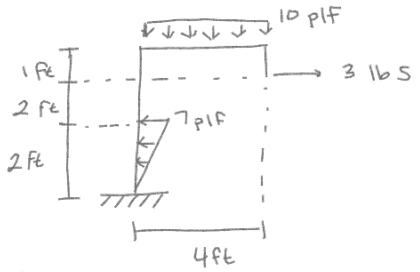
Statics
Intro to Moments
Example #3

From the figure below, determine the resultant force acting on the frame and identify it's location.



STEP #1: SUM MOMENTS ABOUT BASE

$$\circlearrowleft \Sigma M = -\tfrac{1}{2}(2\text{ft})(7\text{plf})\left[\tfrac{2}{3}\cdot 2\text{ft}\right] + 10\text{plf}(4\text{ft})\left[\tfrac{4\text{ft}}{2}\right] + 3\text{lbs}[4\text{ft}]$$

$$= 82.667\ \text{lb}\cdot\text{ft}$$

STEP #2: DETERMINE RESULTANT FORCE & LOCATION

$$M_A = F_{Rx}d_{Ry} + F_{Ry}d_{Rx}$$

$$M_A = 82.67\ \text{lb}\cdot\text{ft}$$

$$\hookrightarrow 82.67\ \text{lb}\cdot\text{ft} = F_{Rx}d_{Ry} + F_{Ry}d_{Rx}$$

$$\pm\rightarrow \Sigma F_x = 3\text{lbs} - \tfrac{1}{2}(2\text{ft})(7\text{plf}) = -4\text{lbs} = F_{Rx}$$

$$+\uparrow \Sigma F_y = -10\text{ plf}(4\text{ft}) = -40\text{ lbs} = F_{Ry}$$

$$\hookrightarrow 82.67\ \text{lb}\cdot\text{ft} = -4d_{Ry} - 40d_{Rx}$$

IF F_R ACTS ON AB $d_{Ry} = 5\text{ft}$ THEREFORE,

$$\hookrightarrow 82.67\ \text{lb}\cdot\text{ft} = -4(5\text{ft}) - 40d_{Rx}$$

$$d_{Rx} = \frac{82.67\ \text{lb}\cdot\text{ft} + 20\ \text{lb}\cdot\text{ft}}{40\text{ lbs}}$$

$$= 2.6\text{ ft}$$

$$\boxed{X = 2.6\text{ ft}}$$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$= \sqrt{(-4)^2 + (-40)^2}$$

$$= 40.2\text{ lbs}$$

$$\boxed{F_R = 40.2\text{ lbs}}$$