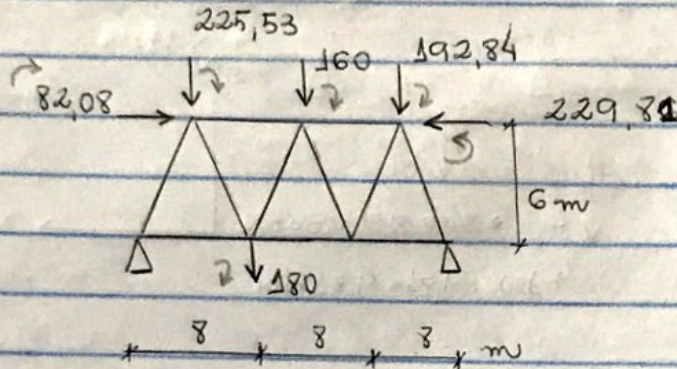


$$R^2 = [82,08 - 229,81]^2 + [-225,53 - 192,84 - 180 - 160]^2$$

$$R = \sqrt{-21,724,15 + (-575,125,06)} = \sqrt{-596,949,21} = -772,62 \text{ N}$$

$$M_A = -82,08 \cdot 6 - 225,53 \cdot 4 - 160 \cdot 12 - 180 \cdot 8 - 192,84 \cdot 20 + 229,81 \cdot 6 = 7232 \text{ N}\cdot\text{m}$$



Aula 4

Equilíbrio de corpos rígidos

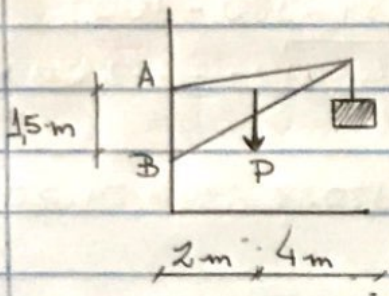
$$\Sigma F = 0 \quad \left\{ \begin{array}{l} \Sigma F_x = 0 \\ \Sigma F_y = 0 \\ \Sigma F_z = 0 \end{array} \right. \quad \Sigma M = 0 \quad \left\{ \begin{array}{l} \Sigma M_x = 0 \\ \Sigma M_y = 0 \\ \Sigma M_z = 0 \end{array} \right.$$

→ diagrama do corpo: devemos indicar todas as forças atuantes no sistema

\* considerar os apoios

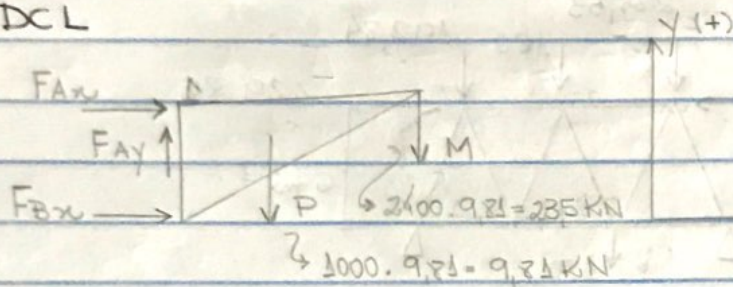
Ex. 1: Um ergaste fixo tem uma massa de 1000 Kg e é usado para suspender um cativeiro de 2400 Kg. O ergaste é mantido na posição indicada na figura por um pino "A" e um suporte basculante em "B". Determine as reações em "A" e "B".





• adotar MA: maior n<sup>o</sup> ou incógnitas

1) DCL



• adotar as forças sempre no sentido xey (+)

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M = 0$$

$$F_{Ax} + F_{Bx} = 0$$

$$F_{Ay} = 9.81 + 235$$

$$(-9.81 \cdot 2) + (-235 \cdot 6) + (F_{Bx} \cdot 1.5)$$

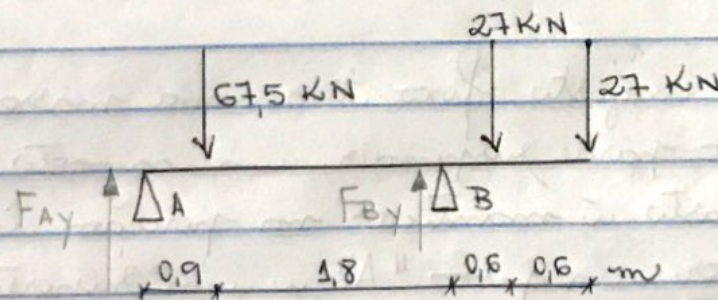
$$F_{Ay} = 33.81 \text{ kN}$$

$$F_{Bx} = 107.08 \text{ kN}$$

$$F_{Ax} + 107.08 = 0$$

$$F_{Ax} = -107.08 \text{ kN} (\leftarrow)$$

Ex. 2: Três cargas são aplicadas a uma viga, como mostra a figura. A viga é sustentada por um rolê em A e por um pino em B. Desprezando o peso da viga, determine as reações em A e B.



$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$F_{Ay} + F_{By} = 121.5 \text{ kN}$$

$$F_x = 0$$

$$F_{Ay} + F_{By} - 67.5 - 27 - 27 = 0$$



$$\Sigma M = 0 \rightarrow \Sigma M_B = 0$$

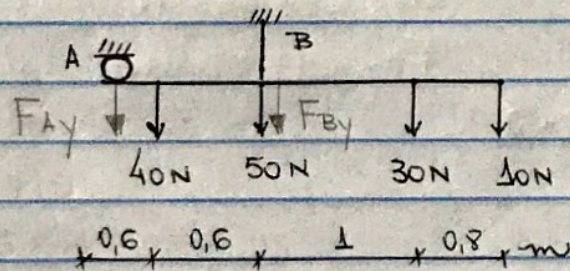
$$(-27 \cdot 1,2) + (-27 \cdot 0,6) + (675 \cdot 1,8) + (-F_{Ay} \cdot 2,7)$$

$$-32,4 - 16,2 + 1215 = F_{Ay} \cdot 2,7$$

$$F_{Ay} = 27 \text{ kN}$$

$$F_{Ay} + F_{By} = 1215 \rightarrow F_{By} = 94,5 \text{ kN}$$

Ex. 3: Uma viga sustentada nas quatro cargas indicadas na figura. Considerando o apoio A do tipo rolante, e um B do tipo pino, determine as reações do apoio.



$$\Sigma F_x = 0$$

$$F_x = 0$$

$$\Sigma F_y = 0$$

$$-F_{Ay} - F_{By} - 40 - 50 - 30 - 10$$

$$\rightarrow -F_{Ay} - F_{By} = 130$$

$$\Sigma M = 0 \rightarrow \Sigma M_A = 0$$

$$(-10 \cdot 3) + (-30 \cdot 2,2) + (-50 \cdot 1,2) + (-40 \cdot 0,6) + (-F_{By} \cdot 1,2)$$

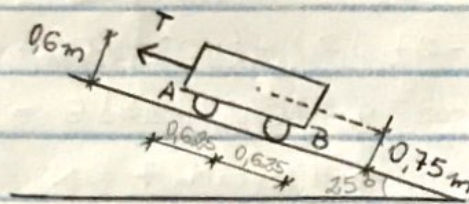
$$-30 - 66 - 60 - 24 = F_{By} \cdot 1,2$$

$$F_{By} = -150 \text{ N}$$

$$-F_{Ay} - F_{By} = 130 \rightarrow F_{Ay} = 20 \text{ N}$$

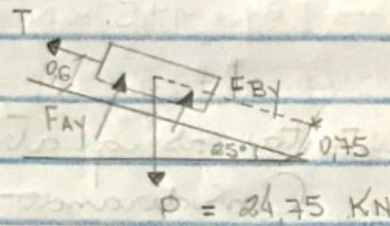


Ex. 4:



$P_{mag} = 24,75 \text{ kN}$   
 $T?$   
 $A \text{ e } B?$

1) DCL



• considerando a rotação do plano:



$$\Sigma F_x = 0$$

$$P_x - T = 0$$

$$(24,75 \cdot \sin 25^\circ) - T = 0$$

$$T = 10,46 \text{ kN}$$

$$\Sigma F_y = 0$$

$$F_{Ay} + F_{By} - (24,75 \cdot \cos 25^\circ) = 0$$

$$F_{Ay} + F_{By} = 22,43 \text{ kN}$$

$$\Sigma M_A = 0$$

$$(T \cdot 0,6) + (-P_x \cdot 0,75) + (-P_y \cdot 0,625) + (F_{By} \cdot 1,25) = 0$$

$$(10,46 \cdot 0,6) + (-P \cdot \sin 25^\circ \cdot 0,75) + (-P \cdot \cos 25^\circ \cdot 0,625) + (F_{By} \cdot 1,25) = 0$$

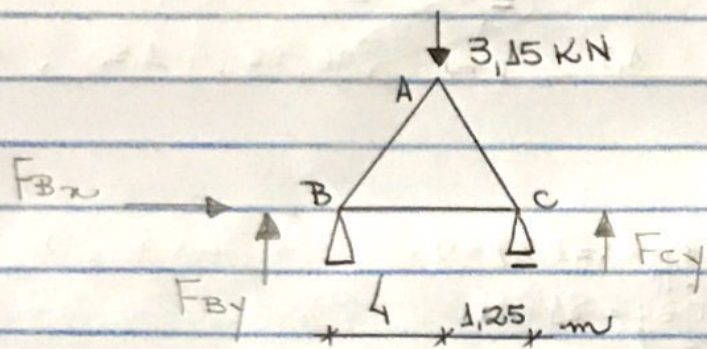
$$6,276 - 7,84 - 14,02 + F_{By} \cdot 1,25 = 0$$

$$-15,584 = -F_{By} \cdot 1,25 \Rightarrow F_{By} = 12,47 \text{ kN}$$

$$F_{Ay} = 9,96 \text{ kN}$$



Ex. 5: Determine as reações nos apoios da Treliça. Considere um apoio fixo e outro móvel

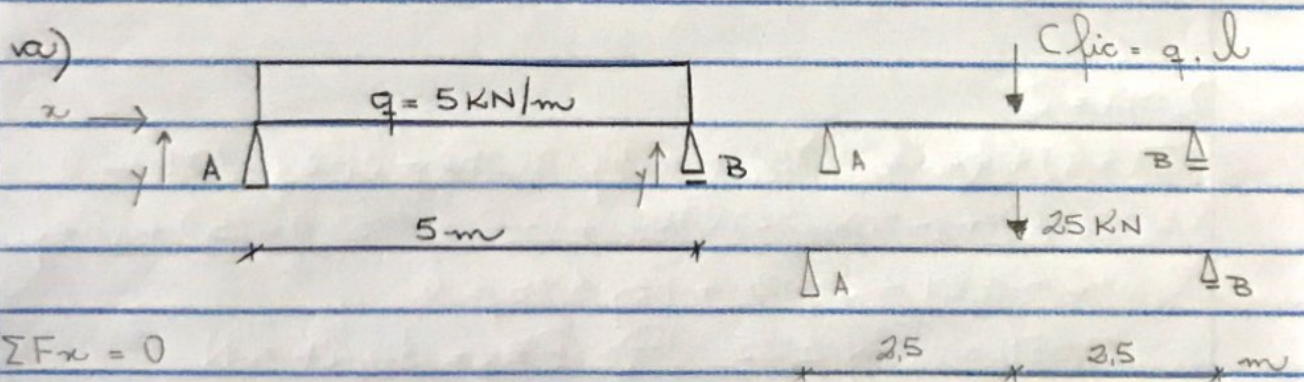


B - fixo  
C - móvel

$$\begin{aligned} \Sigma F_x = 0 & \quad \Sigma F_y = 0 \\ F_x = 0 & \quad F_{By} + F_{Cy} - 3,15 = 0 \end{aligned} \quad \rightarrow \quad F_{By} + F_{Cy} = 3,15 \text{ kN}$$

$$\begin{aligned} \Sigma M_B = 0 \\ -3,15 \cdot 4 + F_{Cy} \cdot 5,25 = 0 \\ F_{Cy} = 2,4 \text{ kN} \\ F_{By} = 0,75 \text{ kN} \end{aligned}$$

Ex. 6: Determine as reações de apoio:

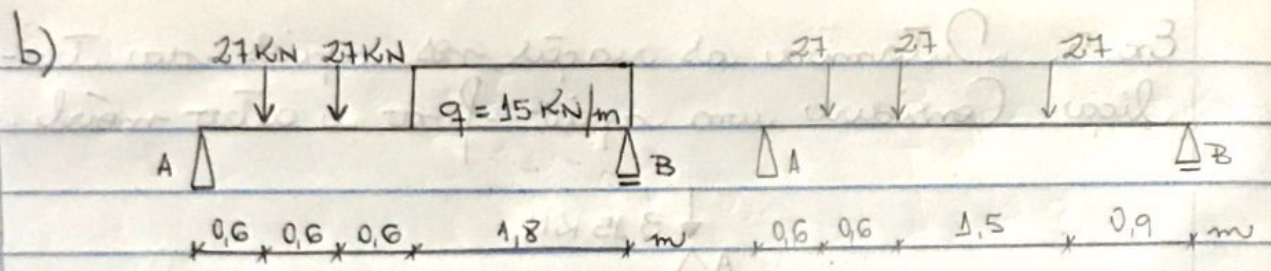


$$\begin{aligned} \Sigma F_x = 0 \\ F_x = 0 \end{aligned}$$

$$\begin{aligned} \Sigma F_y = 0 \\ F_{Ay} + F_{By} - 25 = 0 \\ F_{Ay} + F_{By} = 25 \text{ kN} \end{aligned}$$

$$\begin{aligned} \Sigma M_A = 0 \\ (-25 \cdot 2,5) + (F_{By} \cdot 5) = 0 \\ F_{By} = 12,5 \text{ kN} \\ F_{Ay} = 12,5 \text{ kN} \end{aligned}$$





$$\begin{aligned} \sum F_x &= 0 & \sum F_y &= 0 \\ F_x &= 0 & F_{Ay} + F_{By} - (27 \cdot 3) &= 0 \\ & & F_{Ay} + F_{By} &= 81 \text{ kN} \end{aligned}$$

$$\begin{aligned} \sum M_A &= 0 \rightarrow (-27 \cdot 0,6) + (-27 \cdot 1,2) + (-27 \cdot 2,7) + (F_{By} \cdot 3,6) = 0 \\ & -16,2 - 32,4 - 72,9 = -F_{By} \cdot 3,6 \\ & F_{By} = 33,75 \text{ kN} \\ & F_{Ay} = 47,25 \text{ kN} \end{aligned}$$