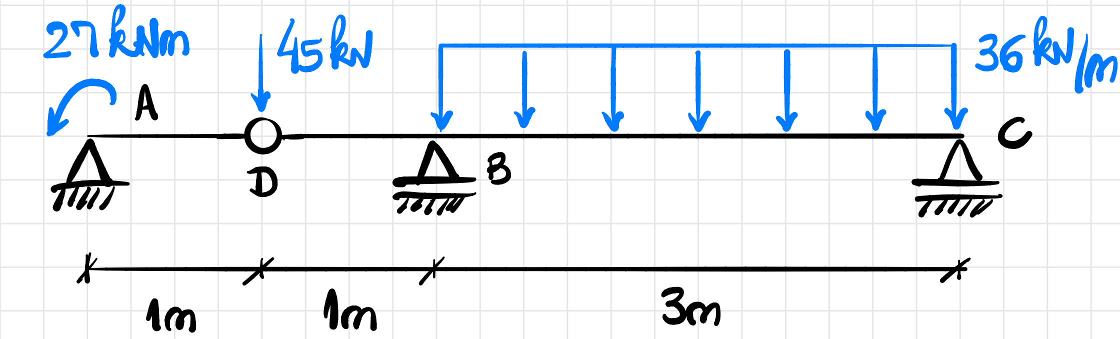
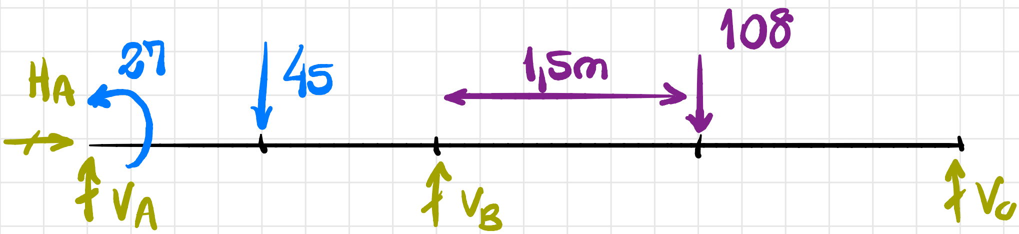


Reações de apoio:



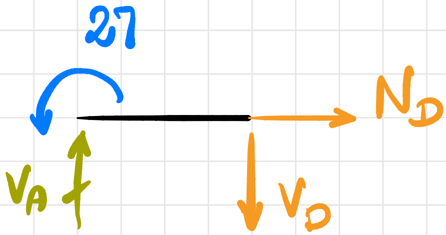
$$\sum F_H = 0: \quad H_A = 0$$

$$\sum F_V = 0: \quad V_A + V_B + V_C = 153$$

$$(+\circlearrowleft) \sum M_B = 0: \quad 27 - V_A \cdot 2 + 45 \cdot 1 - 108 \cdot 1{,}5 + V_C \cdot 3 = 0$$

$$-2V_A + 3V_C = 90$$

Fazendo um corte em D:



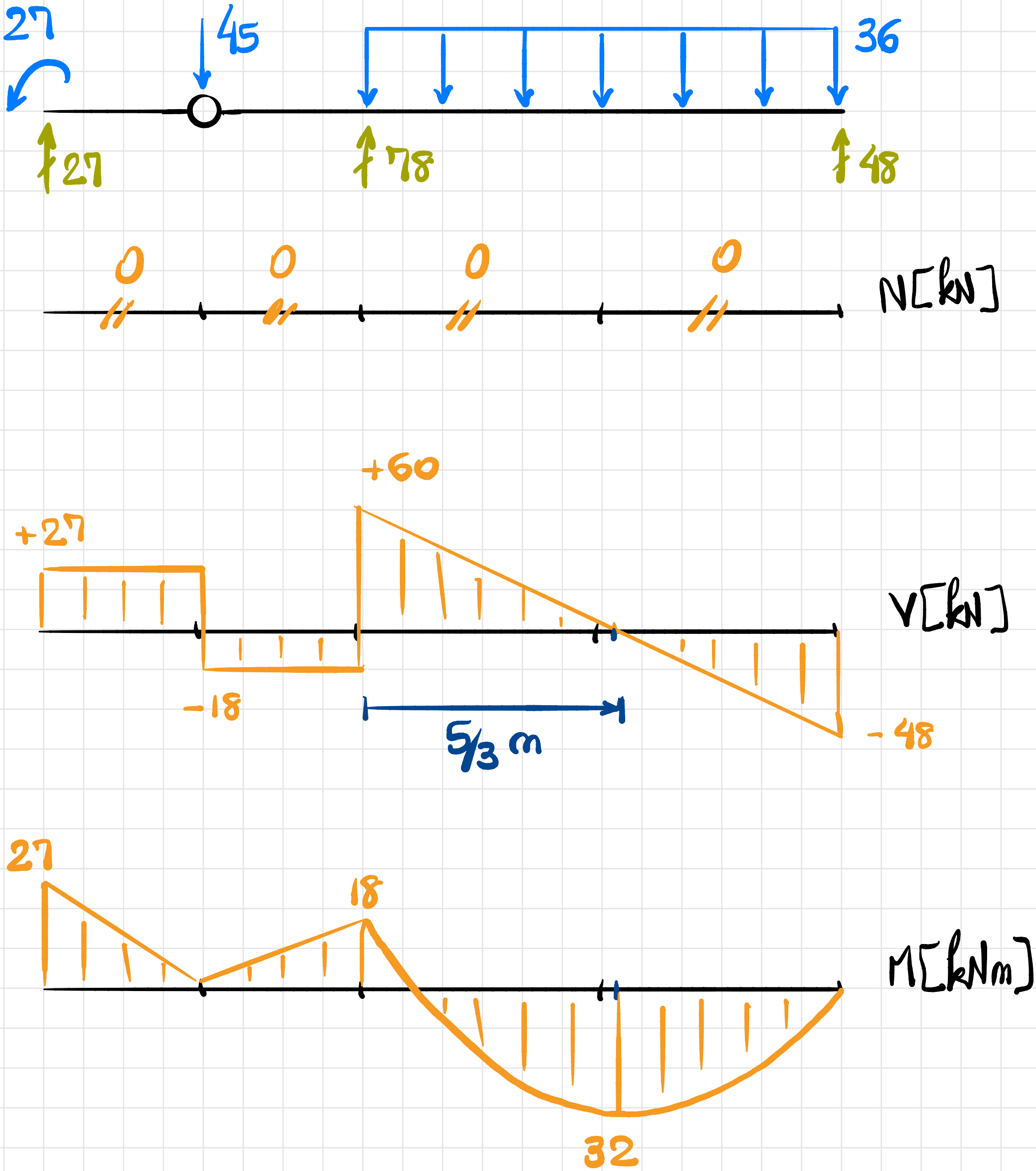
$$\circlearrowleft^{+} \sum M_D = 0: \quad 27 - V_A \cdot 1 = 0 \Rightarrow \boxed{V_A = 27\,kN}$$

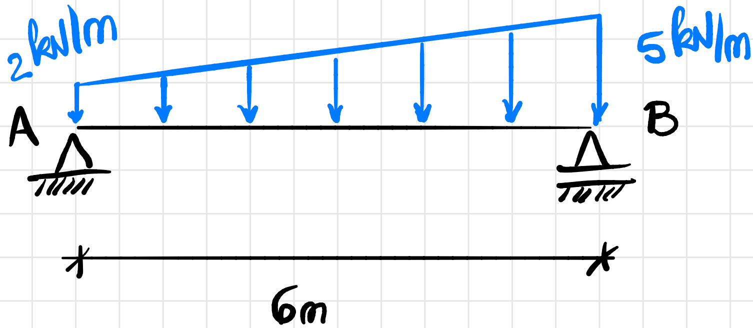
$$3V_C = 90 + 2V_A = 144$$

$$\boxed{V_C = 48\,kN}$$

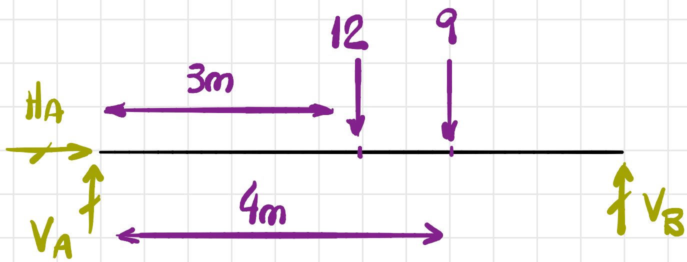
$$V_B = 153 - V_C - V_A = 153 - 27 - 48$$

$$\boxed{V_B = 78\,kN}$$


27
45
36
27
78
48
0
0
0
0
N[kN]
+60
+27
V[kN]
-18
5/3 m
-48
27
18
M[kNm]
32



Reações de apoio



$$\sum F_H = 0: \quad \boxed{H_A = 0}$$

$$\sum F_V = 0: \quad V_A + V_B = 21$$

$$(+) \sum M_A = 0: \quad -12.3 - 9.4 + V_B . 6 = 0$$

$$6V_B = 72 \implies \boxed{V_B = 12\,kN}$$

$$V_A = 21 - V_B \implies \boxed{V_A = 9\,kN}$$

Para resolver, usa-se a equação diferencial de equilíbrio:

$$q(x) = 2 + x/2 \qquad \begin{cases} q(0) = 2 \\ q(6) = 5 \end{cases}$$

Assim:

$$\frac{dV}{dx} = -q(x) = -2 - \frac{x}{2}$$

$$\therefore V(x) = -2x - \frac{x^2}{4} + C_1$$

Como $V(0) = V_A = 9$, então:

$$V(0) = -2.0 + \frac{0^2}{4} + C_1 = 9 \Rightarrow C_1 = 9$$

E portanto:

$$\boxed{V(x) = 9 - 2x - x^2/4}$$

E o momento:

$$\frac{dM}{dx} = V(x) = 9 - 2x - \frac{x^2}{4}$$

$$\therefore M(x) = 9x - x^2 - \frac{x^3}{12} + C_2$$

E $M(0) = 0$. Assim:

$$M(0) = 9.0 - 0^2 - \frac{0^3}{12} + C_2 = 0$$

Portanto, $C_2 = 0$. Assim:

$$\boxed{M(x) = 9x - x^2 - \frac{x^3}{12}}$$

Para traçar os diagramas, observa-se os máximos e mínimos:

$$V(\bar{x}) = 0$$

$$9 - 2\bar{x} - \frac{x^2}{4} = 0 \Rightarrow \bar{x}^2 + 8\bar{x} - 36 = 0$$

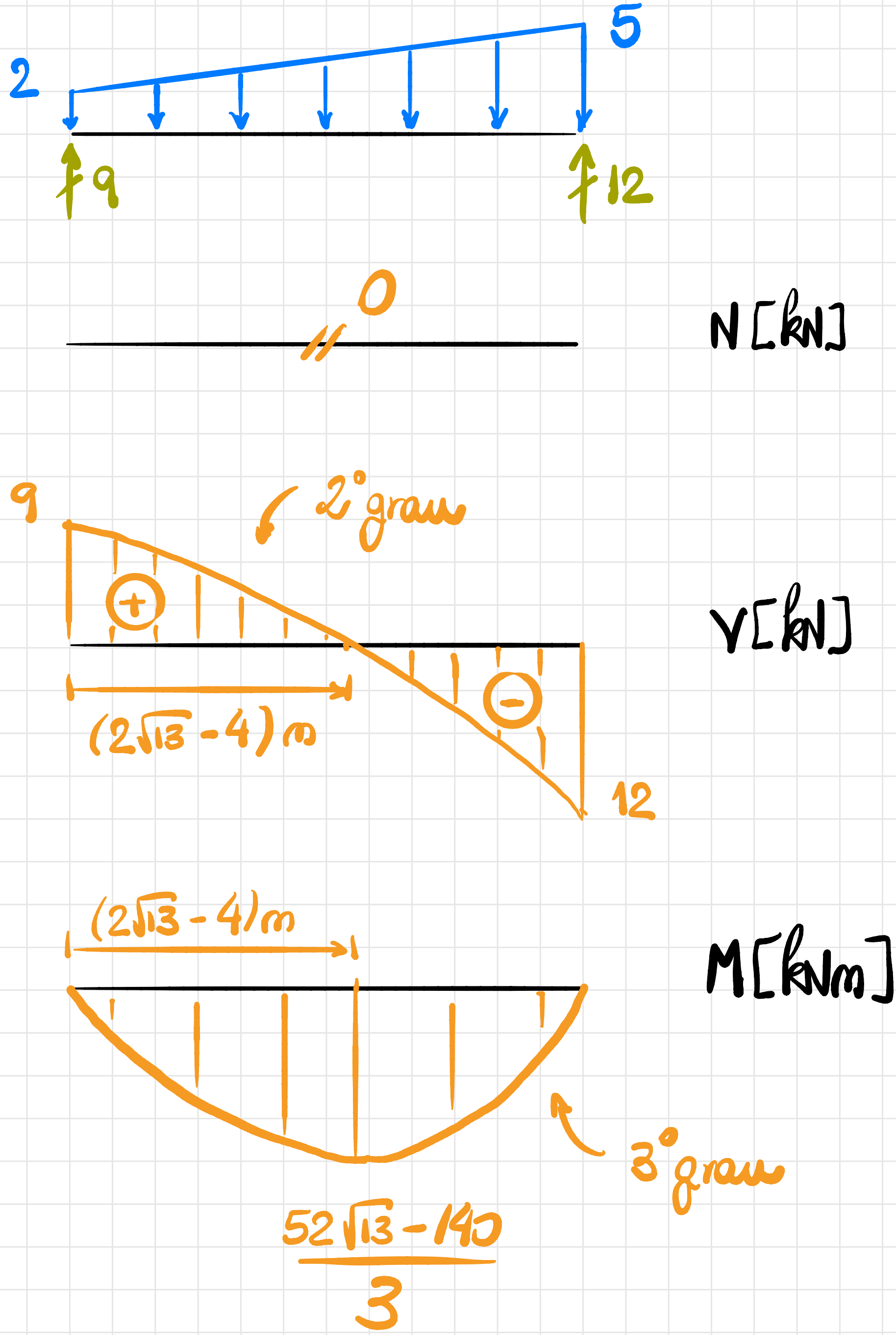
$$\bar{x} = \frac{-8 \pm \sqrt{8^2 - 4.1.(-36)}}{2} = \frac{-8 \pm \sqrt{208}}{2}$$

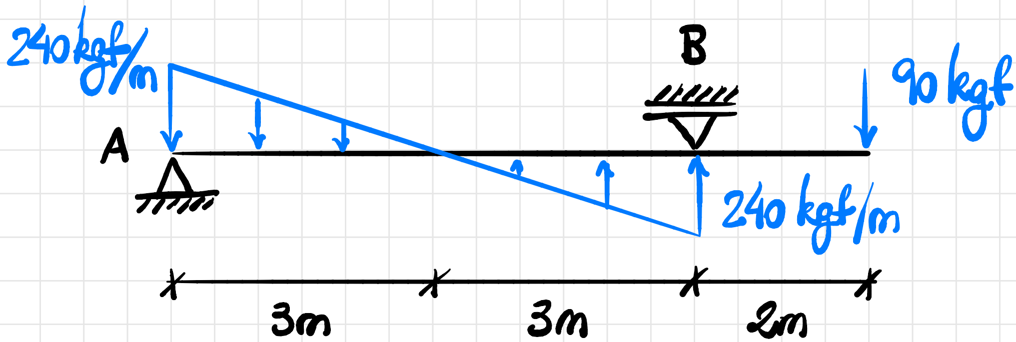
$$\bar{x} = \frac{-8 \pm 4\sqrt{13}}{2} = -4 \pm 2\sqrt{13}$$

$\bar{x} = -4 + 2\sqrt{13}$ $(3{,}21)$ ou $\bar{x} = -4 - 2\sqrt{13}$ $(-11{,}21)$

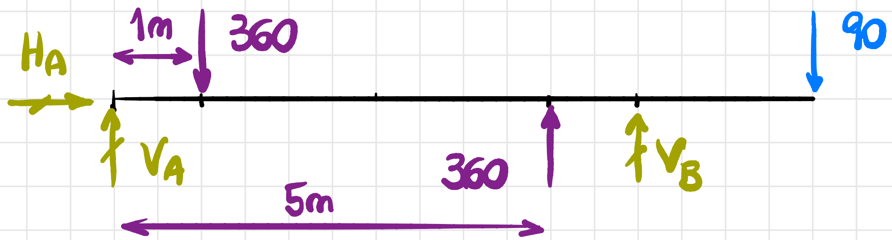
Apenas $-4 + 2\sqrt{13}$ está no intervalo. E:

$$M(-4 + 2\sqrt{13}) = \frac{-140 + 52\sqrt{13}}{3} \; (15{,}83) \text{ kNm}$$


2
5
9
12
0
N[kN]
2° grau
9
V[kN]
(2√13 - 4) m
12
(2√13 - 4) m
M[kNm]
3° grau
(52√13 - 140)/3



Reações de apoio:



$$\sum F_H = 0: \quad \boxed{H_A = 0}$$

$$\sum F_V = 0: \quad V_A + 360 - 360 + V_B - 90 = 0$$

$$\therefore \quad V_A + V_B = 90$$

$$(+)\ \sum M_A = 0: \quad -360.1 + 360.5 + V_B.6 - 90.8 = 0$$

$$6V_B = -720 \Rightarrow \boxed{V_B = -120\ \text{kgf}}$$

$$V_A = 90 - V_B \Rightarrow \boxed{V_A = 210\ \text{kgf}}$$

Entre A e B usa-se a equação diferencial de equilíbrio:

$$q(x) = 240 - 80x \quad \begin{cases} q(0) = 240 \\ q(6) = -240 \end{cases}$$

$$\frac{dV}{dx} = -q(x) = 80x - 240$$

$$V(x) = 40x^2 - 240x + C_1$$

Como $V(0) = 210$ kgf, então $C_1 = 210$. Assim:

$$\boxed{V(x) = 40x^2 - 240x + 210}$$

$$\frac{dM}{dx} = V(x) = 40x^2 - 240x + 210$$

$$M(x) = \frac{40}{3}x^3 - 120x^2 + 210x + C_2$$

Como $M(0) = 0$, então $C_2 = 0$. Assim:

$$\boxed{M(x) = \frac{40}{3}x^3 - 120x^2 + 210x}$$

Pontos de máximo e mínimo:

$$V(x) = 0 \Rightarrow 40x^2 - 240x + 210 = 0$$

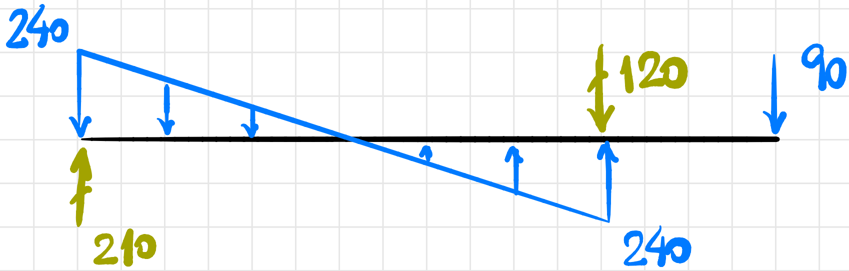
$$4x^2 - 24x + 21 = 0$$

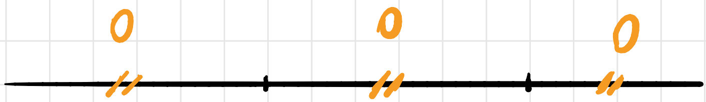
$$x = \frac{24 \pm \sqrt{24^2 - 4.4.21}}{8} = \frac{24 \pm 4\sqrt{15}}{8}$$

$$x = 3 \pm \frac{\sqrt{15}}{2}\ m \quad (1{,}063m \text{ ou } 4{,}936m)$$

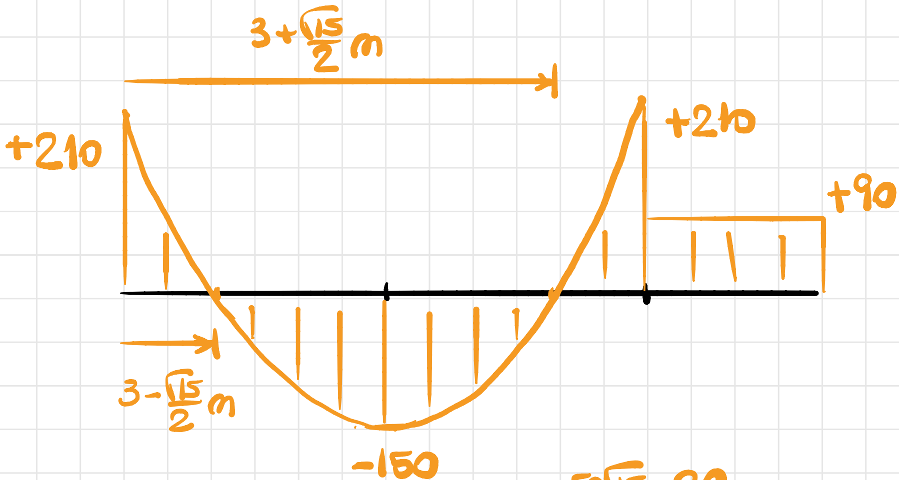
$$M(3 - \sqrt{15}/2) = 50\sqrt{15} - 90 \quad (103{,}65 \text{ kgfm})$$

$$M(3 + \sqrt{15}/2) = -50\sqrt{15} - 90 \quad (-283{,}65 \text{ kgfm})$$

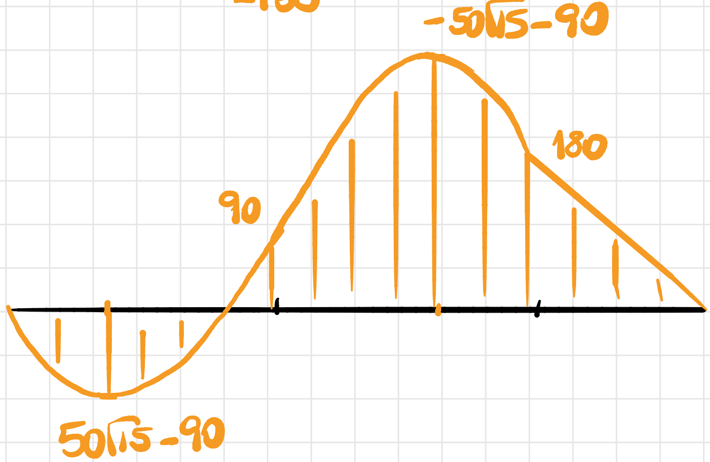

240
120
90
210
240


0
0
0

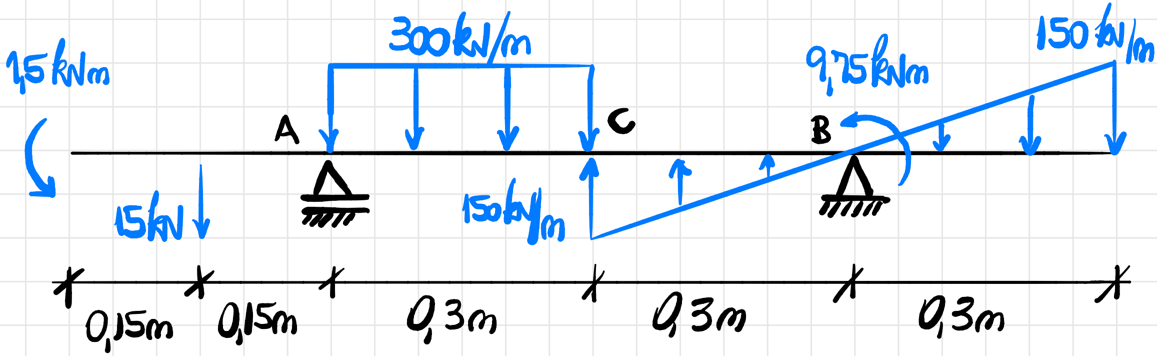
N[kN]


$3+\frac{\sqrt{15}}{2}$ m
+210
+210
+90
$3-\frac{\sqrt{15}}{2}$ m
-150

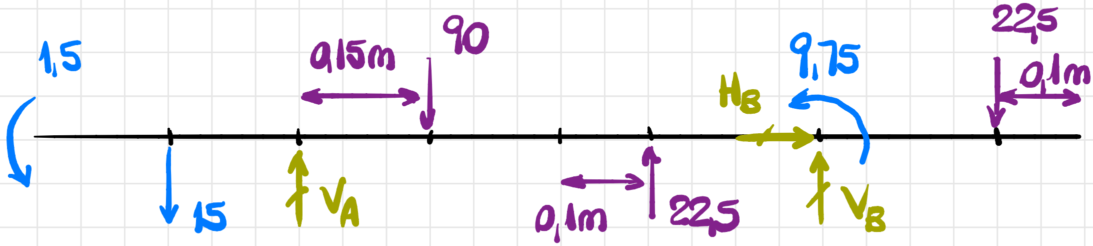
V[kN]


$-50\sqrt{15}-90$
180
90
$50\sqrt{15}-90$

M[kNm]



Reações de apoio:



$$\Sigma F_H = 0 : \boxed{H_B = 0}$$

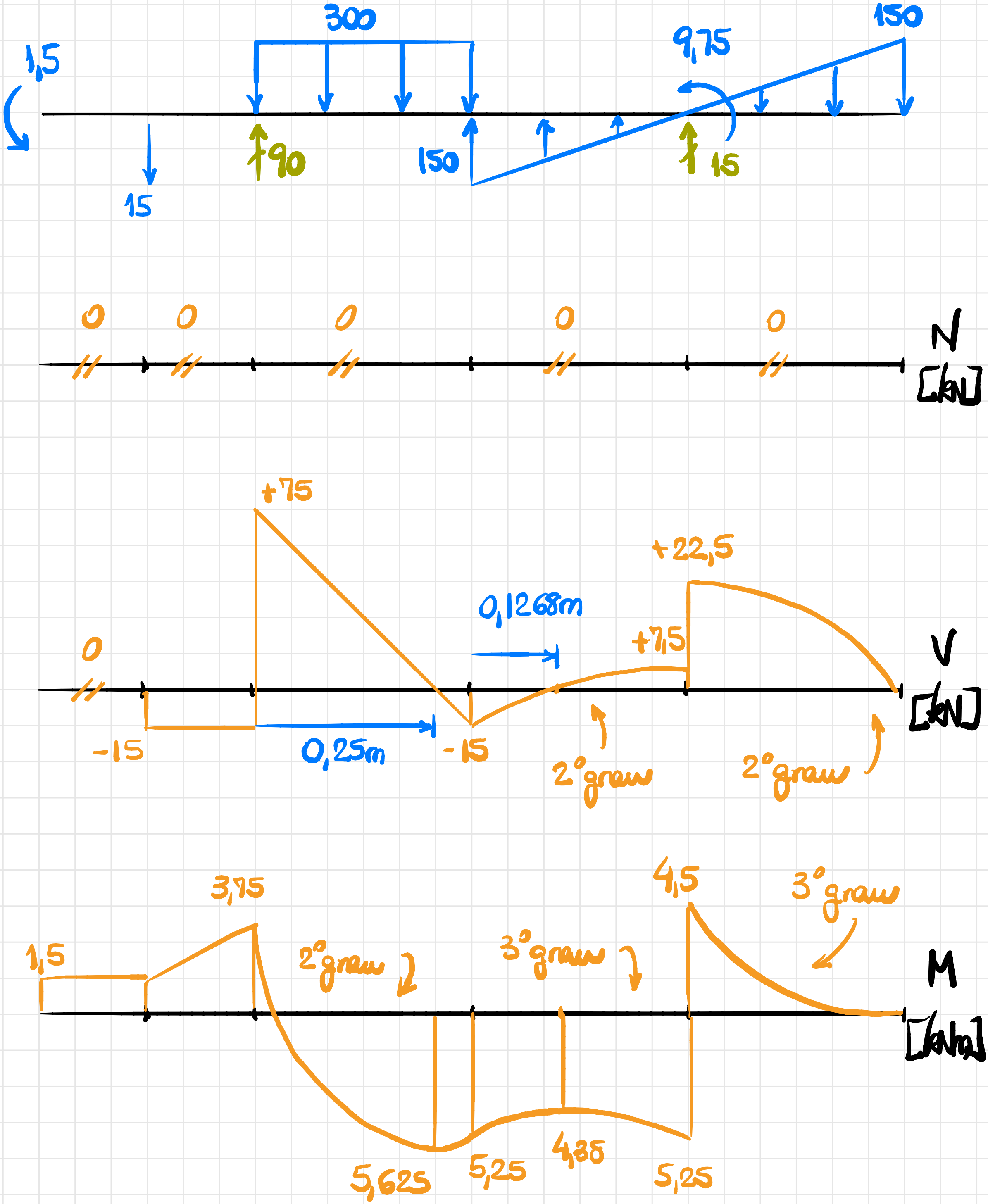
$$\Sigma F_V = 0 : -15 + V_A - 90 + 22{,}5 + V_B - 22{,}5 = 0$$

$$V_A + V_B = 105$$

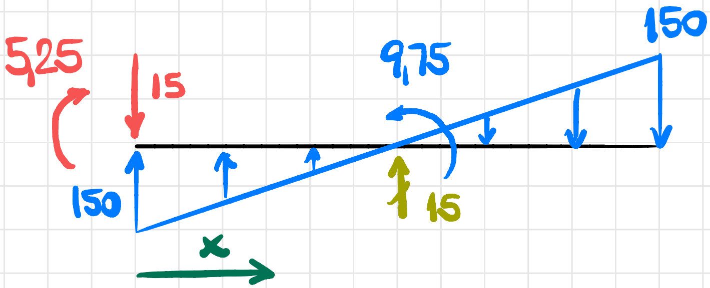
$$(+)\ \Sigma M_A = 0 : 1{,}5 + 15 \cdot 0{,}15 - 90 \cdot 0{,}15 + 22{,}5 \cdot 0{,}4 + V_B \cdot 0{,}6$$

$$+ 9{,}75 - 22{,}5 \cdot 0{,}8 = 0 \Rightarrow 0{,}6 V_B = 9$$

$$\therefore \boxed{V_B = 15\ kN} \Rightarrow \boxed{V_A = 90\ kN}$$


1,5
300
9,75
150
15
90
150
15
0
0
0
0
0
N
[kN]
+75
+22,5
0,1268m
+7,5
0
-15
0,25m
-15
2° grau
2° grau
V
[kN]
3,75
1,5
2° grau
3° grau
4,5
3° grau
M
[kNm]
5,625
5,25
4,85
5,25

Transporte para C:



$$q(x) = -150 + 500x$$

$$\frac{dV}{dx} = 150 - 500x \quad , \quad V(0) = -15$$

$$\boxed{V(x) = 150x - 250x^2 - 15}$$

$$\frac{dM}{dx} = 150x - 250x^2 - 15 \quad , \quad M(0) = 5{,}25$$

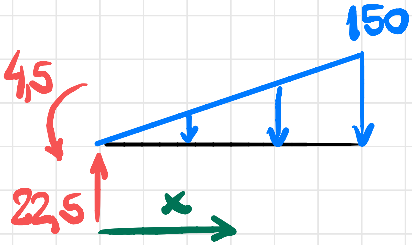
$$\boxed{M(x) = -\frac{250}{3}x^3 + 75x^2 - 15x + 5{,}25}$$

$$V(\bar{x}) = 0 \Rightarrow -250x^2 + 150x - 15 = 0 \ : \ 50x^2 - 30x + 3 = 0$$

$$\bar{x} = \frac{30 \pm \sqrt{900 - 600}}{100} = \frac{30 \pm 10\sqrt{3}}{100} = \begin{cases} 0{,}3 + 0{,}1\sqrt{3} \\ 0{,}3 - 0{,}1\sqrt{3} \end{cases}$$

$(0{,}4732$ ou $0{,}1268)$ $\qquad M(0{,}1268) = 4{,}38\ kNm$

Transporte para B:



$$q(x) = 500x$$

$$\frac{dV}{dx} = -500x, \quad V(0) = 22{,}5$$

$$\boxed{V(x) = -250x^2 + 22{,}5}$$

$$\frac{dM}{dx} = -250x^2 + 22{,}5, \quad M(0) = -4{,}5$$

$$\boxed{M(x) = -\frac{250}{3}x^3 + 22{,}5x - 4{,}5}$$

$$V(\bar{x}) = 0 \Rightarrow -250x^2 + 22{,}5 = 0$$

$$\bar{x} = \pm\sqrt{\frac{22{,}5}{250}} = \begin{cases} 0{,}3 \\ -0{,}3 \end{cases}$$

$$M(0{,}3) = 0.$$