Ejercicios Bellavista.

8.1

a) $W = 200\,J > 0$ lo hace el sistema
$Q = 1000\,cal > 0$ absorbe el sistema

$$\Delta U = Q - W = 1000\,cal - 200\,J = 1000\,cal \cdot \frac{4.19\,J}{1\,cal} - 200\,J = 3990\,J$$

b) $W = -200\,J$ (recibe) $\quad \Delta U = Q - W = -(-200\,J) = 200\,J$
Con $Q = 0\,cal$.

c) $Q = -500\,cal \rightarrow$ cede
$W = -200\,J \rightarrow$ recibe

$$\Delta U = Q - W = -500\,cal - 200\,J = -500\,cal \cdot \frac{4.19\,J}{1\,cal} - 200\,J = 1895\,J$$

8.2

inicial
$p_i = 6\,kp/cm^2$
$V_i = 125\,cm^3$
T_i?

$V = cte$ ⇒

$p_f = 25\,kp/cm^2$
$V_f = 125\,cm^3$
$T_f = 1200\,k.$

$\gamma = 1.4$

Si $V = cte$
$\Delta U = Q - W$
$\Delta U = Q \quad | W = 0$

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*) a $V = cte$ se cumple que $\frac{P_i}{T_i} = \frac{P_f}{T_f} \Rightarrow$

$$T_i = T_f \frac{P_i}{P_f} = 1200\,k \cdot \frac{6\,kp/cm^2}{25\,kp/cm^2} = 288\,k$$

*) $\Delta U = n C_v \Delta T = \frac{nR}{\gamma - 1} \Delta T = \frac{P_i V_i}{T_i} \frac{1}{\gamma - 1} \Delta T = (\star)$

Como $C_p / C_v = \gamma$ y $C_p - C_v = R \Rightarrow C_v = \frac{R}{\gamma - 1}$ // $pV = nRT \Rightarrow nR = \frac{PV}{T}$

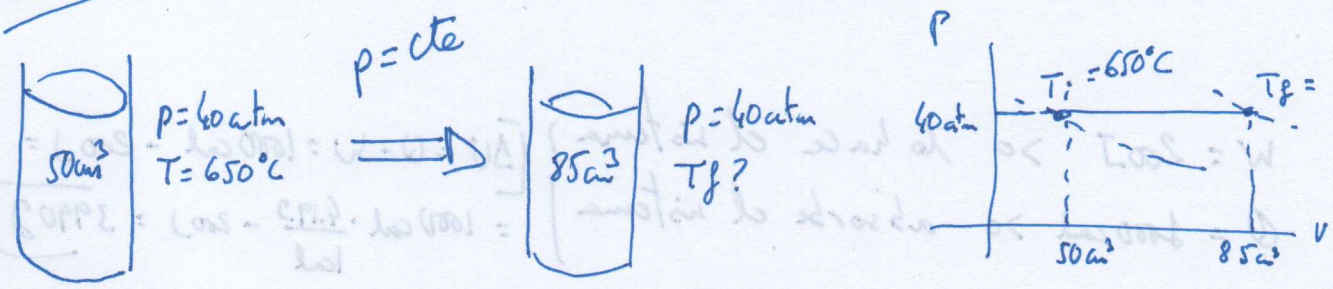
$$(\star) = \frac{6\,kp/cm^2 \cdot 125\,cm^3}{288\,k} \frac{1}{1.4 - 1} \cdot (1200\,k - 288\,k) = 5937{,}5\,kp \cdot cm$$

$$\Delta U = 5937{,}5\,kp \cdot cm = 5937{,}5\,kp\,cm \frac{9{,}8\,N}{1\,kp} \cdot \frac{1\,m}{100\,cm} \cdot \frac{1\,cal}{4.19\,J} = 138{,}87\,cal$$

(J = Julio)

$$Q = \Delta U = 138{,}87\,cal$$

8.3



a) $W = p\Delta V = 40\,atm \cdot (85\,cm^3 - 50\,cm^3) = 1400\,atm \cdot cm^3$

$= 1400\,atm \cdot cm^3 \cdot \frac{101325\,Pa}{1\,atm} \cdot \frac{1\,m^3}{10^6\,cm^3} = 141,86\,J$ } Trabajo a p=cte

b) $\frac{T_i}{V_i} = \frac{T_f}{V_f} \Rightarrow T_f = T_i \cdot \frac{V_f}{V_i} = (650\,°C + 273.15) \cdot \frac{85\,cm^3}{50\,cm^3} = 1569,36\,k$

($650\,°C + 273.15 = 923,15\,k$)

$\Delta U = n\,C_v\,\Delta T = \frac{p_i \cdot V_i}{R \cdot T_i} \cdot C_v \cdot (T_f - T_i) =$

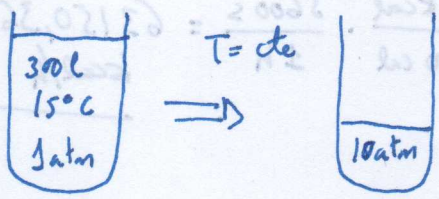
$n = \frac{p_i V_i}{R T_i} = \frac{40\,atm \cdot 50\,cm^3}{923.15\,k} \cdot \frac{3\,cal/(k\,mol)}{2\,cal/(k\,mol)} \cdot (1569,36k - 923,15k) =$

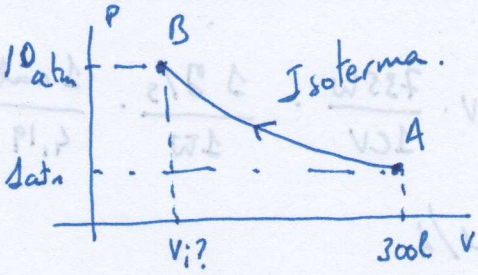
$\Delta U = 2100\,atm \cdot cm^3$

$\Delta U = 2100\,atm \cdot cm^3 \cdot \frac{101325\,Pa}{1\,atm} \cdot \frac{1\,m^3}{10^6\,cm^3} = 212,78\,J$

$Q = \Delta U + W = 212,78\,J + 141,86\,J = 354,6\,J$

8.4





*) En una isoterma $\Delta U = Q - W = 0 \Rightarrow \boxed{Q = W}$ y $\boxed{pV = cte}$

*) $dW = p\,dV = nRT\frac{dV}{V} \Rightarrow W = nRT \ln\left(V_2/V_1\right)$

$W = nRT \ln\left(P_1/P_2\right) = p_1 \cdot V_1 \ln\left(P_1/P_2\right)$

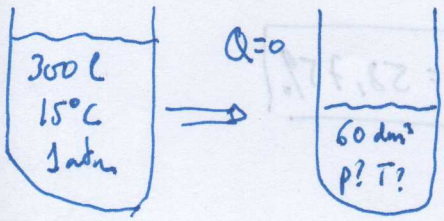
$W = p_1 V_1 \ln\left(P_1/P_2\right) = 1\,atm \cdot 300\,l \cdot \ln\left(\frac{1\,atm}{10\,atm}\right) = -690{,}78\,atm\,l \cdot \frac{8{,}31\,J}{0{,}082\,atm\,l} = \boxed{-70004{,}6\,J}$

$= -70{,}005 \cdot 10^3\,J$

$Q = W = \boxed{-70004{,}6\,J}$

Le hace un trabajo contra el sistema, comprimiéndolo y éste cede calor. $W < 0$ y $Q < 0$

8.5

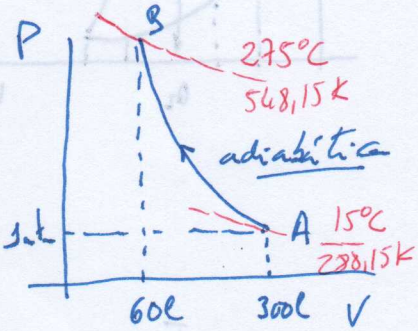


$T_i = 15°C = 288{,}15\,k$

*) Si $Q = 0 \Rightarrow \Delta U = -W$

*) $\Delta U = n C_v \Delta T$

*) $pV^\gamma = cte$ o $TV^{\gamma-1} = cte$.



$\left[T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1} = 288{,}15k \cdot \left(\frac{300l}{60l}\right)^{0.4} = \underline{548{,}15\,k}\right.$

$\underline{T_2 = 275°C}$

*) $\underline{\Delta U} = n C_v \Delta T = \frac{pV}{RT}\frac{R}{\gamma-1}(T_f - T_i) = \frac{P_i V_i}{T_i}\frac{1}{\gamma-1}(T_f - T_i) =$

$= \frac{1atm \cdot 300\,l}{288{,}15k} \cdot \frac{1}{1{,}4-1} \cdot (548{,}15k - 288{,}15k) = \underline{676{,}7\,atm\,l}$

$\Delta U = 676{,}7\,atm\,l \cdot \frac{8{,}31\,J}{0{,}082\,atm\,l} = \boxed{68577{,}8\,J}$

$\boxed{W = -\Delta U = -68577{,}8\,J}$

$n = \frac{PV}{RT}$

$C_p/C_v = \gamma \quad C_p - C_v = R \quad \gamma C_v - C_v = R \quad C_v = \frac{R}{\gamma-1}$

8.6

$$P_{motor} = \frac{W}{t} = 100\,CV \cdot \frac{735\,W}{1\,CV} \cdot \frac{1\,J/s}{1\,W} \cdot \frac{1\,cal}{4{,}19\,J} \cdot \frac{1\,kcal}{1000\,cal} \cdot \frac{3600\,s}{1\,h} = \boxed{63150{,}36\ kcal/h}$$

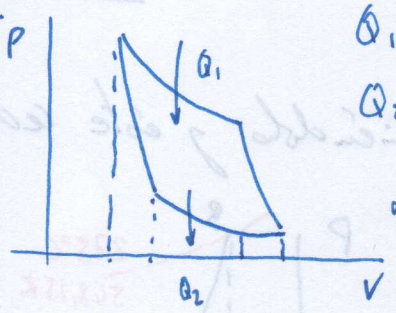
$P_{foco\ cal.} = 200\,000\ kcal/h.$

$$\eta = \frac{W}{Q_1} = \frac{P_{motor}}{P_{foco\ cal.}} = \frac{63150{,}36\ kcal/h}{200\,000\ kcal/h} = 0{,}316 \qquad \eta(\%) = \underline{31{,}6\%}$$

$$\frac{W}{t} = \frac{|Q_1| - |Q_2|}{t} \Rightarrow \boxed{\frac{|Q_2|}{t} = \frac{|Q_1|}{t} - W = 136849{,}6\ kcal/h}$$

$\boxed{P_{foco\ frío} = -136849{,}6\ kcal/h.}$ Potencia (calor por unidad de tiempo) cedida al foco frío por hora.

8.7



$Q_1 = 1000\ kcal \qquad T_1 = 650k$

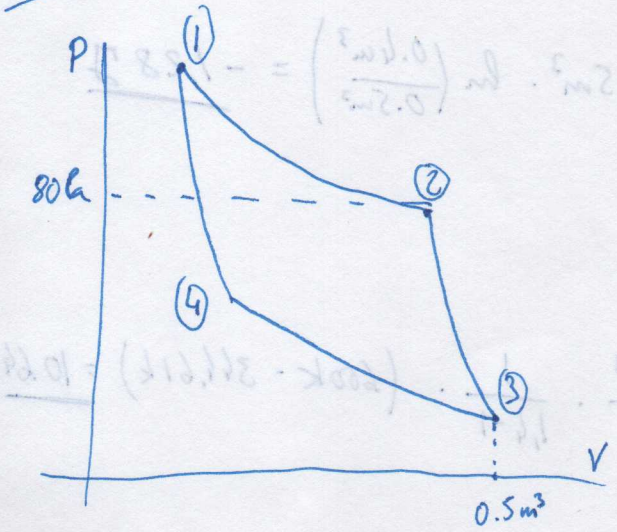
$Q_2 = 480\ kcal$

a) $\boxed{\eta = 1 - \frac{|Q_2|}{|Q_1|} = 1 - \frac{480\,kcal}{1000\,kcal} = 0.52 \qquad \eta(\%) = 52\%}$

b) $\eta = 1 - \frac{T_2}{T_1} \Rightarrow \boxed{T_2 = T_1(1-\eta) = 650k \cdot (1 - 0.52) = 312\,k = 38{,}85°C}$

c) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{(-5°C + 273{,}15)}{650k} = 0.5875 \qquad \boxed{\eta(\%) = 58{,}75\%}$

8.8



*) $p_1 = 100\,Pa \quad V_1 = 0.1\,m^3 \quad T_1 = 600\,k$

*) $V_3 = 0.5\,m^3$

*) $p_2 = 80\,Pa$

$\gamma = 1.4$

$C_p/C_v = \gamma$

$C_p - C_v = R \quad C_v = \frac{R}{\gamma - 1}$

a)

	P	V	T	
1	100 Pa	$0.1\,m^3$	600 k	↓ isoterma
2	80 Pa	$0,125\,m^3$	600 k	↓ adiabática
3	11,48 Pa	$0.5\,m^3$	344,61 k	↓ isoterma
4	~~11,48 Pa~~ 14,36 Pa	$0,4\,m^3$	344,61 k	

a)

Calculo V_2 (isoterma) $p_1 V_1 = p_2 V_2$ $\quad V_2 = \frac{p_1 V_1}{p_2} = \frac{100\,Pa \cdot 0.1\,m^3}{80\,Pa} = \underline{0.125\,m^3}$

Calculo T_3 (adiabática) $TV^{\gamma-1} = cte$ $\quad T_3 = T_2 \left(\frac{V_2}{V_3}\right)^{\gamma-1} = 600k \cdot \left(\frac{0.125\,m^3}{0.5\,m^3}\right)^{0.4} = \underline{344,61\,k}$

Calculo P_3 (adiabática) $pV^{\gamma} = cte$ $\quad p_3 = p_2 \left(\frac{V_2}{V_3}\right)^{\gamma} = 80\,Pa \cdot \left(\frac{0.125\,m^3}{0.5\,m^3}\right)^{1,4} = \underline{11,48\,Pa}$

Calculo V_4 (isoterma) } → $TV^{\gamma-1} = cte$ $\quad T_1 V_1^{\gamma-1} = T_4 V_4^{\gamma-1} \Rightarrow V_4 = V_1 \left(\frac{T_1}{T_4}\right)^{\frac{1}{\gamma-1}}$

No con la adiabática en el punto 1.

$V_4 = 0.1\,m^3 \cdot \left(\frac{600k}{344,61k}\right)^{\frac{1}{\gamma-1}} = 0.399\,m^3 \simeq \underline{0.4\,m^3}$ ($\frac{1}{\gamma-1} = 2.5$)

Calculo p_4 (adiabática con 1) $p_4 = p_1 \left(\frac{V_1}{V_4}\right)^{\gamma} = 100\,Pa \cdot \left(\frac{0.1\,m^3}{0.4\,m^3}\right)^{1.4} = \underline{14,36\,Pa}$

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b) (12) isoterma $\Delta V_{12} = 0$ $\quad W_{12} = Q_{12} = nRT \ln\left(V_2/V_1\right) = p_1 V_1 \ln\left(V_2/V_1\right) =$

$= 100\,Pa \cdot 0,1\,m^3 \cdot \ln\left(\frac{0.125\,m^3}{0.1\,m^3}\right) = \underline{2,23\,J}$

(23) adiabática; $Q = 0 \quad \Delta V = -W$

$\Delta V_{23} = n C_v \Delta T = \frac{p_2 V_2}{T_2} \frac{1}{\gamma - 1} (T_3 - T_2) = \frac{80\,Pa \cdot 0.125\,m^3}{600k} \cdot \frac{1}{1,4-1} \cdot (344,61 - 600k) = \underline{-10.64\,J}$

$\boxed{W_{23} = -\Delta V_{23} = 10.64\,J}$

(34) isoterma. $\Delta U = 0$.

$W_{34} = Q_{34} = P_3 V_3 \ln\left(V_4/V_3\right) = 11{,}48\,Pa \cdot 0{,}5\,m^3 \cdot \ln\left(\frac{0.4\,m^3}{0.5\,m^3}\right) = -1{,}28\,J$

negativo Q_{34}; lo cede el sistema.

(41) adiabática $Q_{41} = 0$

$\Delta U_{41} = \frac{P_1 V_1}{T_1} \frac{1}{\gamma - 1}\left(T_1 - T_4\right) = \frac{100\,Pa \cdot 0{,}1\,m^3}{600\,K} \cdot \frac{1}{1{,}4 - 1} \cdot (600\,K - 344{,}61\,K) = 10.64\,J$

$W_{41} = -\Delta U_{41} = -10.64\,J$

———o———

c) $W = W_{12} + W_{23} + W_{34} + W_{41} = 2{,}23\,J + 10.64\,J - 1{,}28\,J - 10{,}64\,J = 0{,}95\,J$

$Q_{neto} = Q_{12} + Q_{34} = 2{,}23\,J - 1{,}28\,J = 0{,}95\,J$

Se cumple que $\left|W = |Q_{12}| - |Q_{34}| = |Q_1| - |Q_2|\right| = 0.95\,J.$

$\eta = 1 - \frac{|Q_2|}{|Q_1|} = 1 - \frac{|Q_{34}|}{|Q_{12}|} = 1 - \frac{1{,}28\,J}{2{,}23\,J} = 0{,}426$ | 42,6 %

o bien $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{344{,}61\,K}{600\,K} = 0{,}426$

———o———

$\Delta U = \Delta U_{12} + \Delta U_{23} + \Delta U_{34} + \Delta U_{41} = 0\,J - 10.64\,J + 0\,J + 10.64\,J = 0$

En ciclo; la variación de energía interna es cero.