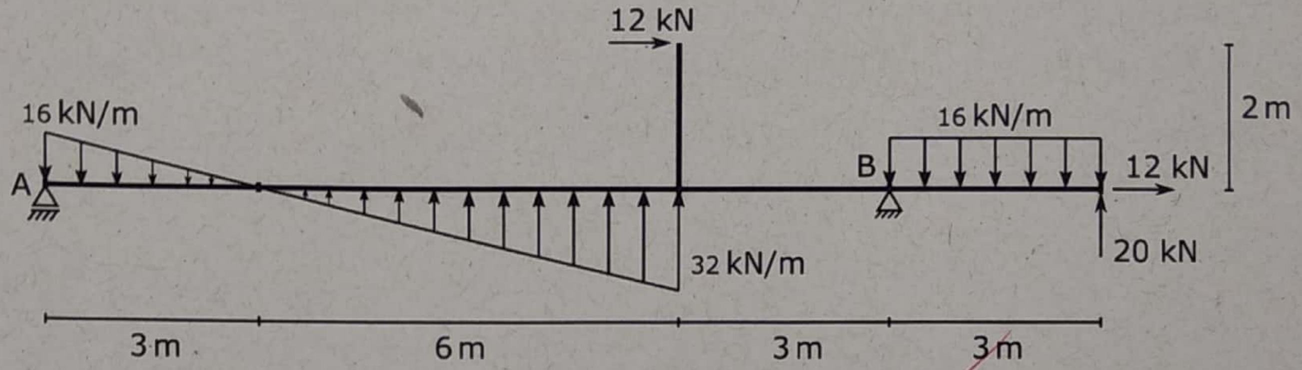
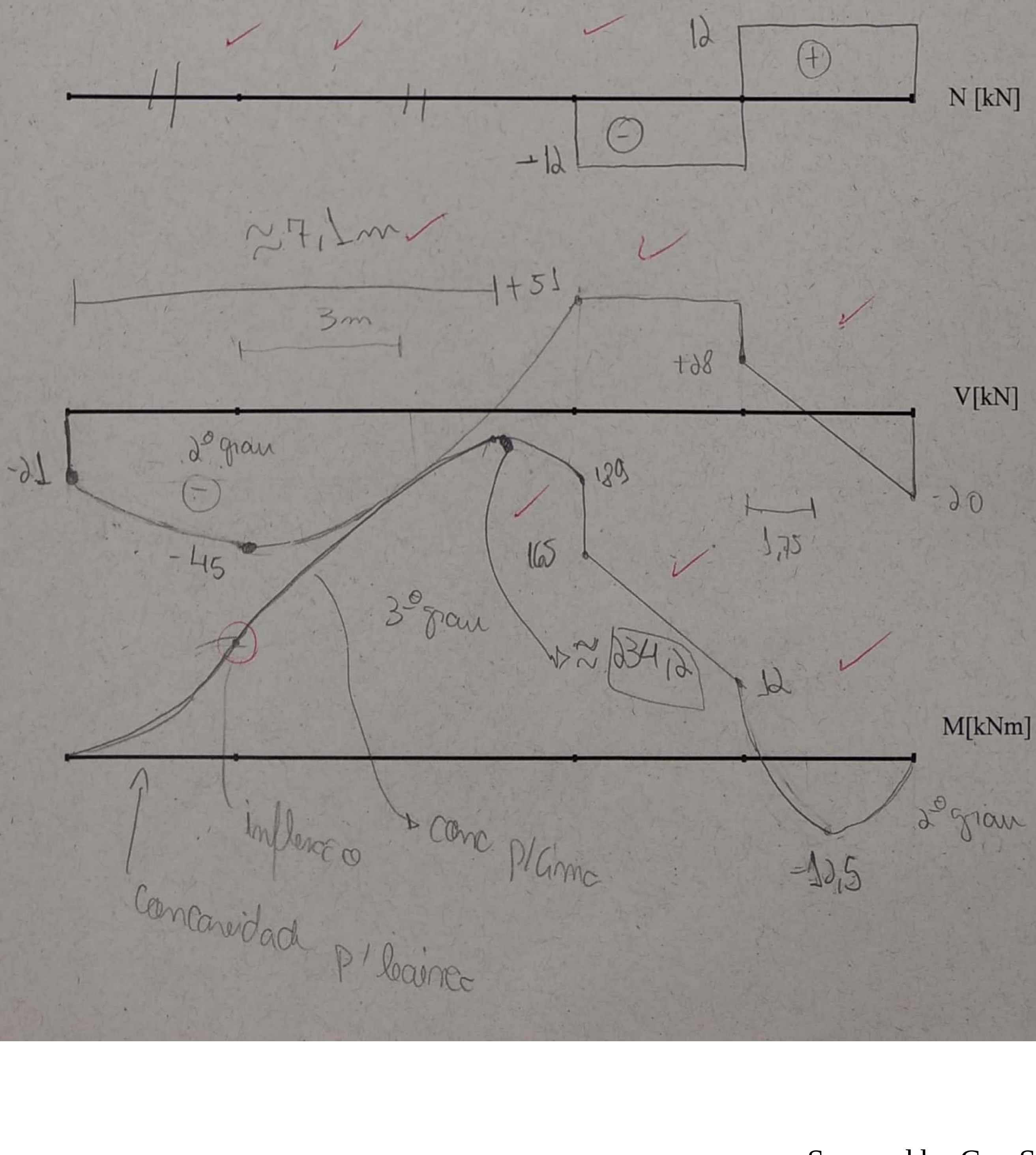
1ª Questão (5 pontos). Para a barra abaixo, trace os diagramas de esforços solicitantes, fornecendo os valores em todos os pontos característicos. Mostre claramente os ressaltos, concavidades, pontos de inflexão e o grau do polinômio em cada trecho.

5,0





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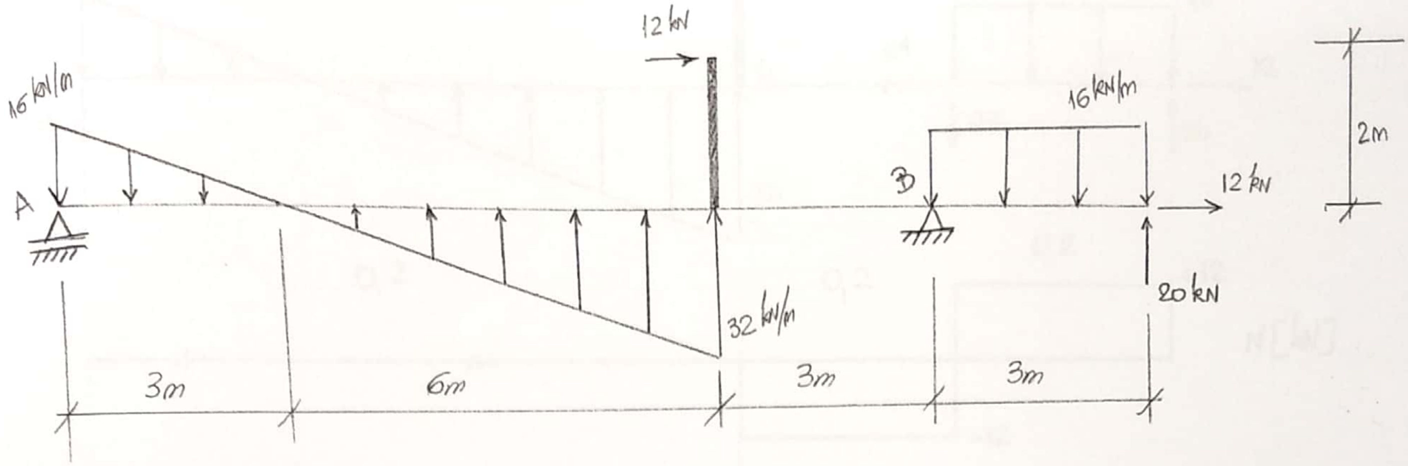
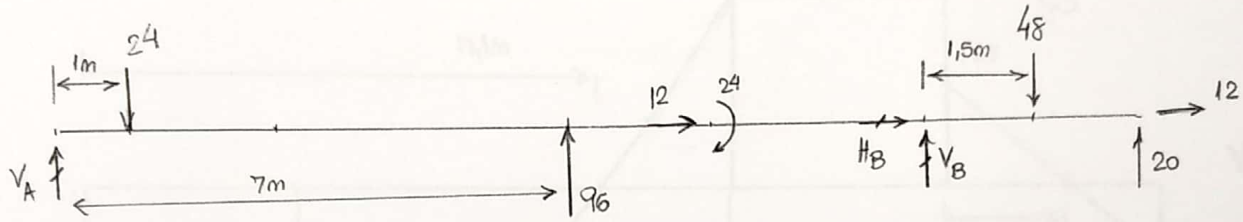
Q1





$\sum F_H = 0: \; 12 + H_B + 12 = 0 \Rightarrow \underline{H_B = -24 \text{ kN}}$

$\sum F_V = 0: \; V_A - 24 + 96 + V_B - 48 + 20 = 0 \Rightarrow V_A + V_B = -44$

0,6

$(+) \; \sum M_A = 0: \; -24.1 + 96.7 - 24 + V_B . 12 - 48.13,5 + 20.15 = 0$

$-24 + 672 - 24 + 12V_B - 648 + 300 = 0$

$12V_B = -276 \Rightarrow \underline{\underline{V_B = -23 \text{ kN}}} \Rightarrow \underline{\underline{V_A = -21 \text{ kN}}}$

Trecho 1 $(0 < x < 9m)$:

$\underline{\underline{N = 0}}$

$q(x) = 16 - \frac{16}{3}x$

$\frac{dV}{dx} = -q(x) = \frac{16}{3}x - 16$

$V(x) = \frac{8x^2}{3} - 16x + C_1$

$V(0) = -21$

$\therefore V(x) = \frac{8}{3}x^2 - 16x - 21$

$\frac{dM}{dx} = V(x) = \frac{8}{3}x^2 - 16x - 21$

$M(x) = \frac{8}{9}x^3 - 8x^2 - 21x + C_2$

$M(0) = 0$

$\therefore M(x) = \frac{8}{9}x^3 - 8x^2 - 21x$

$V(\bar{x}) = 0: \; \bar{x} = \frac{16 \pm \sqrt{256 + 224}}{16/3}$

$\bar{x} = \frac{3}{16}(16 \pm 21,9) \begin{cases} \bar{x} = -1,1m \text{ (fora)} \\ \bar{x} = 7,1m \end{cases}$

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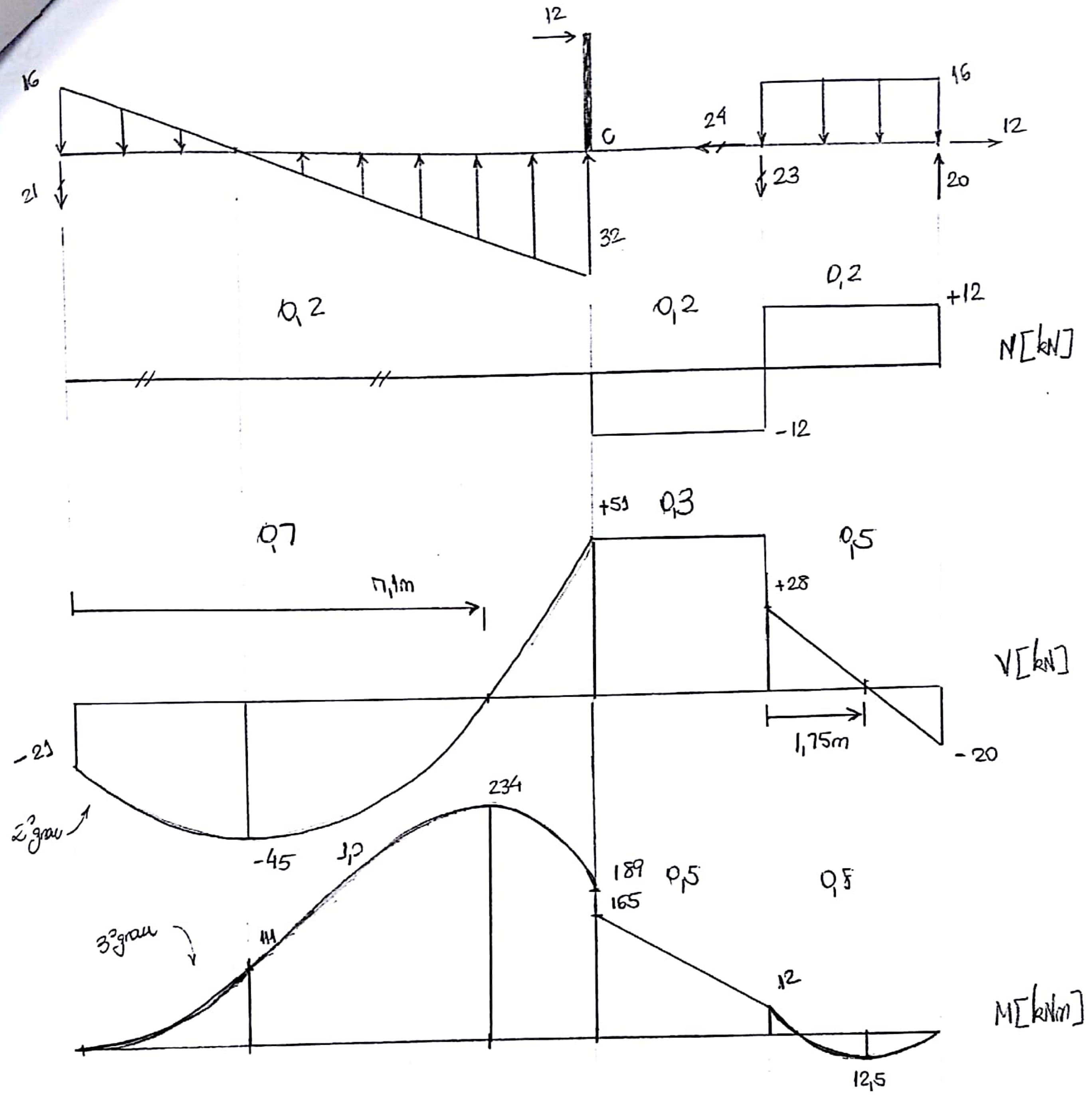
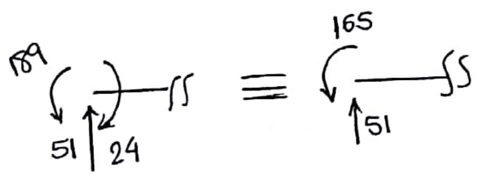


* Transporte para C



$$\begin{cases} V = -21 - 24 + 96 = 51 \\ M = -21.9 - 24.8 + 96.2 = -165 \end{cases}$$

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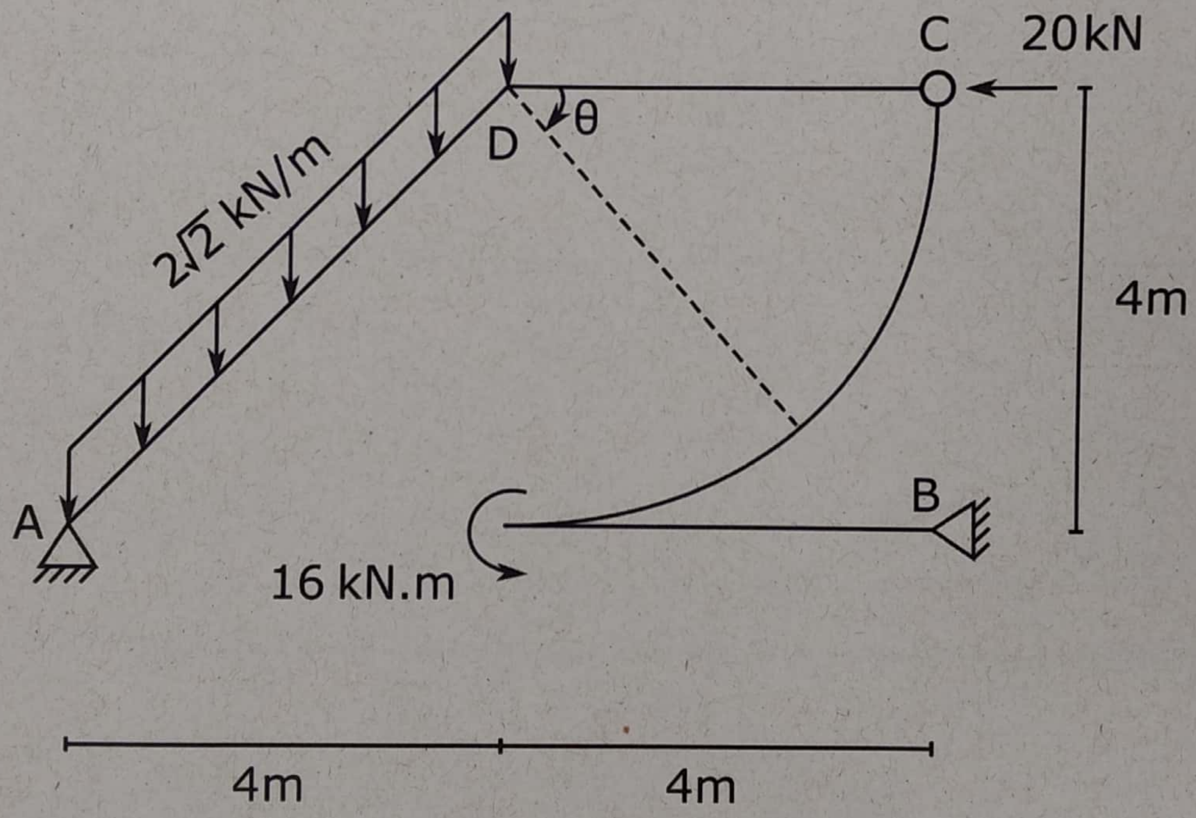
1,0

2ª Questão (5 pontos). Considere a estrutura representada na figura abaixo. Pede-se obter o diagrama de esforços normais (N em kN), de esforços cortantes (V em kN) e de momentos fletores (M em kNm). Determine as equações para o trecho curvo (arco de 90°) em função de θ. Devem ser obedecidos os critérios de sinal definidos em sala de aula. Indicar os valores máximos e mínimos, os ressaltos e concavidades e o grau do polinômio em cada trecho. **Não é necessário desenhar o diagrama do trecho curvo**.



$N(\theta) =$ 6 cos θ − 4 sen θ ✓

$V(\theta) =$ 6 sen θ + 4 cos θ ✓

$M(\theta) =$ 46 + 4 cos θ − 6 sen θ ✗

Q2

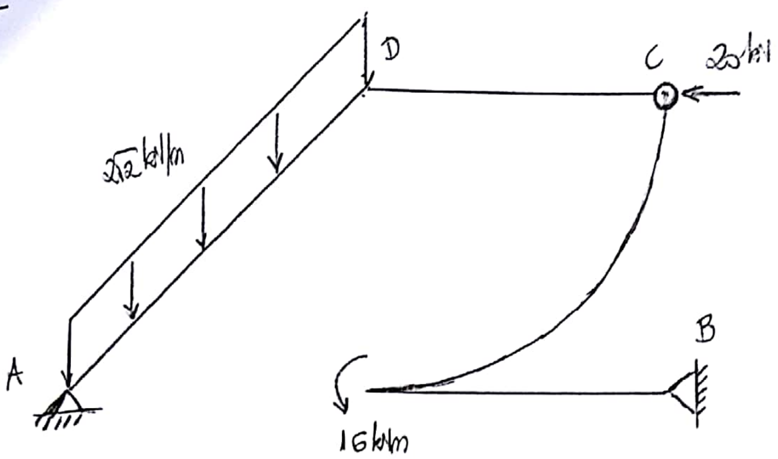
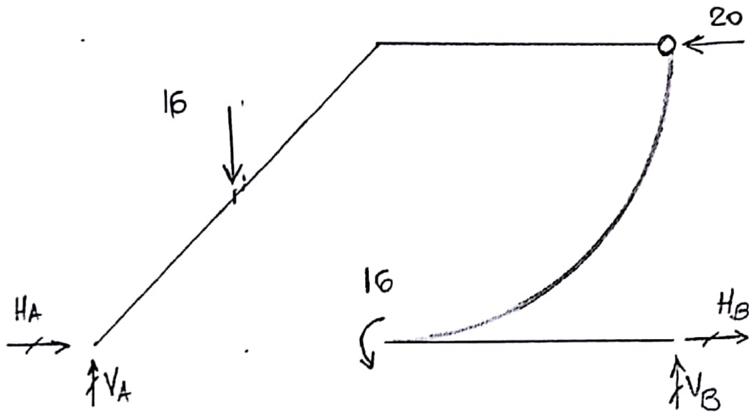


Diagrama de corpo livre:



$\sum F_H = 0: \; H_A + H_B = 20$

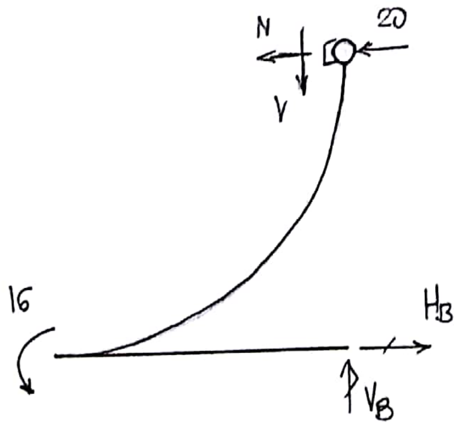
$\sum F_V = 0: \; V_A + V_B = 16$

$\circlearrowright(+)\; \sum M_A = 0: \; -16.2 + 20.4 + 16 + 8V_B = 0 \;\Rightarrow\; 8V_B - 32 + 80 + 16 = 0$

$\therefore\; \underline{V_B = -8\,kN} \;/\!/ \;\Rightarrow\; \underline{V_A = 24\,kN} \;/\!/$

Q,2   Q,2

Corte em C:



$\circlearrowright(+)\; \sum M_C = 0: \; 16 + H_B \cdot 4 = 0 \;\Rightarrow\; \underline{H_B = -4\,kN} \;/\!/$

Q,2

$\underline{H_A = 24\,kN} \;/\!/$

Q,2

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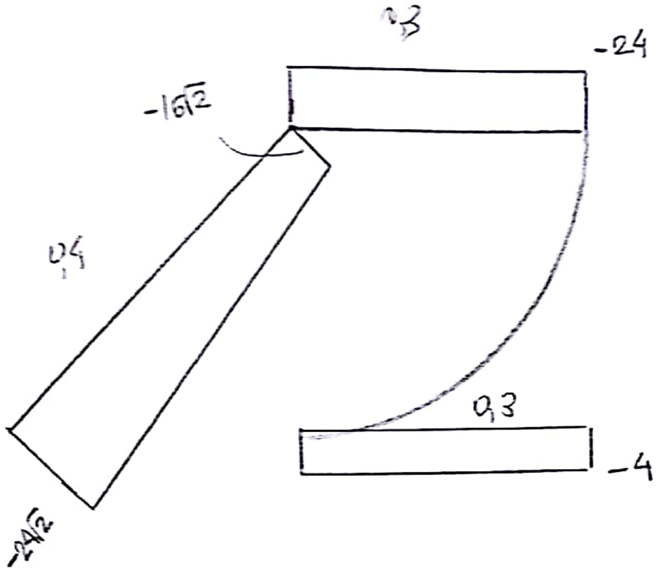
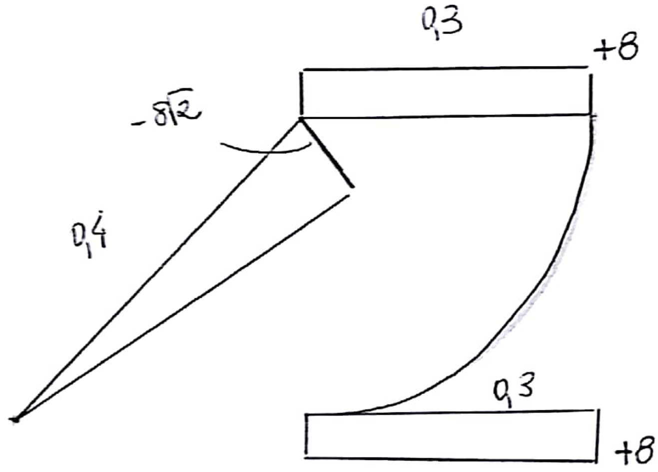
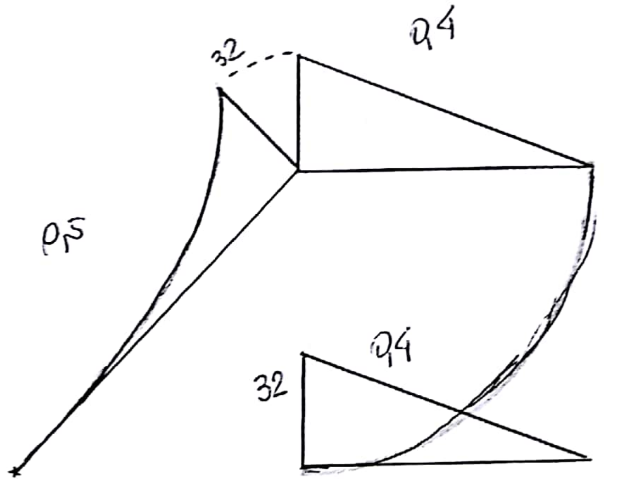


N[kN]



V[kN]



M[kNm]

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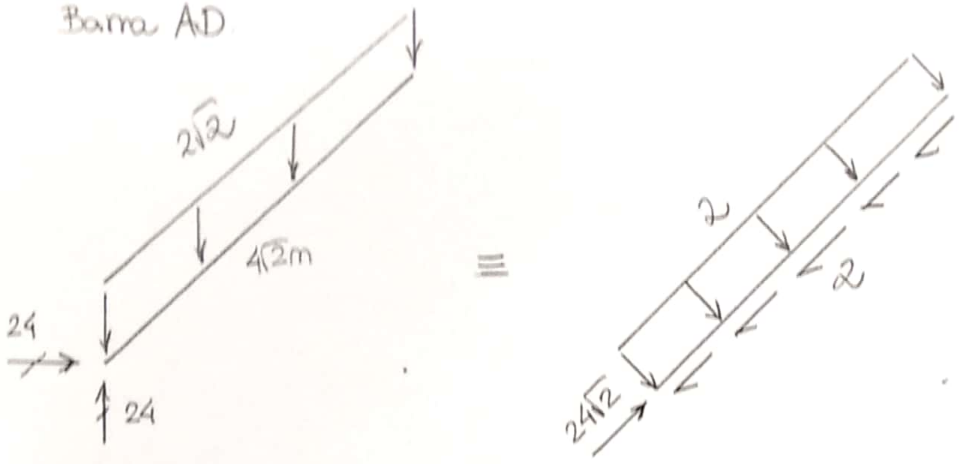
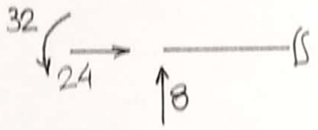
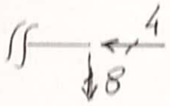
Barra AD



Transporte para D:

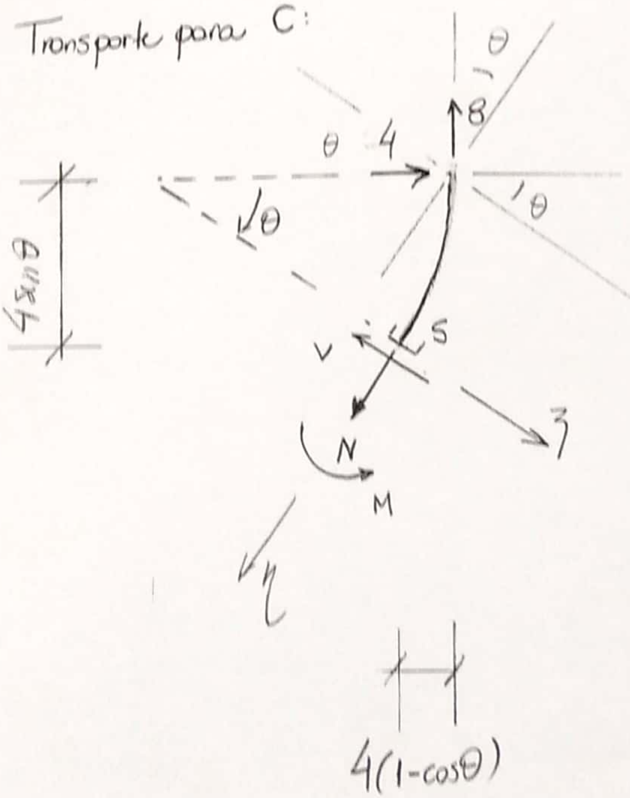


Em B:



Em C:

Transporte para C:



$\sum F_\eta = 0: \ N - 8\cos\theta - 4\,\text{sen}\,\theta = 0$

$\underline{N = 8\cos\theta + 4\,\text{sen}\,\theta}$ Q3

$\sum F_\zeta = 0: \ -V - 8\,\text{sen}\,\theta + 4\cos\theta = 0$

$\underline{V = -8\,\text{sen}\,\theta + 4\cos\theta}$ Q3

$\circlearrowleft + \ \sum M_S = 0: \ M - 4 \cdot 4\,\text{sen}\,\theta + 8 \cdot 4(1-\cos\theta) = 0$

$\underline{M = 16\,\text{sen}\,\theta + 32\cos\theta - 32}$ Q3

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