9-7. Use the method of virtual work and determine the vertical displacement of point B. Each steel member has a cross-sectional area of 2 in^2. $E = 29(10^3)$ ksi.

Member Real Forces N **:** As shown on figure(a).

Member Virtual Forces n **:** As shown on figure(b).

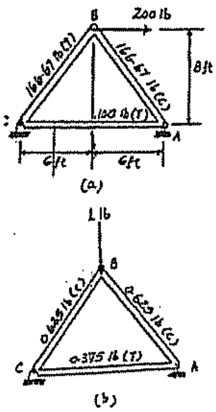
Virtual - Work Equation **:** Applying Eq. 9–15, we have

$$1 \cdot \Delta = \sum \frac{nNL}{AE}$$

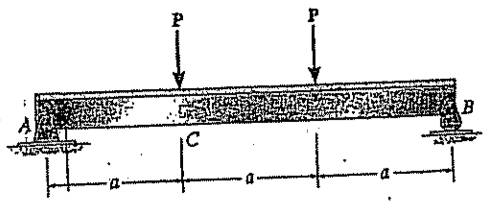
$$1\text{ lb} \cdot (\Delta_B)_v = \frac{1}{AE}[(-0.625)(166.67)(10)(12) + (-0.625)(-166.67)(10)(12) + 0.375(100)(12)(12)]$$

$$1\text{ lb} \cdot (\Delta_B)_v = \frac{5400 \text{ lb}^2 \cdot \text{in}}{AE}$$

$$(\Delta_B)_v = \frac{5400}{2[29.0(10^6)]} = 0.0931(10^{-3}) \text{ in.} \downarrow \qquad \text{Ans}$$



•9-48. Use the method of virtual work and determine the displacement of point C. EI is constant.



Real Moment Function M(x) **:** As shown on figure(a).

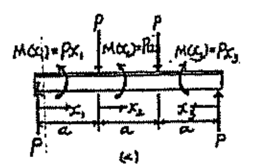
Virtual Moment Functions m(x) **:** As shown on figure(b).

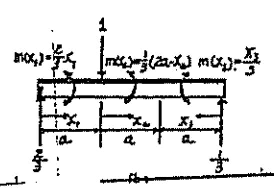
Virtual Work Equation **:** For the displacement at point C, apply Eq. 9–18

$$1 \cdot \Delta = \int_0^L \frac{mM}{EI} dx$$

$$1 \cdot \Delta_C = \frac{1}{EI}\int_0^a \left(\frac{2}{3}x_1\right)(Px_1)\,dx_1 + \frac{1}{EI}\int_0^a \frac{1}{3}(2a - x_2)(Pa)\,dx_2 + \frac{1}{EI}\int_0^a \left(\frac{x_3}{3}\right)(Px_3)\,dx_3$$

$$\Delta_C = \frac{5Pa^3}{6EI} \downarrow \qquad \text{Ans}$$





9-49. Solve Prob. 9–48 using Castigliano's theorem.

Internal Moment Function M(x) **:** The internal moment function in terms of the load P' and externally applied load are shown on the figure.

Castigliano's Second Theorem **:** The displacement at C can be determined using Eq. 9–28 with $\frac{\partial M(x_1)}{\partial P'} = \frac{2}{3}x_1$, $\frac{\partial M(x_3)}{\partial P'} = \frac{x_3}{3}$, $\frac{\partial M(x_2)}{\partial P'} = \frac{1}{3}(2a - x_2)$ and setting $P' = P$. 9–28