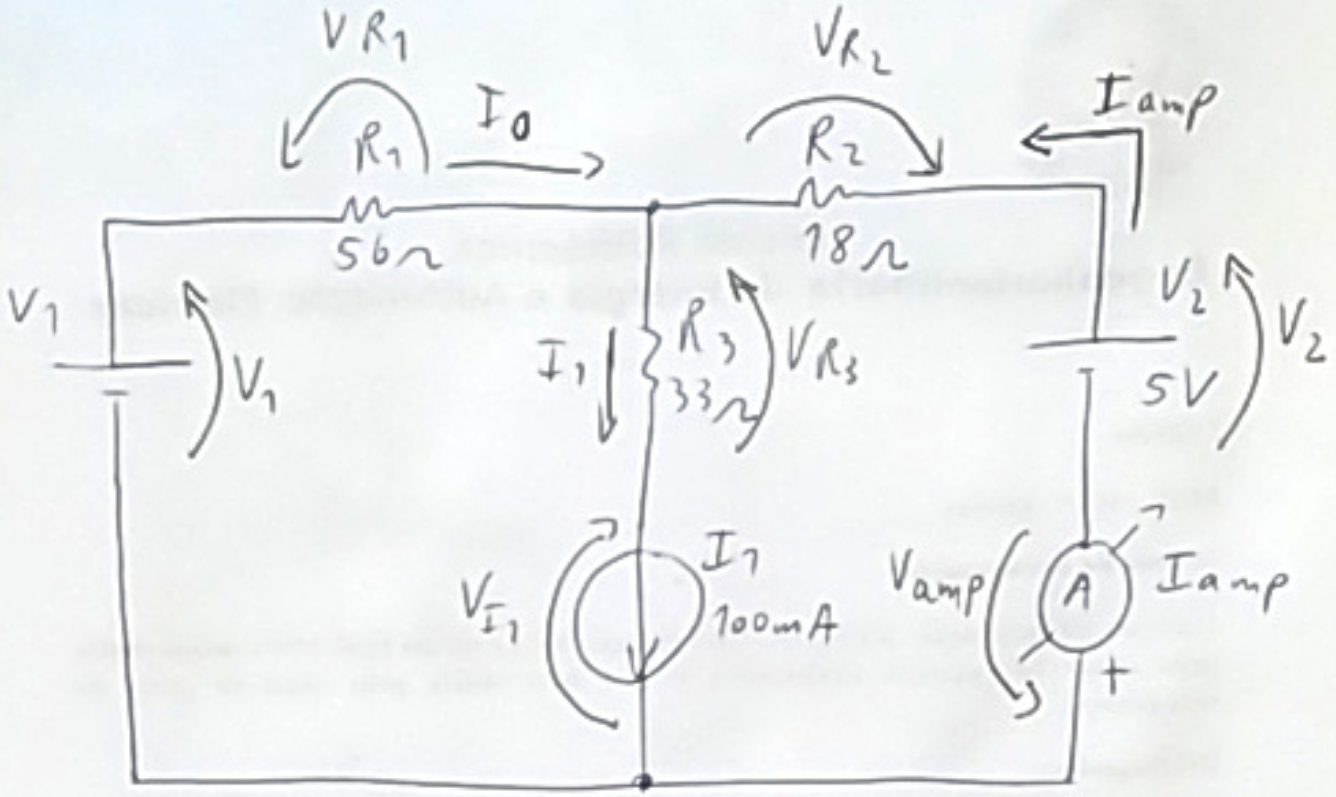
(1)




a) $V_{R_2} = I_{amp} R_2$

$I_0 = I_1 - I_{amp}$

$V_{R_1} = R_1 I_0$

$V_{amp} \cong 0V$

$V_1 = -\overset{0}{V_{amp}} + V_2 - V_{R_2} + V_{R_1}$

$V_1 = V_2 - R_2 I_{amp} +$

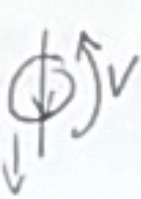
$+ R_1 (I_1 - I_{amp})$

$$\boxed{V_1 = V_2 + R_1 I_1 - (R_1 + R_2) I_{amp}}$$

b)

c) Após os cálculos numéricos, para todos os valores:

- $V_1$, $V_2$ : gerador (ativo), linear
- $I_1$ : receptor ativo, linear
- $R_1$, $R_2$, $R_3$: receptor passivo, linear



b) $P_{V_1} + P_{V_2} = P_{R_1} + P_{R_2} + P_{R_3} + P_{I_1}$

$P_{V_1} = V_1 \cdot I_0$

$P_{V_2} = V_2 \cdot I_{amp}$

$P_{R_1} = R_1 I_0^2$

$P_{R_2} = R_2 I_{amp}^2$

$P_{R_3} = R_3 I_1^2$

$P_{I_1} = V_{I_1} I_1 = (V_1 - V_{R_1} - V_{R_3}) I_1$

<u>Nota</u>: o erro por arredondamento → (diferença na igualdade) deve ser menor que a menor parcela de potência, em pelo menos 100 vezes.

d) No limite,

$I_{amp} = 0\ A$,

pois p/ $V_2$ ser receptor ativo,

$I_{amp} < 0\ A$.

Portanto:

$I_0 = I_1$ e

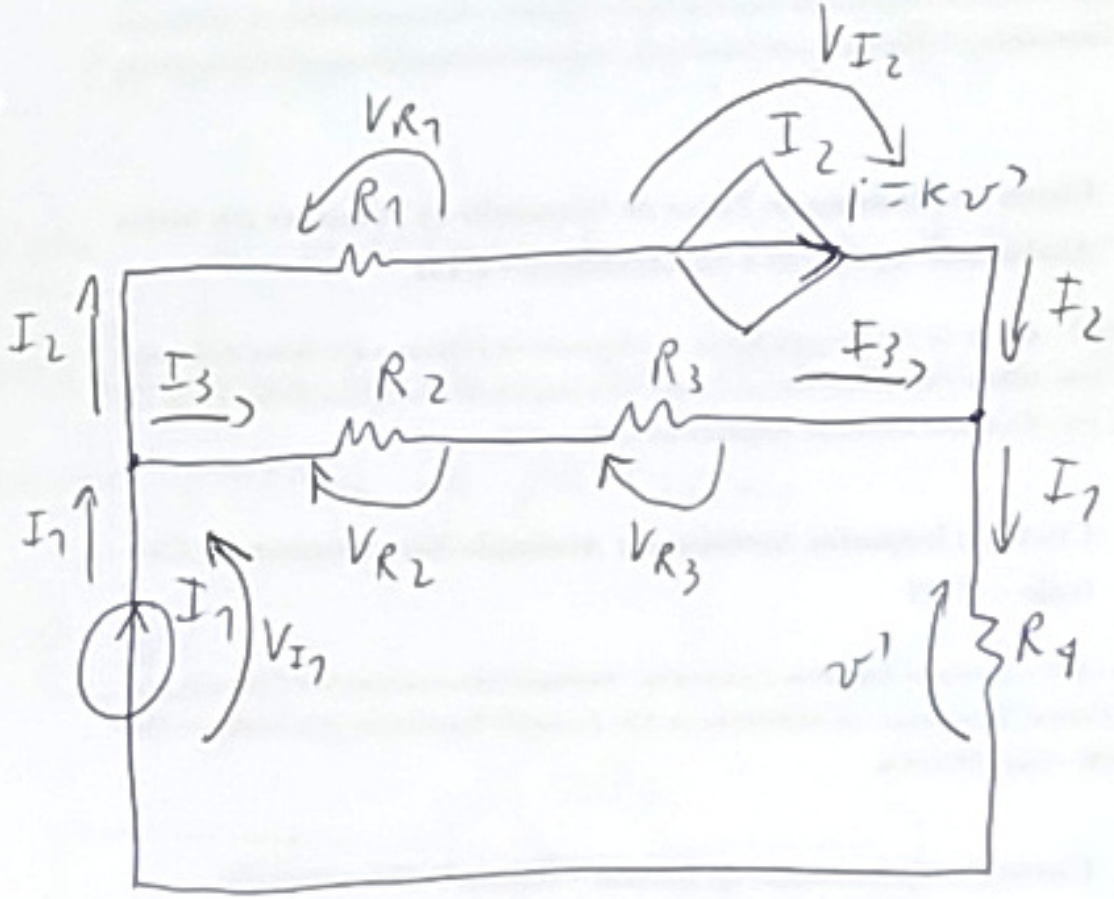
$V_1 = R_1 I_0 + V_2 - \cancel{V_{R_2}}^{\to 0} - \cancel{V_{amp}}^{\to 0}$

$\therefore \boxed{V_1 = R_1 I_0 + V_2}$

(2)

$$V_L = \frac{R_B}{R_A + R_B} \cdot \frac{R_L}{R_C + R_L} \cdot K \cdot V_{cc}$$

(3)




$v' = R_4 I_1$

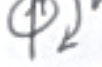
$I_2 = K v' = K R_4 I_1$

$I_3 + I_2 = I_1 \Rightarrow I_3 = I_1 - I_2$

$V_{I_1} = v' + V_{R_3} + V_{R_2}$

$V_{I_2} = V_{R_1} - V_{R_2} - V_{R_3}$

$I_1$: receptor ativo, linear



$I_2$: gerador (ativo), linear

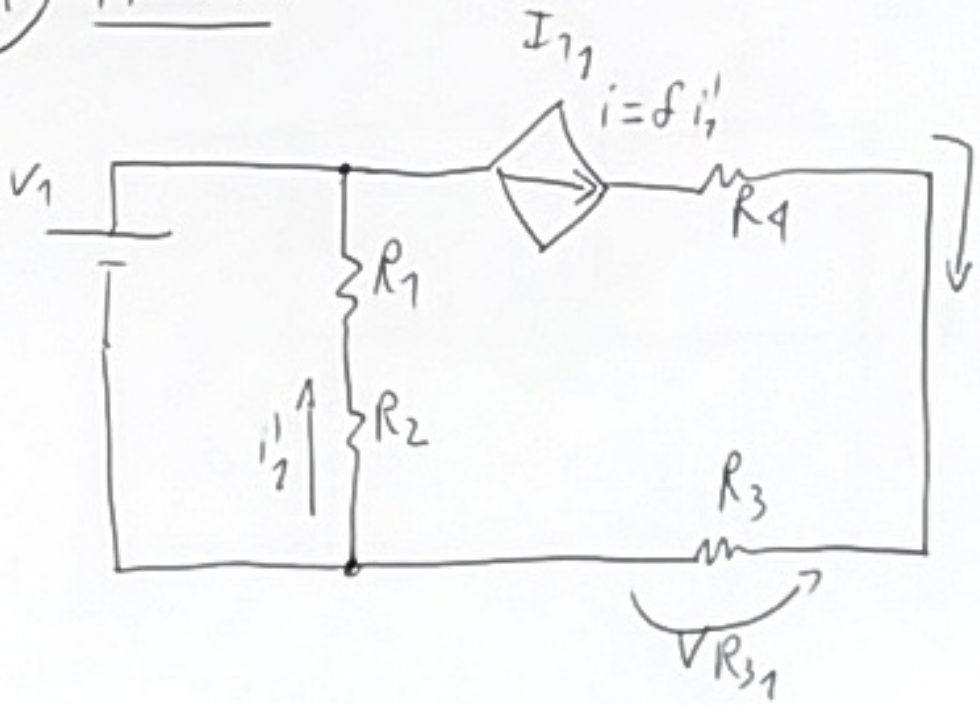
$R_1 \ldots R_4$: receptor passivo, linear

$$P_{I_2} = P_{I_1} + P_{R_1} + P_{R_2} + P_{R_3} + P_{R_4}$$

$$P_{I_2} = V_{I_2} \cdot I_2 \qquad P_{R_2} = V_{R_2} \cdot I_3$$
$$P_{I_1} = V_{I_1} \cdot I_1 \qquad P_{R_3} = V_{R_3} \cdot I_3$$
$$P_{R_1} = V_{R_1} \cdot I_2 \qquad P_{R_4} = v' \cdot I_1$$

Nota: a diferença da igualdade, ≠ por erro de arredondamento, deve ser 100x menor que a menor parcela de potencia.

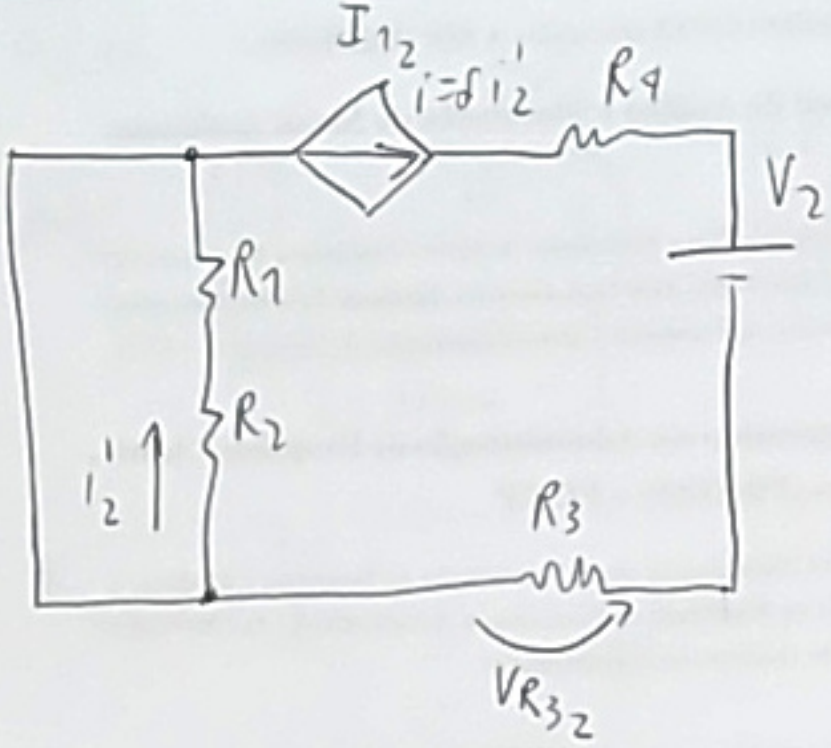
(4) P/ $V_1$:




$$i_1' = -\frac{V_1}{R_1 + R_2}$$

$$V_{R_{3_1}} = -\frac{\beta R_3}{R_1 + R_2} V_1$$

P/ $V_2$ :

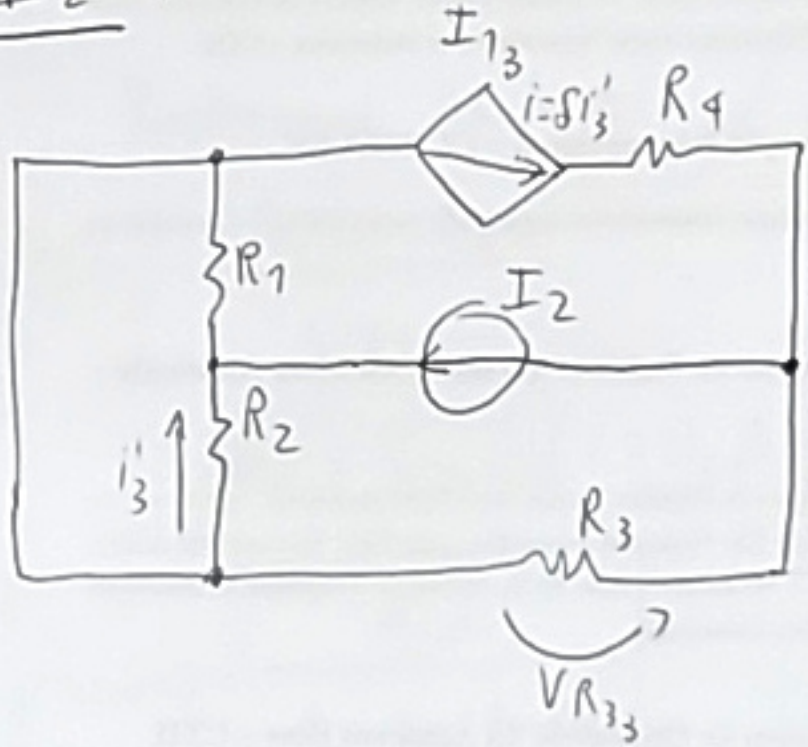



$i_2' = 0A$

$\therefore I_{1_2} = 0A$

$\therefore \boxed{V_{R_{3_2}} = 0V}$

P/ $I_2$ :



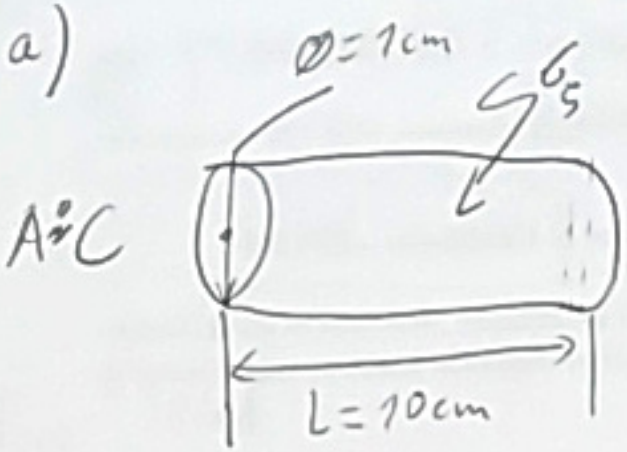

$$i_3' = -\frac{R_1}{R_1+R_2} I_2$$

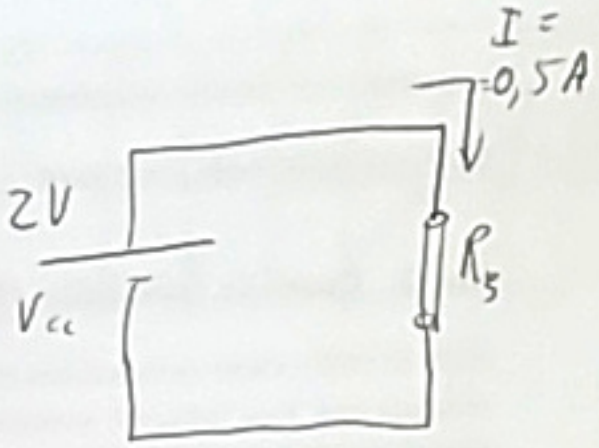
$$\boxed{V_{R_{3_3}} = -\frac{\delta R_1 R_3}{R_1+R_2} I_2}$$

$\therefore \boxed{V_{R_3} = V_{R_{3_1}} + V_{R_{3_2}} + V_{R_{3_3}}}$

(5)

a)




b) $R_{S(A°C)} = \dfrac{V_{cc}}{I}$

$$R_{S(A°C)} = \rho_{S(A°C)} \frac{L_{(A°C)}}{S_{(A°C)}}$$

Desprezando $\Delta L$ e $\Delta S$ c/ $\Delta\theta$:

$$\rho_{S(A°C)} = \frac{R_{S(A°C)} \cdot S_{(A°C)}}{L_{(A°C)}}$$

$$\rho_{S(A°C)} = \rho_{S(20°C)} (1 + \alpha_S \Delta\theta)$$

$$\therefore \boxed{\rho_{S(20°C)} = \frac{\rho_{S(A°C)}}{1 + \alpha_S (A - 20)}}$$

$$\boxed{\sigma_{S(20°C)} = \frac{1}{\rho_{S(20°C)}}}$$

c) $E = P \cdot \Delta t =$

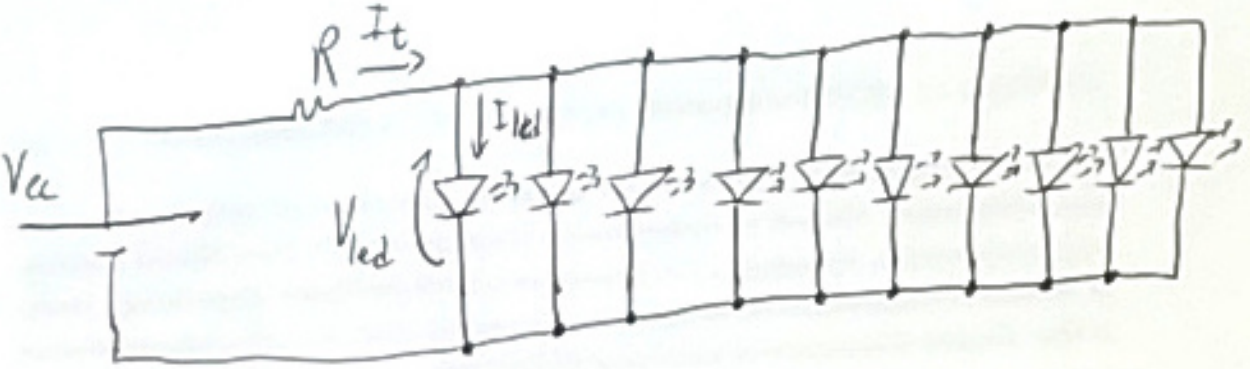
$= V_{cc} \cdot I \cdot \Delta t_{(s)}$

$E_{cal} = E_J / K$

$K = 4,18$ J/cal

(ou $K \cong 4,2$ J/cal)

(6) a)




$I_{led} = 10\,mA$

$I_t = 10\, I_{led}$

$R = \frac{V_{cc} - V_{led}}{I_t}$ => Adotar o valor comercial mais próximo. Múltiplo da potência de 10 de:

| | | | |
|---|---|---|---|
| 1,0 | 1,2 | 1,5 | 1,8 |
| 2,2 | 2,7 | 3,3 | 3,9 |
| 4,7 | 5,6 | 6,8 | 8,2 |

Tolerância: 5%

$P_{R_{máx}} = \frac{V_R^2}{R_{mín}} = \frac{(V_{cc} - V_{led})^2}{0,95\,R}$

$P_{Rmarg.} = 1,20 \cdot P_{Rmáx}$ (20% a mais)

=> Adotar $P_{Rnom}$ maior que $P_{Rmarg.}$, dentro de:

$\frac{1}{8}W$, $\frac{1}{4}W$, $\frac{1}{2}W$, 1W, 2W, 3W, 5W, 10W.