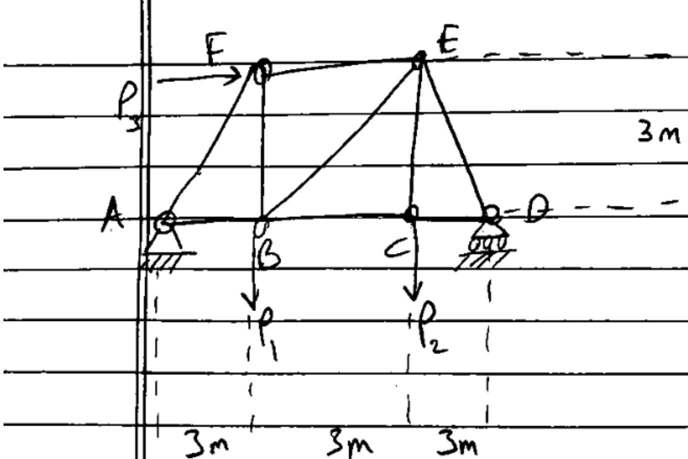
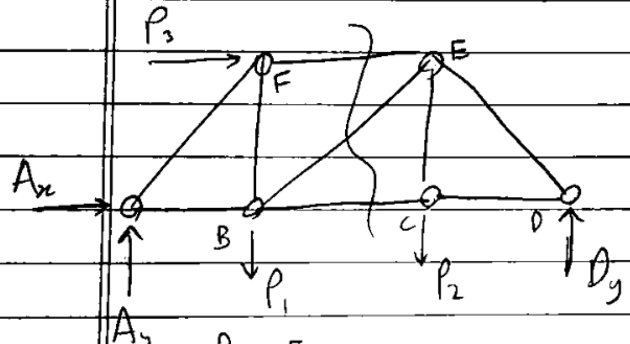
Problem 1



$P_1 = 6\ kN$

$P_2 = 9\ kN$

$P_3 = 12\ kN$

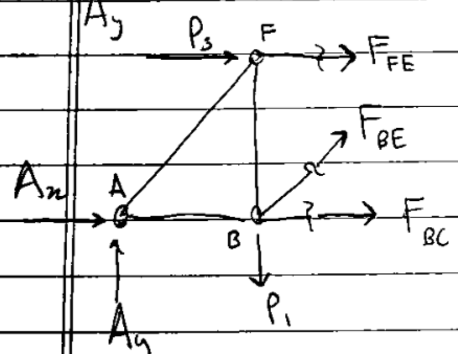


$\sum M_D = 0$

$\hookrightarrow 9A_y + 3P_3 = 6P_1 + 3P_2$

$\boxed{A_y = 3\ kN}$

$\sum F_x = 0 \rightarrow \boxed{A_x = -12\ kN}$



$\sum M_B = 0$

$\hookrightarrow 3A_y + 3P_3 + 3F_{FE} = 0$

$F_{FE} = -3 - 12 = -15kN$

$\boxed{F_{FE} = 15kN\ (C)}$

$\sum F_y = 0 \rightarrow A_y - P_1 + \frac{\sqrt{2}}{2} F_{BE} = 0$

$\boxed{F_{BE} = 3\sqrt{2}\ (T)}$

$\sum F_x = 0 \rightarrow P_3 + F_{FE} + A_x + F_{BC} + \frac{\sqrt{2}}{2} F_{BE} = 0$

$\boxed{F_{BC} = 12\ kN\ (T)}$

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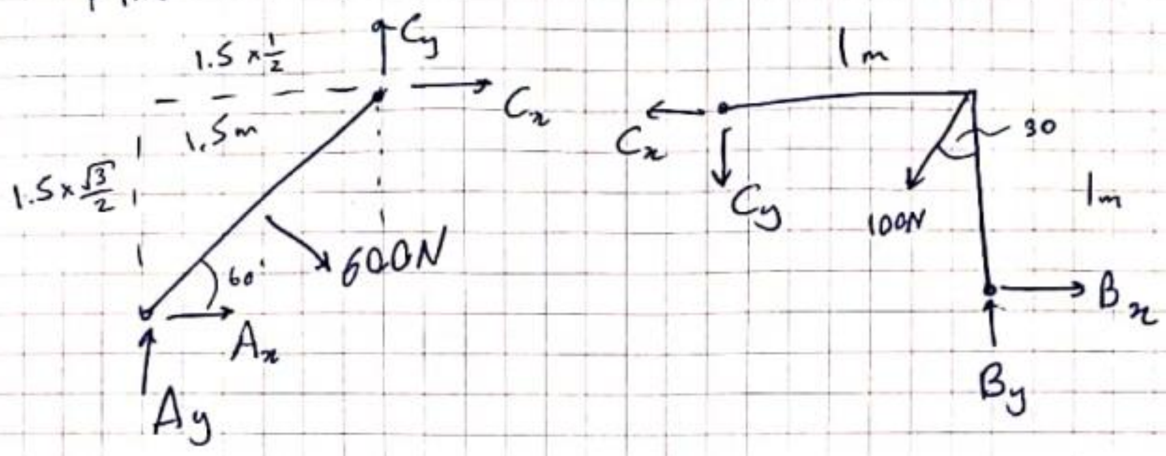
Problem 2

Find forces on pin C.



$$\Sigma M_A = 0 \rightarrow \quad 600 \times 0.75 + C_x \times \frac{1.5}{2}\sqrt{3} - C_y \times \frac{1.5}{2} = 0$$

$$\Rightarrow \quad 600 \times \frac{3}{4} + C_x \frac{3\sqrt{3}}{4} - C_y \frac{3}{4} = 0$$

$$\Rightarrow \sqrt{3}\, C_x - C_y = -600 \quad \text{— (1)}$$

$$\Sigma M_B = 0 \rightarrow \quad C_x + C_y + 100 \sin 30 = 0$$

$$C_x + C_y = -50 \quad \text{— (2)}$$

from (1) & (2) $\Rightarrow$

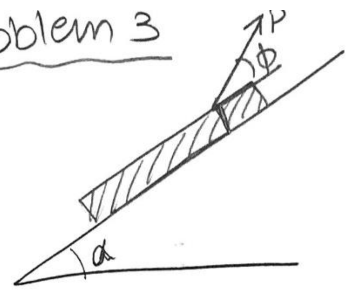
$$\sqrt{3}\, C_x - (-50 - C_x) = -600$$

$$C_x(\sqrt{3}+1) = -650$$

$$\boxed{C_x = -\frac{650}{\sqrt{3}+1}}$$

$$\boxed{C_y = -50 + \frac{650}{\sqrt{3}+1}}$$

Problem 3

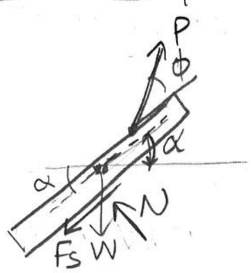


Pipe of weight W

• show that for slipping $P = W \cdot \frac{\sin(\alpha+\theta)}{\cos(\phi-\theta)}$

where $\theta = \tan^{-1}\mu_s$ (μ_s is static friction coefficient).

FBD



Along the inclined plane right before the pipe starts moving we have $\Sigma F = 0$ and $F_s = \mu_s N$, therefore

$$P\cos\phi - F_s - W\sin\alpha = 0$$

or $\boxed{P\cos\phi - \mu_s N - W\sin\alpha = 0}$ ⊛

Also we have $\Sigma F = 0$ perpendicular to the inclined plane, hence

$$P\sin\phi + N - W\cos\alpha = 0 \Rightarrow \boxed{N = W\cos\alpha - P\sin\phi} \circledast\circledast$$

From ⊛ and ⊛⊛ we get:

$$P\cos\phi - \mu_s W\cos\alpha + \mu_s P\sin\phi - W\sin\alpha = 0$$

$$P(\cos\phi + \mu_s\sin\phi) = \mu_s W\cos\alpha + W\sin\alpha \quad \mu_s = \tan\theta$$

$$P\left(\cos\phi + \frac{\sin\theta}{\cos\theta}\sin\phi\right) = \frac{\sin\theta}{\cos\theta} W\cos\alpha + W\sin\alpha$$

$$P(\cos\phi\cos\theta + \sin\theta\sin\phi) = W(\cos\alpha\sin\theta + \cos\theta\sin\alpha)$$

$$\Rightarrow \boxed{P = \frac{W\sin(\alpha+\theta)}{\cos(\phi-\theta)}}$$