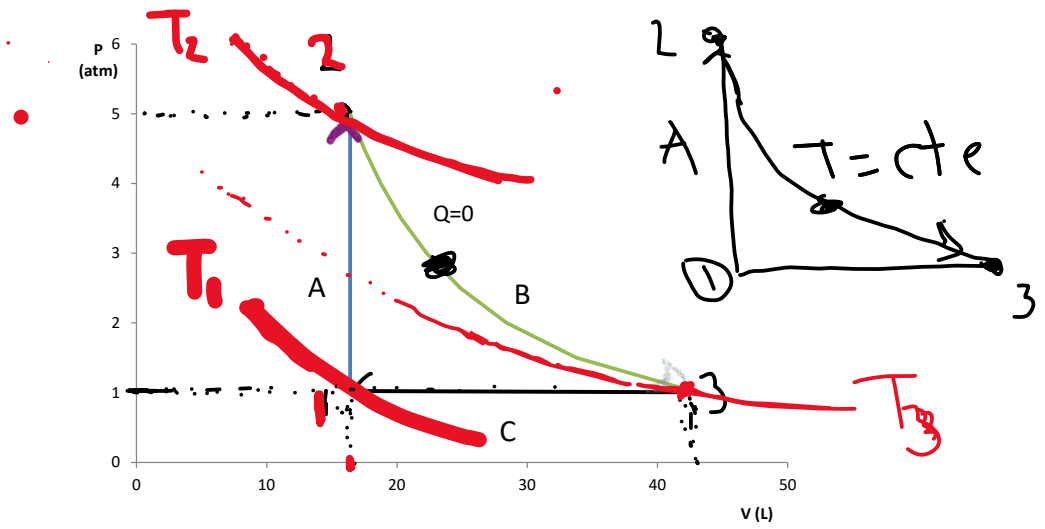
TERMODINAMICA (1212)
CICLO

Semestre 2021-1 26-ene-2021

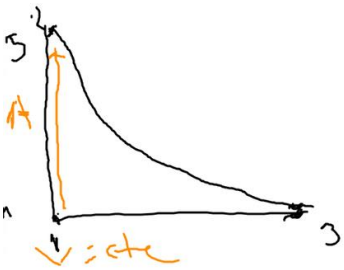
1. Dos moles de argón, que ocupan un volumen de 16.4 litros, realizan el ciclo reversible mostrado abajo. Calcular Q, W, ΔU, ΔH y ΔS para cada una las etapas y para el ciclo completo. Ordena tus resultados en las tablas.



Punto	P (atm)	V (L)	T (K)
1	1	16.4	100
2	5	16.4	500
3	1		262.15

	PROCESO	Q	W	ΔU	ΔH	ΔS
A	ISOCÓRICO	9976.8 J	0	9976.8 J	16628 J	40.14 J/K
B	ADIABÁTICO	0	-5932.45 J	-5932.45 J	-9887.42 J	0
C	ISOBÁRICO	-6740.57 J	2696.24 J	-4044.34 J	-6740.57	-40.06 J/K
CICLO	CICLO	3236.23 J	-3236.21 J	0	0	0

$\Delta U_c = Q_c + W_c$ $\quad W_c = -Q_c$



Datos

$n = 2\,mol$

Ar monoatómico

$C_v = \frac{3}{2}R$

$C_p = \frac{5}{2}R$

$\gamma = 1.4$

$V_1 = 16.4\,L$

$P_1 V_1 = nRT_1 \quad T_1 = \frac{P_1 V_1}{nR}$

$T_1 = \frac{(1\,atm)(16.4\,L)}{(0.082\,\frac{atm\,L}{mol\,K})(2\,mol)} = 100\,K$

Estado 2 Isocórico $1 \rightarrow 2$ LIGL

$V_2 = 16.4\,L$

$n = 2\,mol$

$P_2 = 5\,atm$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$T_2 = \frac{P_2 T_1}{P_1} = \frac{(5\,atm)(100\,K)}{1\,atm}$

$T_2 = 500\,K$

Estado 3

$P_3 = 1\,atm$

$P_2 = 5\,atm$

$T_2 = 500\,K$

Aclaración

$\gamma = 1.67$

Monoatómico

$2 \rightarrow 3$ adiabático $Q = 0$

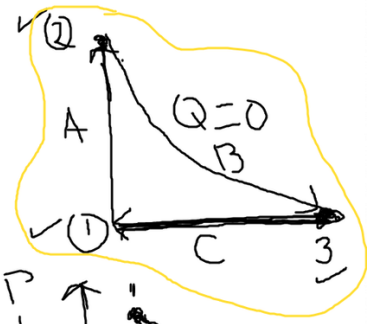
$P \downarrow \quad T \uparrow$

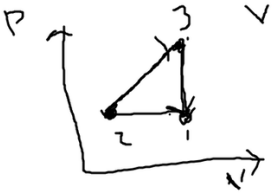
$P \uparrow \quad T \downarrow$

$P \leftrightarrow T$

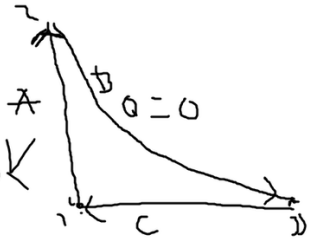
$\left(\frac{T_f}{T_i}\right)^{\gamma} = \left(\frac{P_f}{P_i}\right)^{\gamma-1} \cdot \left(\frac{T_3}{T_2}\right)^{\gamma} = \left(\frac{P_3}{P_2}\right)^{\gamma-1}$

$T_3 = \left[\left(\frac{P_3}{P_2}\right)^{\frac{\gamma-1}{\gamma}}\right] T_2$





$$T_3 = \left[\left(\frac{1\,atm}{5\,atm}\right)^{\frac{(1.67-1)}{1.67}}\right] 500\,K = 262.15\,K$$



$$P_3 V_3 = n R T_3 \qquad V_3 = \frac{n R T_3}{P_3} = \frac{(2\,mol)(0.082\,\frac{L\,atm}{mol\,K})(262.15\,K)}{1\,atm}$$

$$V_3 = 43\,L$$

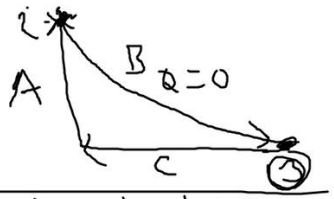
Proceso A isocórico $V = cte$

$W = 0$ $V = cte$ $\Delta U = n C_v (T_f - T_i) = n C_v (T_2 - T_1)$

$\Delta U = Q$ $\Delta U = (2\,mol)(3/2)(8.314\,J/mol\,K)(500-100)\,K$

$C_v = 3/2 R$ $\Delta U = 9976.8\,J$

$C_p = 5/2 R$



$\Delta H = n C_p (T_f - T_i)$

$\Delta H = n C_p (T_2 - T_1)$

$\Delta H = (2\,mol)(5/2)(8.314\,J/mol\,K)(500-100)\,K$

$\Delta H = 16628\,J$

$\Delta S = n C_v \ln \frac{T_f}{T_i}$

$\Delta S = n C_v \ln \frac{T_2}{T_1}$

$\Delta S = (2\,mol)(3/2)(8.314\,J/mol\,K) \ln\left(\frac{500\,K}{100\,K}\right)$

$\Delta S = 40.14\,J/K$

Proceso B (2 → 3) adiabático

$Q = 0$ $\Delta U = -W$

$\Delta U = n C_v (T_f - T_i)$

$\Delta U = n C_v (T_3 - T_2)$

$\Delta U = (2\,mol)(3/2)(8.314\,J/mol\,K)(262.15-500)\,K$

$\Delta U = -5932.4\,J$

$\Delta U = W$

$W = -5932.4\,J$

$\Delta H = nC_p(T_f - T_i)$

$\Delta H = nC_p(T_3 - T_2)$

$\Delta H = (2\text{mol})(5/2)(8.314\ J/\text{mol K})(262.15 - 500)K$

$\Delta H = -1989.25\ J$

$\Delta S = \emptyset \quad dS = \frac{\delta Q_{rev}}{T}$ ($\delta Q \to 0$)

$dS = 0$

Proceso C isobárico
P = cte $\quad \Delta H = Q_p$

$\Delta U = nC_V(T_f - T_i)$

$\Delta U = nC_V(T_1 - T_3)$

$\Delta U = (2\text{mol})3/2(8.314\ J/\text{mol K})(100 - 262.15)K$

$\Delta U = -4044.3\ J$

$\Delta H = nC_p(T_f - T_i) = nC_p(T_1 - T_3)$

$\Delta H = (2\text{mol})5/2(8.314\ J/\text{mol K})(100 - 262.15)K$

$\Delta H = -6740.58\ J$

$\Delta U = Q + W \quad Q = \Delta H$

$W = \Delta U - Q$

$W = (-4044.34 - (-6740.58))\ J$

$W = 2696.24\ J$

$\Delta S = nC_p \ln \frac{T_f}{T_i} = nC_p \ln \frac{T_1}{T_3}$

$\Delta S = (2\text{mol})5/2(8.314\ J/\text{mol K}) \ln \frac{100K}{262.15K}$

$\Delta S = -40.06\ J/K$