Solución 2do Parcial 2do semestre 2015

Problema 1

(a) 2da Ley de Newton al pistón, según la vertical:

$$P \cdot A - mg - P_0 A = 0 \quad \Rightarrow \quad P = P_0 + \frac{mg}{A}$$

(cuasiestático → acel. $\cong 0$)

$$\boxed{P_A = 107{,}75 \text{ kPa}}$$

Ec. de estado $P_A V_A = nRT_A$

$$V_A = \frac{nRT_A}{P_A} \rightarrow \boxed{V_A = 0{,}035 \text{ m}^3}$$

(b) (I) Pistón alcanza los topes a $P = CTE$

$$T = \frac{PV}{nR} \rightarrow T = 515{,}5 \text{ K}$$

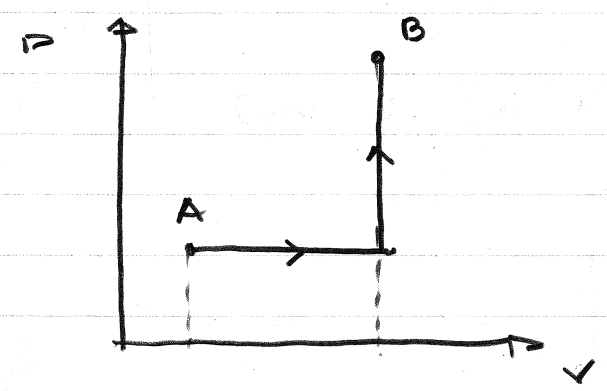
$$Q = nC_p(T - T_A)$$

$$C_p = \frac{7}{2}R$$

$$\boxed{Q = 9{,}4 \text{ KJ}}$$

(II) $Q = 10 \text{ KJ} > 9{,}4 \text{ KJ}$

Pistón alcanza los topes y aumenta su temp. a $V = CTE$



→ Trabajo

$W_{AB} = P_A (V_B - V_A) \rightarrow$ **$W_{AB} = 2{,}68$ kJ**

↓

Efectuado por el gas.

→ 1ra Ley proceso AB

$\Delta U_{AB} = Q_{AB} - W_{AB} = 7{,}32$ kJ

$\Delta U_{AB} = n C_V (T_B - T_A) \rightarrow$ **$T_B = 534{,}8$ K**

Ec de estado $P_B V_B = nRT_B$

$$P_B = \frac{nRT_B}{V_B} \rightarrow \boxed{P_B = 111{,}2 \text{ kPa}}$$

(C) Gas en equilibrio térmico con la fuente $T_C = T_L$
Además $P_C = P_A$:

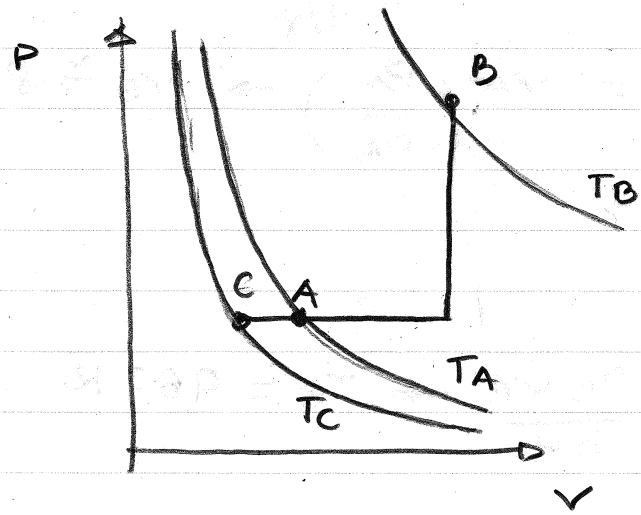
$$T_C = \frac{P_C V_C}{nR} \rightarrow T_L = 257{,}8 \text{ K}$$

1ra Ley Proceso BC

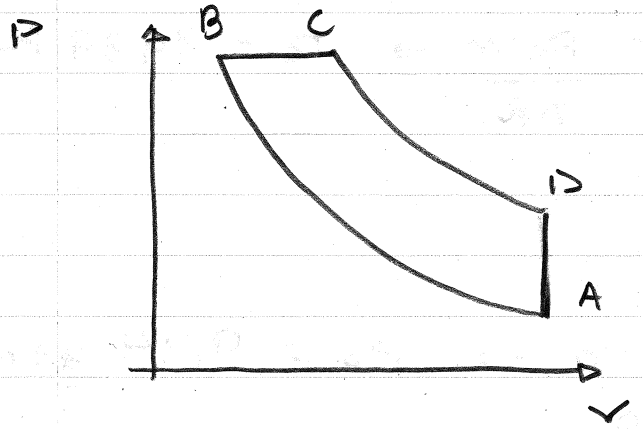
$$nC_V (T_C - T_B) = Q_{BC} - P_C (V_C - V_B)$$

→ **$Q_{BC} = -11{,}9$ kJ**
$Q_{Fuente} = -Q_{BC}$

(d)



Problema 2



AB adiabática

CD isotérmica

$T_A = 293\ K$

$P_A = 1{,}5\ atm$

$V_C = 2\,V_B$

$P_B = P_C = 30\ atm$

$R = 8{,}3145\ \frac{Pa.m^3}{mol.K}$

$1\ atm - 101{,}3\ kPa$

$1\ m^3 - 1000\ L$

$\Big\}$ $R = 0{,}082\ \frac{atm.L}{mol.K}$.

(a) $V_A = \frac{nRT_A}{P_A} \rightarrow V_A = 48\ L$.

Proceso AB

$$P_A V_A^{\gamma} = P_B V_B^{\gamma} \rightarrow V_B = V_A \left(\frac{P_A}{P_B}\right)^{1/\gamma} \rightarrow V_B \cong 8\,L$$

$$\left(\gamma = \frac{C_P}{C_V} = \frac{5}{3}\right)$$

$$\text{E.C de estado} \rightarrow T_B = \frac{P_B V_B}{nR} \rightarrow T_B = 969\,K$$

Proceso BC

$$\left.\begin{array}{l} V_C = 2V_B = 16\,L \\ P_C = 30\ atm \end{array}\right\} \quad T_C = \frac{P_C V_C}{nR} \rightarrow T_C = 1939\,K$$

Proceso CD

$$P_C V_C = P_D V_D \rightarrow P_D = \frac{P_C V_C}{V_D} \rightarrow P_D = 9{,}94\ atm$$

$$(V_D = V_A)$$

→ Resumen

Estado	P(atm)	V(L)	T(K)
A	1,5	48	293
B	30	8	969
C	30	16	1939
D	9,94	48	1939

(b) Proceso AB – adiabático

$$W_{AB} = \frac{P_B V_B - P_A V_A}{\gamma - 1} \rightarrow W_{AB} = 25{,}8\ kJ$$

$Q_{BC} = 0$ (adiabático)

$\Delta U_{AB} = W_{AB}$

Proceso BC – isobaro

$W_{BC} = -P_B (V_C - V_B) = -24{,}3\ kJ$

$Q_{BC} = n C_p (T_C - T_B) = 60{,}5\ kJ$

$\Delta U_{BC} = Q_{BC} + W_{BC} = 36{,}2\ kJ$

Proceso CD – isotérmico

$W_{CD} = -nRT_C \ln(V_D / V_C) = -53{,}2\ kJ$

$\Delta U_{CD} = 0$ ($T = cte$)

$Q_{CD} = -W_{CD}$

Proceso DA – isocoro.

$W_{DA} = \emptyset$ ($V = cte$)

$Q_{CD} = n C_v (T_A - T_D) = -61{,}6\ kJ$

$\Delta U_{CD} = Q_{CD}$

→ Resumen

Proceso	ΔU (KJ)	Q (KJ)	W (KJ)
AB	25,8	0	25,8
BC	36,2	60,5	-24,3
CD	0	53,2	-53,2
DA	61,6	-61,6	0

(b) $W_{TOTAL} = 51,7\ KJ$
$Q_{ABSOR} = 113,7\ KJ$ } $\eta = 45,5\ \%$

Problema 3

Aluminio
↓ Q_H
↻ ← W
↓ Q_L
Mercurio

(a)

$Q_H = m_{AL} L_{F,AL} = 397\ J$
$Q_L = m_{Hg} L_{F,Hg} = 177\ J$

$W = Q_H - Q_L = 220\ J$

(b) $\eta = \frac{W}{Q_H} \rightarrow \eta = 55,4\ \%$

(c) $\Delta S_u = \Delta S_{FUENTES} = \frac{Q_L}{T_{Hg}} - \frac{Q_H}{T_{AL}}$

$\Delta S_u = 0,33\ J/K > 0$ NO se viola la 2da Ley

(d) El máx rendimiento es el de una MT de Carnot

$\eta_c = 1 - \frac{T_{Hg}}{T_{AL}} \rightarrow \eta_c = 74,9\ \%$