)

$$0.577 \cdot 0.311\,a - 20 = -0.558\,a$$

$$-20 = -0.358\,a$$

$$a = 27.9 \text{ ft/s}^2$$

From (4)

$$F_{Bx} = 8.665 \text{ lb}$$

$$\Sigma \vec{M}_G = \vec{0}$$

$$-1.54 F_A + 0.625 F_{By} + 0.208 F_{Bx} = 0 \qquad (6)$$

$$-1.54 F_A + 0.625 F_{By} = -1.805$$

and

$$F_A + F_{By} = 5$$

$$\begin{bmatrix} -1.54 & 0.625 \\ 1 & 1 \end{bmatrix} \begin{Bmatrix} F_A \\ F_{By} \end{Bmatrix} = \begin{bmatrix} -1.805 \\ 5 \end{bmatrix}$$

$$\underline{F_A = 2.28 \text{ lb}}$$