P1

a) $P_{Ai} = P_{Bi}$ $\qquad V_{Ai} = V_0 - V_{Bi}$

$$n_A = \frac{P_{Ai} V_{Ai}}{R T_{Ai}} = \boxed{248{,}05 \text{ mol}}$$

$$n_B = \frac{P_{Bi} V_{Bi}}{R T_{Bi}} = \boxed{149{,}35 \text{ mol}}$$

b) Cuasistático $\Rightarrow$ $P_A = P_B$ en todo momento

Proceso de A adiabático $\Rightarrow$ $P_{Ai} V_{Ai}^{\gamma_A} = P_{Af} V_{Af}^{\gamma_A}$

$$\Rightarrow P_{Af} = P_{Ai} \left(\frac{V_{Ai}}{V_{Af}}\right)^{\gamma_A} = P_{Bf}$$

donde $\gamma_A = \frac{7}{5}$ (diatómico) y $V_{Af} = V_0 - V_{Bf}$

$$T_{Af} = \frac{P_{Af} V_{Af}}{n_A R} \qquad T_{Bf} = \frac{P_{Bf} V_{Bf}}{n_B R}$$

A

	P(kPa)	V(m^3)	T(K)
i	150	6,5	473
f	216,6	5	525,3

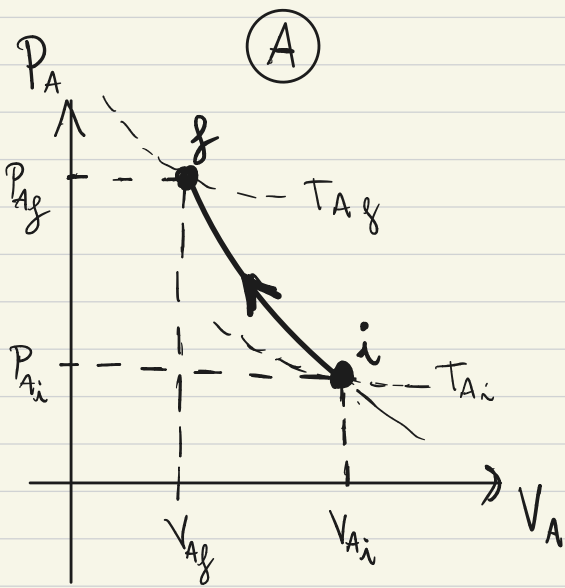
B

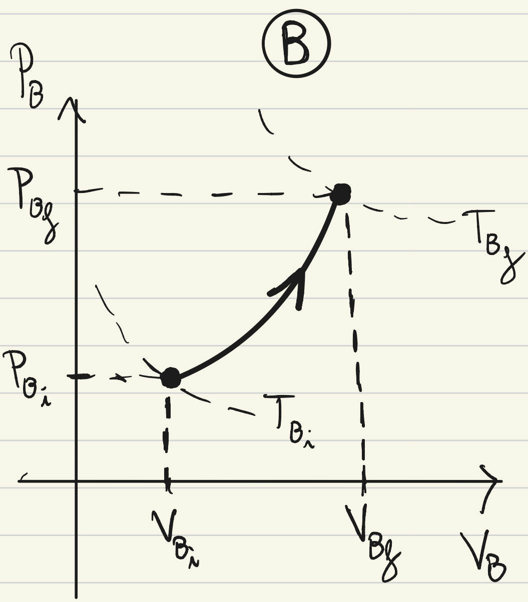
	P(kPa)	V(m^3)	T(K)
i	150	3,5	423
f	216,6	5	872,5

c) Proceso gas A → Adiabático

Proceso gas B → Politrópico

$$\boxed{P_A(V_A) = \frac{cte}{V_A^{\gamma_A}}} \quad , \quad P_A = P_B \Rightarrow \quad \boxed{P_B(V_B) = \frac{cte}{(V_0 - V_B)^{\gamma_A}}}$$





d) $\Delta U_B = Q_B + W_B \Rightarrow Q_B = \Delta U_B - W_B$

- $\Delta U_B = n_B C_{V_B} \Delta T_B = \underline{836{,}8\ kJ}$, $C_{V_B} = \frac{3}{2} R$

- $W_B = -W_A$ ($P_A = P_B$ siempre)

- $W_A = W_{adiabático} = \frac{n_A R}{\gamma_A - 1} (T_{Af} - T_{Ai}) = \boxed{269{,}7\ kJ}$

$\Longrightarrow Q_B = \Delta U_B + W_A = \boxed{1106{,}5\ kJ}$

$W_{TOT} = W_A + W_B = W_A - W_A = \boxed{0\ J}$

$$\Delta U_{TOT} = \Delta U_A + \Delta U_B \qquad \Delta U_A = \cancel{Q_A}^{0} + W_A$$

$$\Delta U_{TOT} = \cancel{W_A} + Q_B + \cancel{W_B} = Q_B$$

$$\Rightarrow \boxed{\Delta U_{TOT} = 1106,5 \text{ kJ}}$$

e) $\Delta S_u = \Delta S_A + \Delta S_B + \Delta S_{Res}$

- $\Delta S_A = 0 \rightarrow$ Adiabático

$$c_{p_B} = \frac{5}{2} R$$

- $\Delta S_B = n_B \left(c_{v_B} \ln\left(\frac{P_{Bf}}{P_{if}}\right) + c_{p_B} \ln\left(\frac{V_{Bf}}{V_{Bi}}\right)\right)$

$$= 1,79 \text{ kJ/K}$$

- $\Delta S_{Res} = -\dfrac{Q_B}{T_{Res}} = -805,9 \text{ J/K} \Rightarrow \boxed{\Delta S_u = 984,6 \text{ J/K}}$

P2

a)

	P(kPa)	V(lt)	T(K)
a	100	135	812,27
b	500	27	812,27
c	500	35	1052,95
d	129,63	135	1052,95

Estado b $\quad T_a = T_b \Rightarrow P_a V_a = P_b V_b \quad , V_a = 5 V_b$

$$\Rightarrow \quad P_b = 5 P_a = \boxed{500 \text{ kPa}}$$

$$Q_{bc} = n C_p \Delta T_{bc} = \frac{5}{2} n R (T_c - T_b) = \frac{5}{2} P_b (V_c - V_b)$$

$$\Rightarrow V_b = -\frac{2}{5} \frac{Q_{bc}}{P_b} + V_c = \boxed{27 \text{ lt}}$$

$$T_b = \frac{P_b V_b}{nR} = \boxed{812,27 \text{ K}}$$

Estado c

$$P_c = P_b \qquad T_c = \frac{P_c V_c}{nR} = \boxed{1052{,}95\ K}$$

Estado d

$$\frac{V_a}{V_b} = 5 \Rightarrow V_d = V_a = 5V_b = \boxed{135\ lt}$$

$$T_d = T_c \qquad P_d = \frac{nRT_d}{V_d} = \boxed{129{,}63\ kPa}$$

Estado a

$$T_a = T_b$$

b)

$$\overset{\text{calor absorbido}}{Q_{abs}} = Q_{bc} + Q_{cd} \quad , \quad \overset{\text{calor entregado}}{Q_{ent}} = Q_{da} + Q_{ab}$$

- $Q_{bc} = 10 \text{ kJ}$
- $Q_{cd} = -W_{cd} = nRT_c \ln\left(\frac{V_d}{V_c}\right)$ (Isotermo $\Delta U = 0$)

$$= 23{,}62 \text{ kJ}$$

- $Q_{da} = n c_v (T_a - T_d) = -6 \text{ kJ}$

- $Q_{ab} = -W_{ab} = nRT_a \ln\left(\frac{V_b}{V_a}\right)$ (Isotermo $\Delta U = 0$)

$$= -21{,}73 \text{ kJ}$$

$$\Rightarrow \boxed{Q_{abs} = 33{,}62 \text{ kJ}} \qquad \boxed{Q_{ent} = -27{,}73 \text{ kJ}}$$

$$\cancel{\Delta U}^{\,0}_{ciclo} = Q + W$$

$$\Rightarrow \quad W = -Q = -\left(Q_{abs} + Q_{ent}\right) = \boxed{-5{,}89\ kJ}$$

c) $$\eta = \frac{|W|}{|Q_{abs}|} = \boxed{17{,}52\ \%}$$

d) $$\eta_{máx} = \eta_{Carnot} = 1 - \frac{T_L}{T_H} = 1 - \frac{T_a}{T_c}$$

$$\Rightarrow \quad \boxed{\eta_{máx} = 22{,}86\ \%}$$

$$\eta_{máx} = \frac{|W_{máx}|}{|Q_{abs}|} \Rightarrow |W_{máx}| = \eta_{máx}\,|Q_{abs}| = \boxed{7{,}68\ kJ}$$

P3

a) $\Delta S_u = \cancel{\Delta S_{ciclo}}^{0} + \Delta S_{agua} + \Delta S_{amb} + \cancel{\Delta S_{\text{Fuente fría}}}^{0}$

- $\Delta S_{agua} = \int \frac{dQ_{agua}}{T_{agua}} = \int_{T_{ai}}^{T_{af}} \frac{m_a C_a \, dT}{T} - \frac{|Q_f|}{T_f}$ fusión

$$= m_a C_a \ln\left(\frac{T_{af} \to 273K}{T_{ai} \to 298K}\right) - \frac{m_a |L_f|}{T_f \to 273K} = -2{,}38 \; kJ/K$$

- $\Delta S_{amb} = \frac{|Q_H|}{T_{amb}} = \frac{|W| + |Q_L|}{T_{amb}}$

$|Q_L| = -Q_a = -m_a C_a (T_{af} - T_{ai}) + m_a |L_f| = 656{,}25 \; kJ$

$\Rightarrow \Delta S_{amb} = 2{,}42 \; kJ/K \Rightarrow \boxed{\Delta S_u = 37{,}1 \; J/K}$

b) $K_{máx} = K_{Carnot} = \dfrac{1}{\frac{T_H}{T_L} - 1} = \dfrac{1}{\frac{313K}{273K} - 1} = \boxed{6{,}825}$

Carnot es <u>reversible</u> $\Rightarrow$ $\Delta S_u = 0$

c) $|W'| = 50\ kJ \Rightarrow K' = \dfrac{|Q_L|}{|W|} = 13{,}12$

$K' > K_{Carnot} \Rightarrow$ $\boxed{\text{Es imposible}}$