LISTA - MECANISMOS DE TROCA DE CALOR

1- Condutividade ⟶ Lei de Fourier

$\dot{Q}'' = 3\,kW = 3000\,W/m$ $\quad A = 10\,m^2$

$\dot{Q}'' = -KA\frac{dT}{dx}$

$L = 2{,}5\,cm = 0{,}025\,m$

$T_1 = 415°C = 688{,}15K \quad T_2 = ?$ $\quad \boxed{\dot{Q}'' = -KA\frac{(T_2 - T_1)}{L}}$

$K = 0{,}2\,W/m.K$

$\dot{Q}'' = -KA\frac{(T_2 - T_1)}{L} \therefore \dot{Q}'' = -\frac{KAT_2}{L} + \frac{KAT_1}{L}$

$\frac{KAT_2}{L} = \frac{KAT_1}{L} - \dot{Q}'' \therefore T_2 = T_1 - \frac{L\dot{Q}''}{KA}$

$T_2 = 688{,}15 - \frac{0{,}025 \cdot 3000}{0{,}2 \cdot 10} \simeq 688{,}15 - 371{,}5$

$T_2 = 650{,}65\,K = 377{,}5°C$

2- $L_1 = ?$

$\dot{Q}''_1 = 0,8\dot{Q}''_2$

$K_1 = 0,75 \frac{W}{mK}$

$-\frac{K_1 \Delta T}{L_1} = -0,8 K_2 \frac{\Delta T}{L_2}$

$\dot{Q}''_1 = 80\% \dot{Q}''_2$

$\frac{L_1}{K_1} = \frac{L_2}{0,8 K_2}$

$K_2 = 0,25 \frac{W}{mK}$

$L_1 = \frac{L_2 K_1}{0,8 \cdot K_2}$

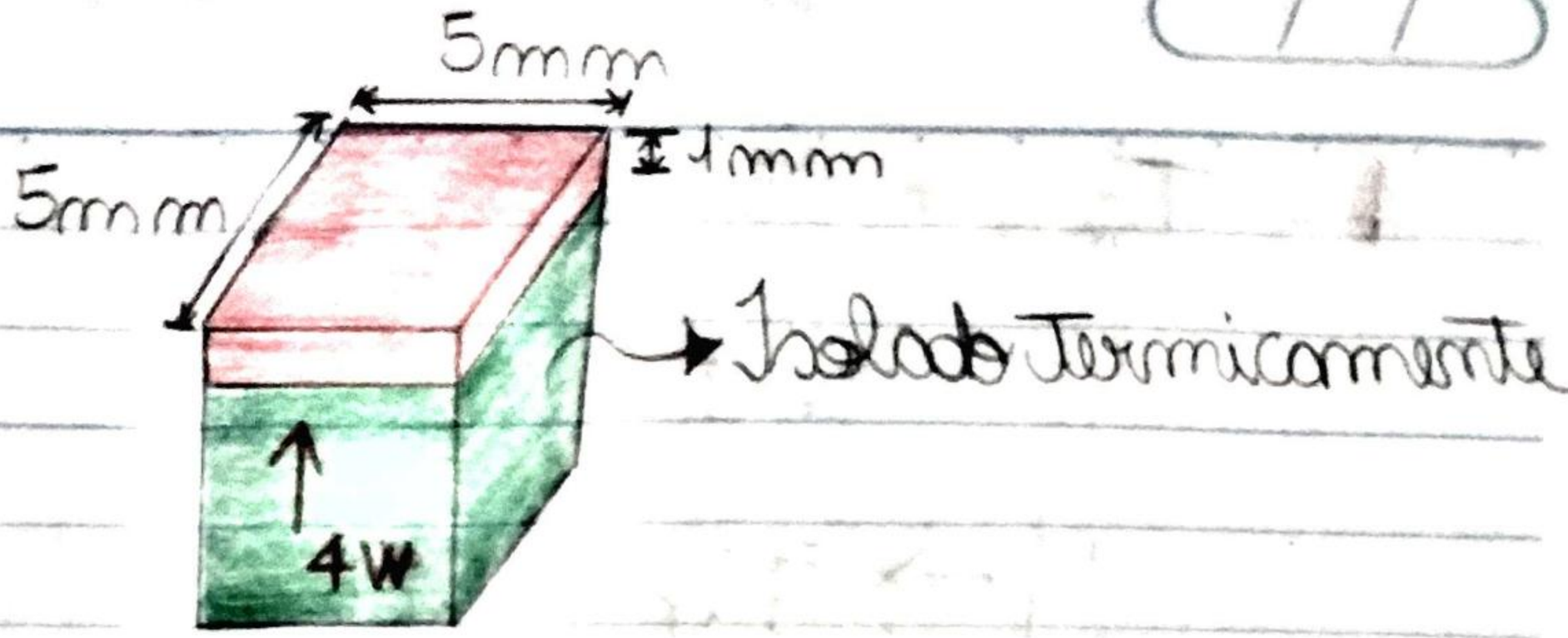
$L_2 = 100 mm$

$(\Delta T)_1 = (\Delta T)_2$

$L_1 = \frac{100 \cdot 10^{-3} \cdot 0,75}{0,8 \cdot 0,25}$

$L_1 = \frac{0,075}{0,2} = 0,375m = 37,5cm$

3-



$\dot{Q}'' = 4W$

$\Delta T = ?\ [K]$

$K = 150 \frac{W}{mK}$

$L = 1 \times 10^{-3}\ m$

$A = (5 \times 10^{-3})^2\ m^2$
$= 25 \cdot 10^{-6}\ m^2$

$\Delta T \cong 1,1\ K = 1,1°C$

$\dot{Q}'' = -KA \frac{\Delta T}{L}$

$\Delta T = \frac{L \dot{Q}''}{-KA}$

$\Delta T = \frac{1 \cdot 10^{-3} \cdot 4}{-150 \cdot 25 \cdot 10^{-6}}$

$\Delta T = -1,0667\ K$

Chip da Questão 3

4 - $T_{max} = 85°C$

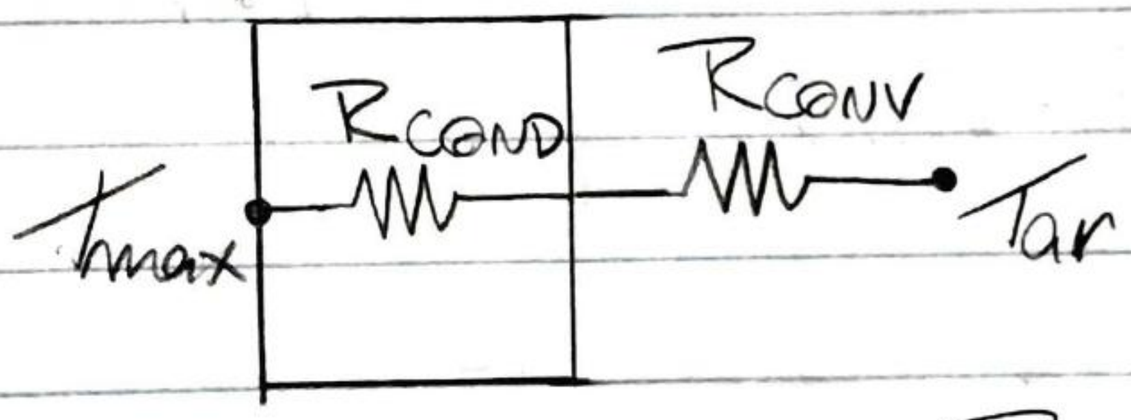
Corrente de ar

→ $T_{ar} = 15°C$

→ $h = 200 \frac{W}{m^2 K}$

$\dot{Q}''_{max} = ?$

$R_{cond} = \frac{\Delta x}{KA}$



$R_{conv} = \frac{1}{hA}$

$R_{eq} = R_{cond} + R_{conv}$

$\dot{Q}'' = \frac{\Delta T}{R_{eq}}$

$R_{cond} = \frac{1 \times 10^{-3}}{150 \cdot 25 \cdot 10^{-6}}$

$\dot{Q}'' = \frac{\Delta T}{R_{cond} + R_{conv}}$

$R_{conv} = \frac{1}{200 \cdot 25 \cdot 10^{-6}}$

$\dot{Q}'' = \frac{85 - 15}{0,267 + 200}$

$\Delta T = T_{max} - T_{ar}$

$\dot{Q}''_{max} = 0,35 W$ (a)

(b) Troquei o valor de h

$$h = 400 \frac{W}{m^2 K}$$

$$R_{conv} = \frac{1}{hA} = \frac{1}{400 \cdot 25 \cdot 10^{-6}}$$

$$\dot{Q}''_{max} = \frac{\Delta T}{R_{cond} + R_{conv}}$$

$$\dot{Q}''_{max} = \frac{85 - 15}{0,267 + 100} \cong 0,7\ W$$

5- Caso de um corpo envolto por um corpo muito maior.

$$\dot{Q}'' = \varepsilon \sigma (T_s^4 - T_{sur}^4)$$

$\varepsilon = 0,9$

$T_{sur} = 15°C = (15 + 273,15)K$

$T_s = 85°C = (85 + 273,15)K$

$\sigma = 5,67 \cdot 10^{-8} \frac{W}{m^2 K^4}$

$$\dot{Q}''_{rad} = \varepsilon \sigma A (T_s^4 - T_{sur}^4)$$

$= 0,9 \cdot 5,67 \cdot 10^{-8} \cdot 25 \cdot 10^{-6} (358,15^4 - 288,15^4)$

$\cong 1,2195 \cdot 10^{-2}$ W

$$\dot{Q}''_{conv} = h A (T_s - T_\infty)$$

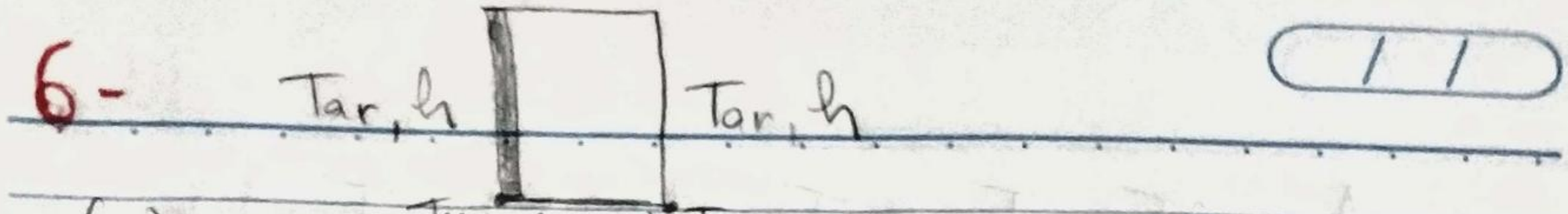
$= 200 \cdot 25 \cdot 10^{-6} (85 - 15)$

$\cong 0,35$ W

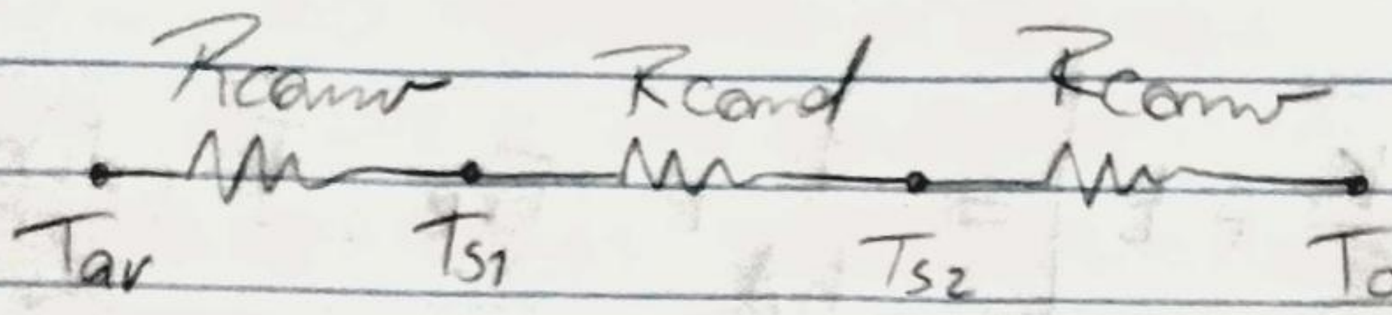
$$\dot{Q}''_{max} = \dot{Q}''_{rad} + \dot{Q}''_{conv}$$

$\cong 0,35 + 0,012 = \underline{0,362 \text{ W}}$

6-



(a)



→ O calor dissipado pelo processador é jogado para o ar por convecção

$$\dot{Q} = hA(T_{s1} - T_{ar}) + hA(T_{s2} - T_{ar}) = 0,5\,W$$

→ O calor que o processador dissipa para o PCB por condução é jogado para o ar por convecção

$$-KA\frac{(T_{s1} - T_{s2})}{t} = hA(T_{s1} - T_{ar})$$

$$-KT_{s1} + KT_{s2} = thT_{s1} - thT_{ar}$$

$$KT_{s2} = T_{s1}(th + K) - T_{ar}th$$

→ $$T_{s2} = T_{s1}\frac{(th + K)}{K} - \frac{T_{ar}th}{K}$$

$$hAT_{s1} - hAT_{ar} + hAT_{s2} - hAT_{ar} = \frac{1}{2}$$

$$hAT_{s1} - 2hAT_{ar} + hAT_{s2} = \frac{1}{2}$$

$$T_{s2} = \frac{1}{2hA} + 2T_{ar} - T_{s1}$$

1 D

$$\frac{1}{2hA} + 2Tar - Ts1 = Ts1 \frac{(th+K)}{K} - Tar\,th$$

$$Ts2\left[\frac{th+K}{K} + 1\right] = \frac{1}{2hA} + 2Tar + \frac{Tar\,th}{K}$$

$$Ts1 = \frac{\frac{1}{2hA} + Tar\left(2 + \frac{th}{K}\right)}{\frac{th+K}{K} + 1}$$

$Tar = 20 + 375,15 = 395,15\ K$
$t = 0,02\ m$
$K = 0,25\ \frac{W}{mK}$

$A = 25\,(10^{-3})^2\ m^2 = 25 \cdot 10^{-6}\ m^2$
$h = 250\ \frac{W}{m^2K}$

$\therefore Ts1 \simeq \frac{8773,3}{22} \simeq 398,79\,K \simeq \underline{\underline{23,6°C}}$

$$Ts2 = \frac{1}{2hA} + 2Tar - Ts1 \simeq 471,51K \simeq \underline{\underline{96,36°C}}$$

(b) face 1

Apenas Convecção

$$\dot{Q} = hA(T_{s1} - T_{ar})$$
$$\dot{Q} = 250 \cdot 25 \cdot 10^{-6} (23,6 - 20)$$

$$\dot{Q} \cong 0,0225 W$$

face 2

Convecção + Condução

$$\dot{Q} = -KA\frac{(T_{s1} - t_{s2})}{t} + hA(T_{s2} - T_{ar})$$

$$\dot{Q} \cong 0,4773 W$$