LISTA - PRIMEIRA LEI

1) $P = 15 KW = 15 KJ/s$

Taxa de perda c/ calor: $1{,}8 KW = 1{,}8 KJ/s$

E: Energia armazenada pela bateria

8 horas $= (8 \times 60)$ min $= (8 \times 60 \times 60)$ s

$E = [(15 - 1{,}8) \times 10^3](8 \times 60 \times 60)$

$E = 380.160.000{,}00 J = 0{,}38 \cdot 10^9 J$

$E = 0{,}38 GJ$

2) $m = 5 Kg$

$u_1 = 2709{,}9 KJ/Kg$

$u_2 = 2659{,}6 KJ/Kg$

Energia recebida $= 80 KJ + 18{,}5 KJ = 98{,}5 KJ$

$U_1 = 5 u_1 = 13.549{,}5 KJ$

$U_2 = 5 u_2 = 13.298{,}0 KJ$

$\Delta U = U_2 - U_1 = -251{,}5 KJ$

→ O gás exerceu um trabalho de 251,5 KJ no pistão.

Conservação da energia

↳ $W_{pistão} = -\Delta U + Q + W_{pw}$

$W_{pistão} = 251,5\,KJ + 80\,KJ + 18,5\,KJ$

$\underline{W_{pistão} = 350\,KJ}$

3)

$Q = Ah(T_s - T_\infty)$ $\qquad T_\infty = 25°C = 298,15K$

$T_s = ?$

Da conservação da energia $Q_{TA} = -3W$ (a)

(b) $Q_{AT} = AhT_s - AhT_\infty \therefore AhT_s = Q + AhT_\infty$

$$T_s = \frac{Q_{AT}}{Ah} + T_\infty = \frac{+3}{5\cdot10^{-4}\cdot100} + 298,15$$

$T_s = 60 + 298,15 = 358,15\,K$

$T_s = (358,15 - 273,15)°C = \underline{85°C}$

4 - $p_1 = 8\,\text{bar}$, $V_1 = 0{,}02\,m^3$

$p_2 = 2\,\text{bar}$, $V_2 = ?$

n (índice politrópico) $= 1{,}2 \quad \therefore \; pV^{1,2} = \text{cte}$

$m = 0{,}25\,\text{Kg}$

$\Delta U = -55\,\text{KJ}/\text{Kg}$

$$p_1 V_1^{1,2} = p_2 V_2^{1,2} \quad \therefore \quad V_2^{1,2} = \frac{p_1 V_1^{1,2}}{p_2}$$

$$\boxed{V_2 = \left(\frac{p_1 V_1^{1,2}}{p_2} \right)^{\frac{1}{1,2}}}$$

$p_1 = 8 \cdot 10^5\,Pa$

$V_1 = 0{,}02\,m^3$

$p_2 = 2 \cdot 10^5\,Pa$

$V_2 = ??\,[m^3]$

$V_2 \simeq 0{,}063496\,m^3$

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$pV^m = CTE \quad \therefore \quad p = \frac{CTE}{V^m}$

$$W = \int_{V_1}^{V_2} p\,dV = \int_{V_1}^{V_2} \frac{CTE}{V^m}\,dV = CTE \int_{V_1}^{V_2} V^{-m}\,dV$$

$$W = CTE \left[\frac{V^{-m+1}}{-m+1}\right]_{V_1}^{V_2} = CTE \cdot \frac{V_2^{-m+1}}{-m+1} - CTE \cdot \frac{V_1^{-m+1}}{-m+1}$$

$$W = p_1 V_2^m \frac{V_2^{-m+1}}{-m+1} - p_1 V_1^n \frac{V_1^{-m+1}}{-m+1}$$

$$W = \frac{p_2 V_2}{-m+1} - \frac{p_1 V_1}{-m+1} = \frac{1}{-m+1}\left[p_2 V_2 - p_1 V_1\right]$$

$$W = \frac{1}{-1,2+1}\left[2 \cdot 10^5 \cdot 0,063496 - 8 \cdot 10^5 \cdot 0,02\right]$$

$W = 16504\,J \simeq \underline{16,5\,KJ}$

Trabalho total envolvido na expansão do gás

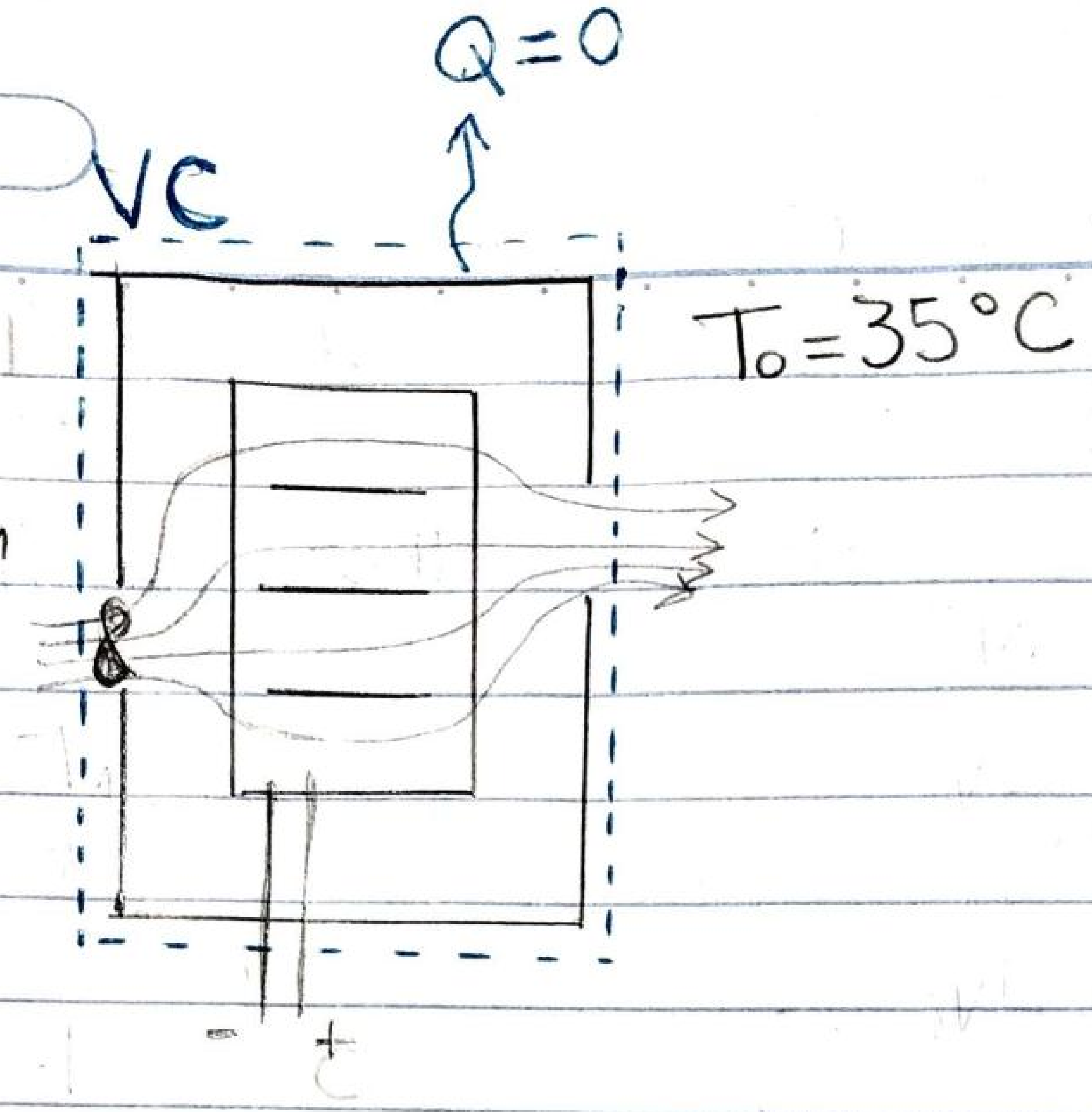
1º lei da termodinâmica

↳ $\boxed{Q = W + \Delta U} \quad \therefore \quad Q = 16,5\,KJ - 55\,\frac{KJ}{\cancel{Kg}}\; 0,25\,\cancel{Kg}$

$Q = 16,5\,KJ - 13,75\,KJ = \underline{2,75\,KJ}$

↳ quantidade de calor total fornecida ao sistema

5-



① Determinar $\dot{V}\,[m^3/s]$

1ª Lei da Termodinâmica para Volume de Controle

$$\frac{dE}{dt} = \cancel{\dot{Q}}^{\,0} - \dot{W} + \dot{m}(h_e - h_s)$$

Entalpia: $h = u + pv$ $\left[\frac{m^3}{kg}\right]$

$$h = u + \frac{p}{\rho}$$

$$\frac{dE}{dt} = -\dot{W} + \dot{m}(h_e - h_s)$$

$$\dot{W} = 25\,W + 100\,W = 125\,W$$

Ar: Gás Ideal $\therefore pV = mRT \therefore p\frac{V}{m} = RT$

$$pv = RT$$

$$c_p = \left.\frac{\partial h}{\partial T}\right|_p$$

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$$c_p = \frac{dh}{dT} \therefore \int dh = \int c_p\, dT$$

$$\boxed{h_2 - h_1 = c_p (T_i - T_e)}$$

Considerando Regime Permanente

$$\frac{dE}{dt} = 0 \therefore \quad 0 = -\dot{W} + \dot{m}(h_e - h_s)$$
$$0 = -\dot{W} + \dot{m}\, c_p (T_i - T_e)$$

$$c_p \simeq 1005 \frac{J}{Kg\,K}$$

$$\dot{m} = \frac{\dot{W}}{c_p(T_i - T_e)} = \frac{-100 - 25}{1005(20-35)} = \frac{-125}{1005(-15)}$$

$$\dot{m} \cong 0{,}0083 \, Kg/s$$

$$\dot{m} = \rho V A = \rho \dot{V} \therefore \quad \dot{V} = \frac{\dot{m}}{\rho} \left[\frac{m^3}{s}\right]$$

$$p\underbrace{v}_{1/\rho} = RT$$

$$\frac{p}{\rho} = RT \therefore \quad \rho = \frac{p}{RT} = \frac{10^5}{287 \cdot (20 + 273{,}15)}$$

$$\rho \cong 1{,}19 \, Kg/m^3$$

$$\dot{V} = \frac{0{,}0083}{1{,}19} \cong 0{,}007 \, \frac{m^3}{s}$$

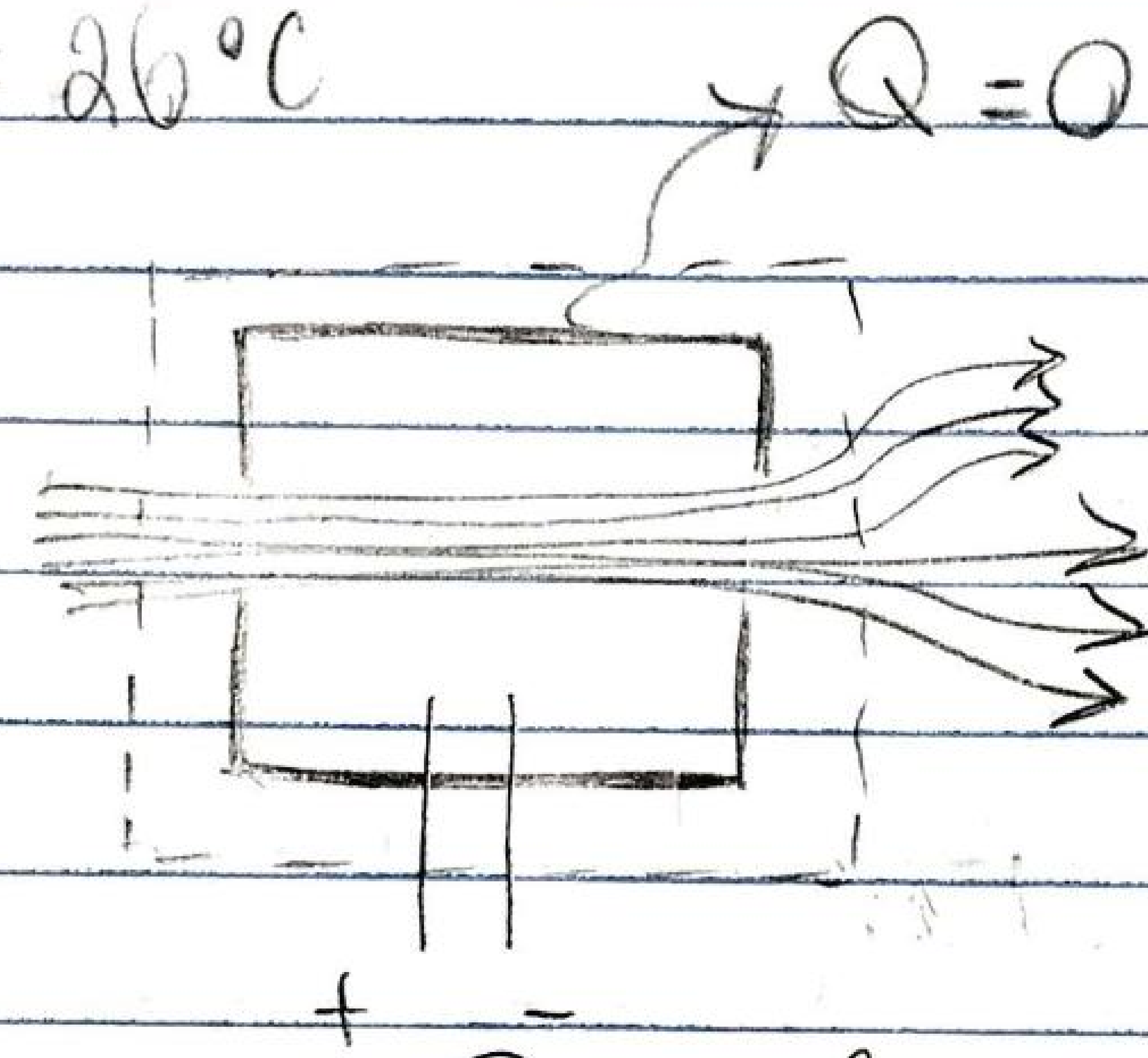
6- $\dot{m} = 10\,\frac{kg}{min} = 10\,\frac{kg}{\cancel{min}} \cdot \frac{\cancel{60\,s}}{60\,s} = \frac{1}{6}\,kg/s$

$\dot{m} = 0{,}1667\,kg/s$

$T_i = 22°C$

$T_o = 26°C$

$\Delta p \cong 0$



$P_{max} = ?$

1ª Lei da Termodinâmica para volume de controle

↳ $\frac{dE}{dt} = \cancel{\dot{Q}}^{\,0} - \dot{W} + \dot{m}(h_E - h_S)$

Entalpia: $h = u + pv \therefore h = u + \frac{p}{\rho}$

$\frac{dE}{dt} = -\dot{W} + \dot{m}(h_E - h_S)$

$\dot{W} = P_{max}$

$\frac{dE}{dt} = \dot{m}(h_E - h_S) - P_{max}$

Considerando Regime Permanente

$\frac{dE}{dt} = 0 \therefore P_{max} = \dot{m}(h_i - h_o)$

Para este caso $dh = du = c\,(T_i - T_o)$

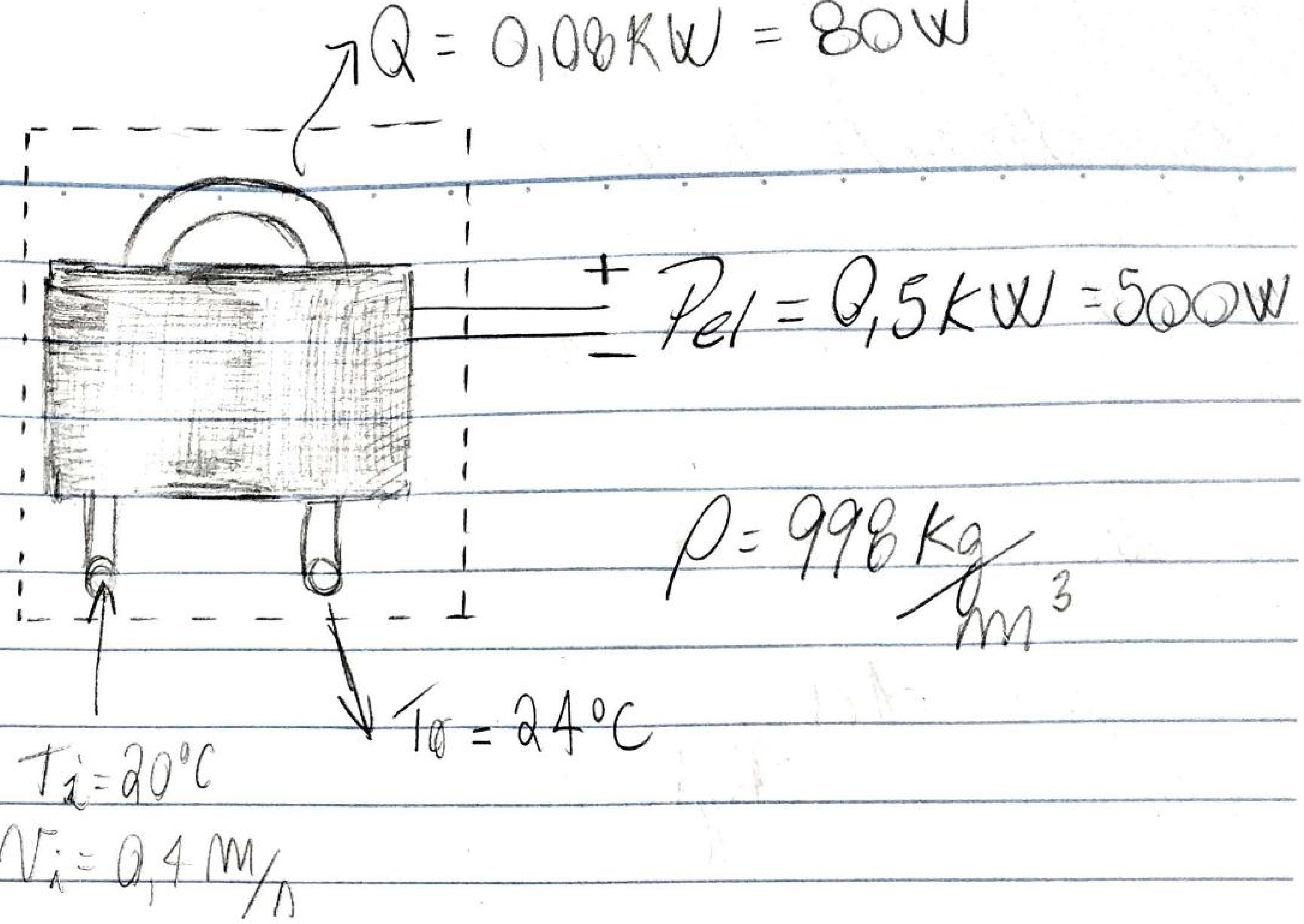
$c = 4186\ J/KgK$

$dh = c\,(22 - 26) = 4186 \cdot (-4) = -16744\ J/Kg$

$P_{max} = 0{,}1667 \cdot (16744) = 2790{,}67\ J/s$

$P_{max} \simeq \underline{\underline{2{,}8\ KW}}$

7-



Primeira Lei da Termodinâmica para Volume de Controle

$$\frac{dE}{dt} = \dot{Q} - \dot{W} + \dot{m}\,dh$$

$\frac{dE}{dt} \rightarrow 0$ (Regime Permanente)

$$\dot{W} - \dot{Q} = \dot{m}\,\Delta h = \dot{m}\,c\,\Delta T$$

$$\dot{m} = \rho V_i A = \rho \frac{V_i D^2 \pi}{4}$$

$$\dot{W} - \dot{Q} = \rho \frac{V_i D^2 \pi}{4} \cdot c\,\Delta T$$

$$D^2 = \frac{4(\dot{W} - \dot{Q})}{\rho V_i \pi c \Delta T} \therefore D = \sqrt{\frac{4(\dot{W} - \dot{Q})}{\rho V_i \pi c \Delta T}}$$

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$$D = 2\sqrt{\frac{\dot{W} - Q}{\rho v_i \pi c \Delta T}}$$

$\dot{W} = 500W$

$\dot{Q} = 80W$

$\rho = 998 \, kg/m^3$

$c = 4179 \, J/kgK$

$\Delta T = 24 - 20 = 4$

$$D = 2\sqrt{\frac{500 - 80}{998 \cdot 0{,}4 \cdot \pi \cdot 4179 \cdot 4}} \cong 8{,}9519 \times 10^{-3} m$$

$$\boxed{D \simeq 0{,}895 cm}$$