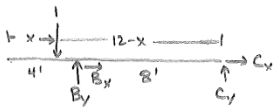
Problem 1

a) B_y, D_y, F_y, V_E, M_E

B_y



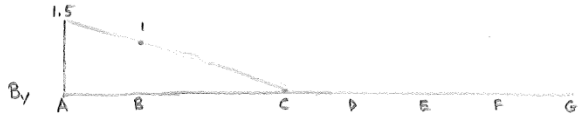
For $0 \le x \le 12$

$\circlearrowleft \Sigma M_C = 0$: $1(12-x) - B_y(8) = 0 \Rightarrow B_y = \frac{3}{2} - \frac{x}{8}$

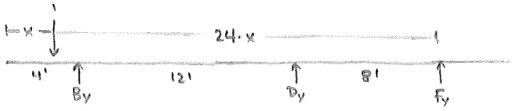
For $12 \le x \le 28$

$\circlearrowleft \Sigma M_C = 0$: $-B_y(8) = 0 \Rightarrow B_y = 0$

$$B_y = \begin{cases} \frac{3}{2} - \frac{x}{8} & 0 \le x \le 12 \\ 0 & 12 \le x \le 28 \end{cases}$$



D_y



Note: the FBD stays the same for x greater than and less than 12, the equation for B_y changes though

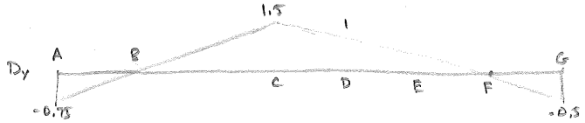
For $0 \le x \le 12$

$\circlearrowleft \Sigma M_F = 0$: $1(24-x) - B_y(20) - D_y(8) = 0 \Rightarrow D_y = -\frac{3}{4} + \frac{3x}{16}$ ($B_y = \frac{3}{2} - \frac{x}{8}$)

For $12 \le x \le 28$

$\circlearrowleft \Sigma M_F = 0$: $1(24-x) - B_y(20) - D_y(8) = 0 \Rightarrow D_y = 3 - \frac{x}{8}$ ($B_y = 0$)

$$D_y = \begin{cases} -\frac{3}{4} + \frac{3x}{16} & 0 \le x \le 12 \\ 3 - \frac{x}{8} & 12 \le x \le 28 \end{cases}$$



F_y

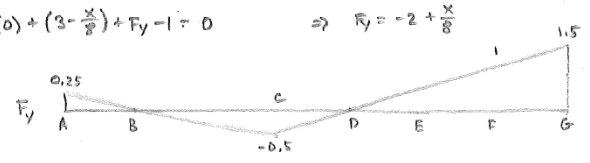
For $0 \le x \le 12$

$+\uparrow \Sigma F_y = 0$: $B_y + D_y + F_y - 1 = 0 \Rightarrow \left(\frac{3}{2} - \frac{x}{8}\right) + \left(-\frac{3}{4} + \frac{3x}{16}\right) + F_y - 1 = 0 \Rightarrow F_y = \frac{1}{4} - \frac{x}{16}$

For $12 \le x \le 28$

$+\uparrow \Sigma F_y = 0$: $B_y + D_y + F_y - 1 = 0 \Rightarrow (0) + \left(3 - \frac{x}{8}\right) + F_y - 1 = 0 \Rightarrow F_y = -2 + \frac{x}{8}$

$$F_y = \begin{cases} \frac{1}{4} - \frac{x}{16} & 0 \le x \le 12 \\ -2 + \frac{x}{8} & 12 \le x \le 28 \end{cases}$$



V_E

For $0 \le x \le 12$

$+\uparrow \Sigma F_y = 0$: $B_y + D_y - 1 - V_E = 0 \Rightarrow \left(\frac{3}{2} - \frac{x}{8}\right) + \left(-\frac{3}{4} + \frac{3x}{16}\right) - 1 - V_E = 0$

For $12 \le x \le 20$

$+\uparrow \Sigma F_y = 0$: $B_y + D_y - 1 - V_E = 0 \Rightarrow (0) + \left(3 - \frac{x}{8}\right) - 1 - V_E = 0$

For $20 \le x \le 28$

$+\uparrow \Sigma F_y = 0$: $B_y + D_y - V_E = 0 \Rightarrow (0) + \left(3 - \frac{x}{8}\right) - V_E = 0$

$$V_E = \begin{cases} -\frac{1}{4} + \frac{x}{16} & 0 \le x \le 12 \\ 2 - \frac{x}{8} & 12 \le x \le 20 \\ 3 - \frac{x}{8} & 20 \le x \le 28 \end{cases}$$

(M_E)

For $0 \le x \le 12$

$\circlearrowleft \sum M_E = 0$: $1(20-x) - B_y(16) - D_y(4) + M_E = 0 \Rightarrow 1(20-x) - \left(\frac{3}{2} - \frac{x}{8}\right)(16) - \left(-\frac{3}{4} + \frac{3x}{16}\right)(4) + M_E = 0$

For $12 \le x \le 20$

$\circlearrowleft \sum M_E = 0$: $1(20-x) - B_y(16) - D_y(4) + M_E = 0 \Rightarrow 1(20-x) - (0)(16) - \left(3 - \frac{x}{8}\right)(4) + M_E = 0$

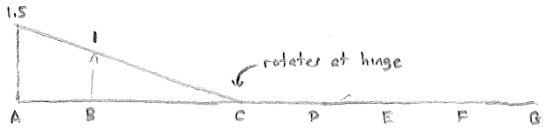
For $20 \le x \le 28$

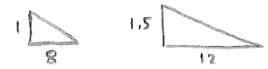
$\circlearrowleft \sum M_E = 0$: $-B_y(16) - D_y(4) + M_E = 0 \Rightarrow -(0)(16) - \left(3 - \frac{x}{8}\right)(4) + M_E = 0$

$$M_E = \begin{cases} 1 - \frac{x}{4} & 0 \le x \le 12 \\ -8 + \frac{x}{2} & 12 \le x \le 20 \\ 12 - \frac{x}{2} & 20 \le x \le 28 \end{cases}$$

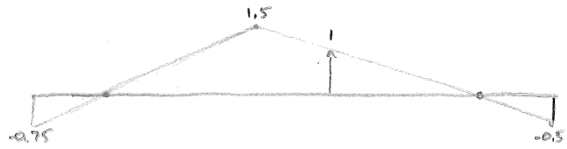
b) Müller-Breslau Principle

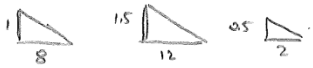
(B_y) Push By up 1 unit



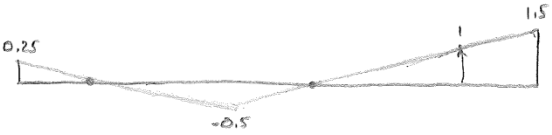


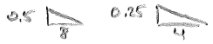
(D_y)





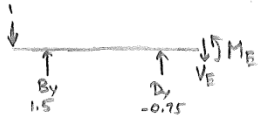
(F_y)





(V_E)

Split at E, solve for one part to find the rest



$+\uparrow \sum F_y = 0$: $-1 + 1.5 - 0.75 - V_E = 0 \Rightarrow V_E = -0.25$

(M_E)

Replace E with a hinge and push up
Solve for a value of M_E

$\circlearrowleft \sum M_E = 0$: $1(20) - 1.5(16) + 0.75(4) + M_E = 0$

$\Rightarrow M_E = 1$