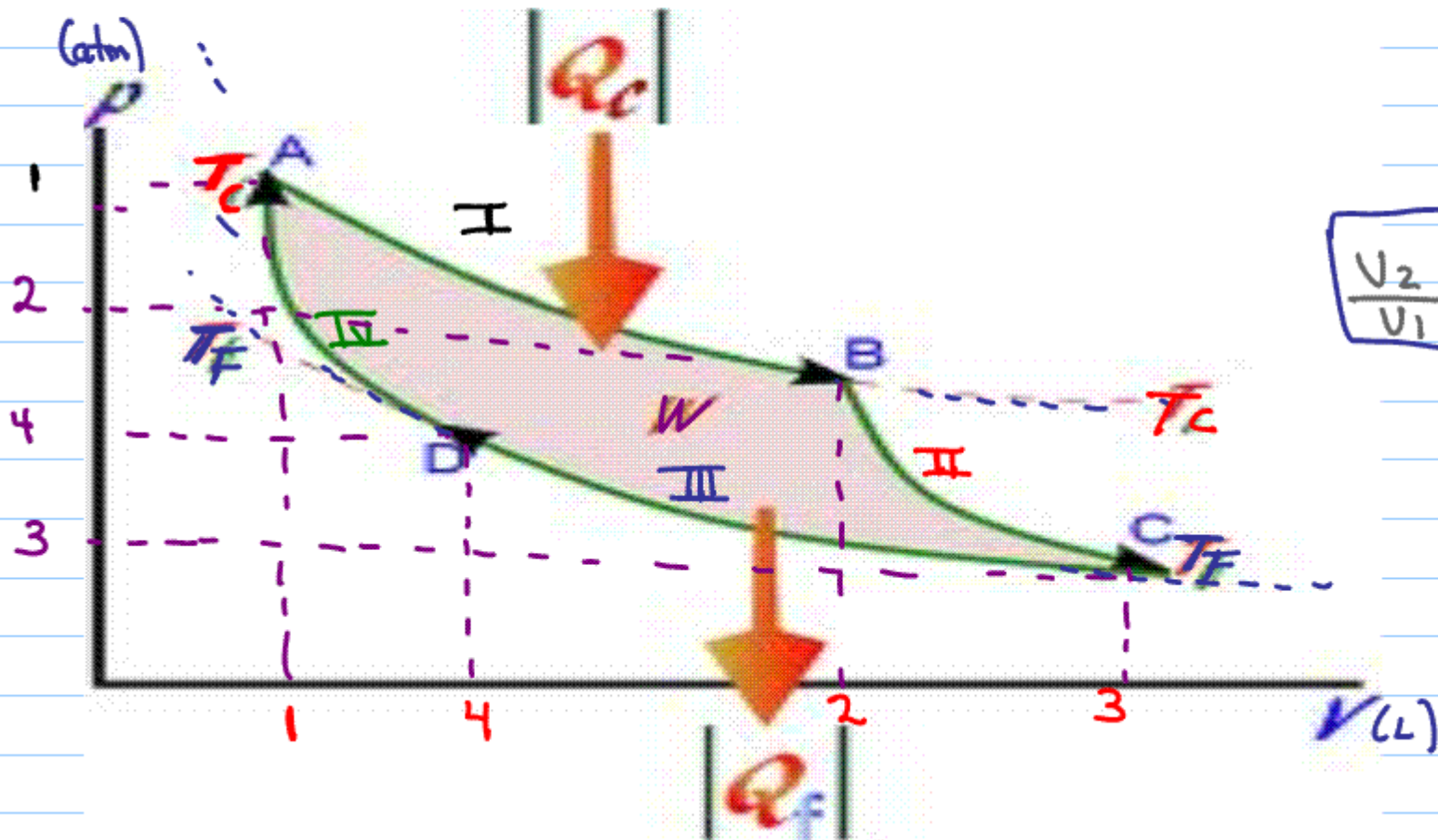


Clase 20 3 Septiembre 2014

Título de la nota

03/09/2014

Ciclo de Carnot

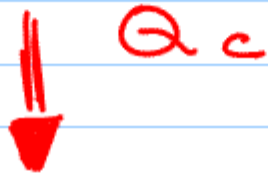


✓

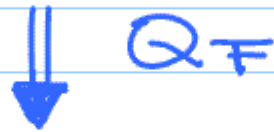
$$\frac{V_2}{V_1} = \frac{V_3}{V_4}$$

Maquina Tipo Carnot (Térmica)

Fte caliente $T_C = T_A$



Maquina \longrightarrow Wciclo



Fte Fria $T_F = T_B$

Bosquejo preliminar

I
 $n_1 \rightarrow n_2 = \text{cte}$

II
 $n_2 \rightarrow n_3 = \text{cte}$

III
 $n_3 \rightarrow n_4 = \text{cte}$

IV
 $n_4 \rightarrow n_1 = \text{cte}$

$$T_1 \rightarrow T_2 = \text{cte}$$

$$T_2 \rightarrow T_3 \downarrow$$

$$T_3 \rightarrow T_4 = \text{cte}$$

$$T_4 \rightarrow T_1 \uparrow$$

$$v_1 \rightarrow v_2 \uparrow$$

$$v_2 \rightarrow v_3 \uparrow$$

$$v_3 \rightarrow v_4 \downarrow$$

$$v_4 \rightarrow v_1 \downarrow$$

$$p_1 \rightarrow p_2 \downarrow$$

$$p_2 \rightarrow p_3 \downarrow$$

$$p_3 \rightarrow p_4 \uparrow$$

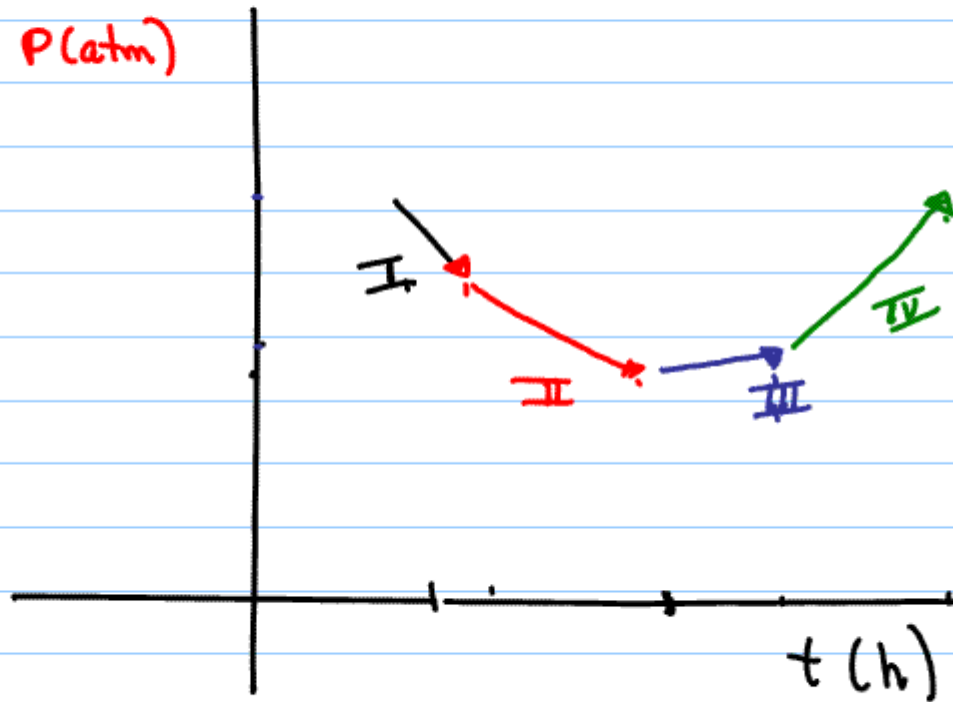
$$p_4 \rightarrow p_1 \downarrow$$

✓
 $v_3 > v_2 > v_4 > v_1$

✓
 $p_1 > p_2 > p_4 > p_3$

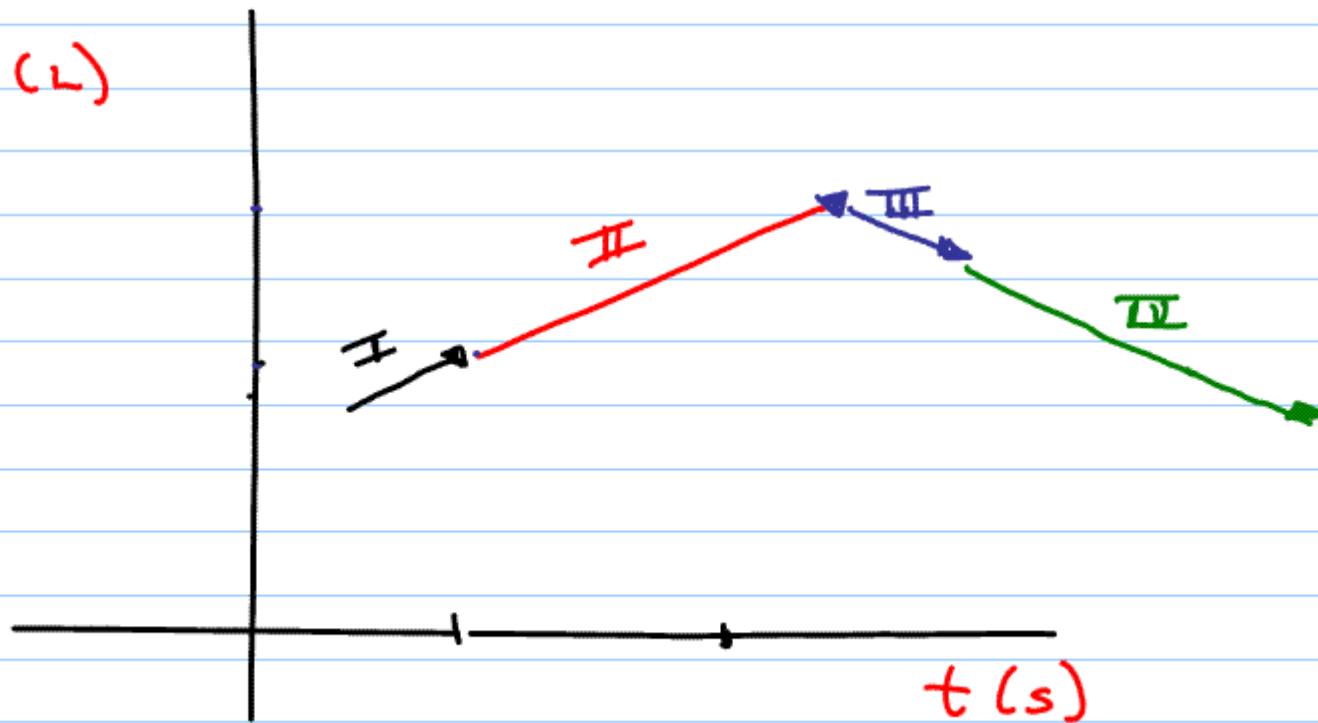
✓
 $T_1 = T_2 > T_3 = T_4$

Diagramas Adicionales grado de avance

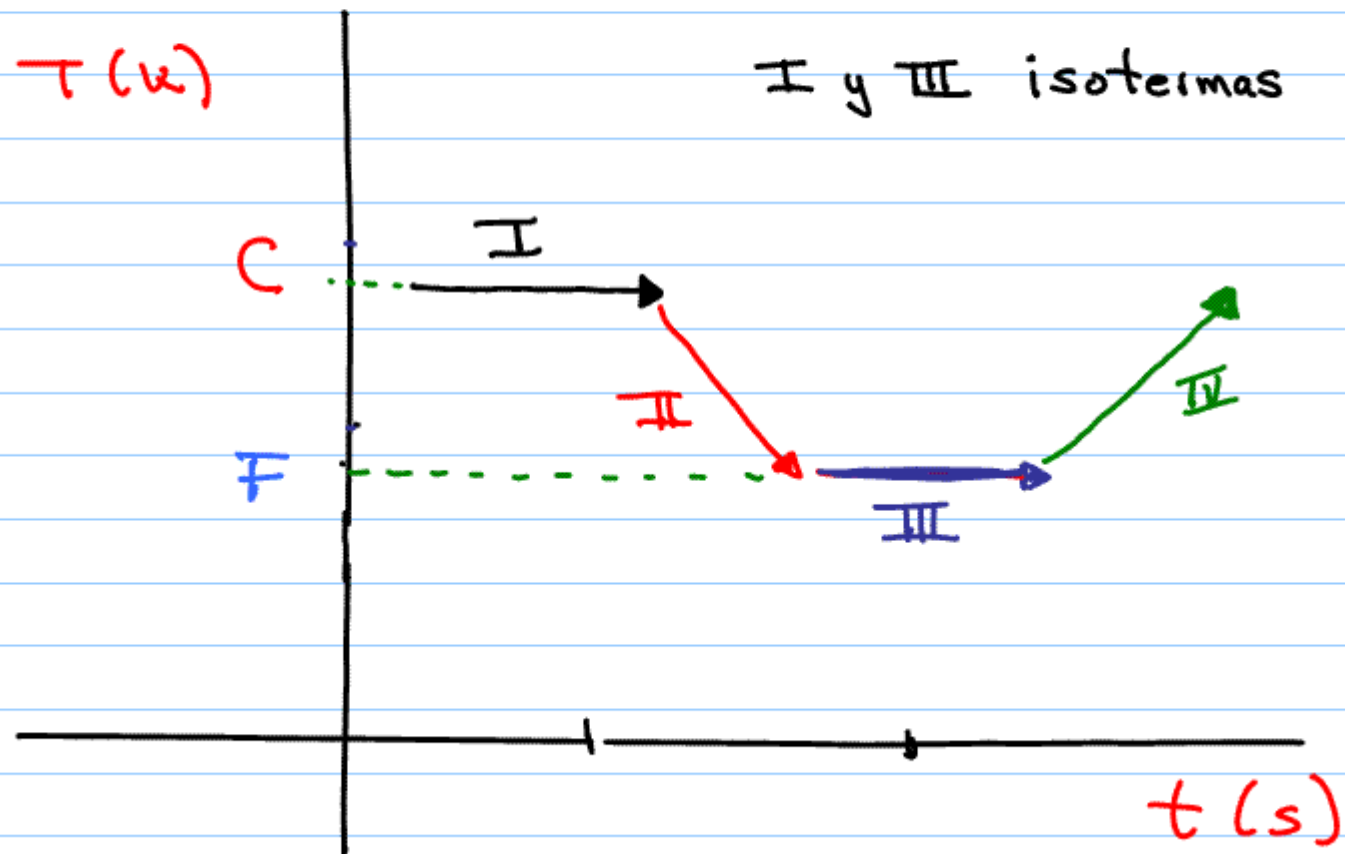


Gráficos de grado de avance

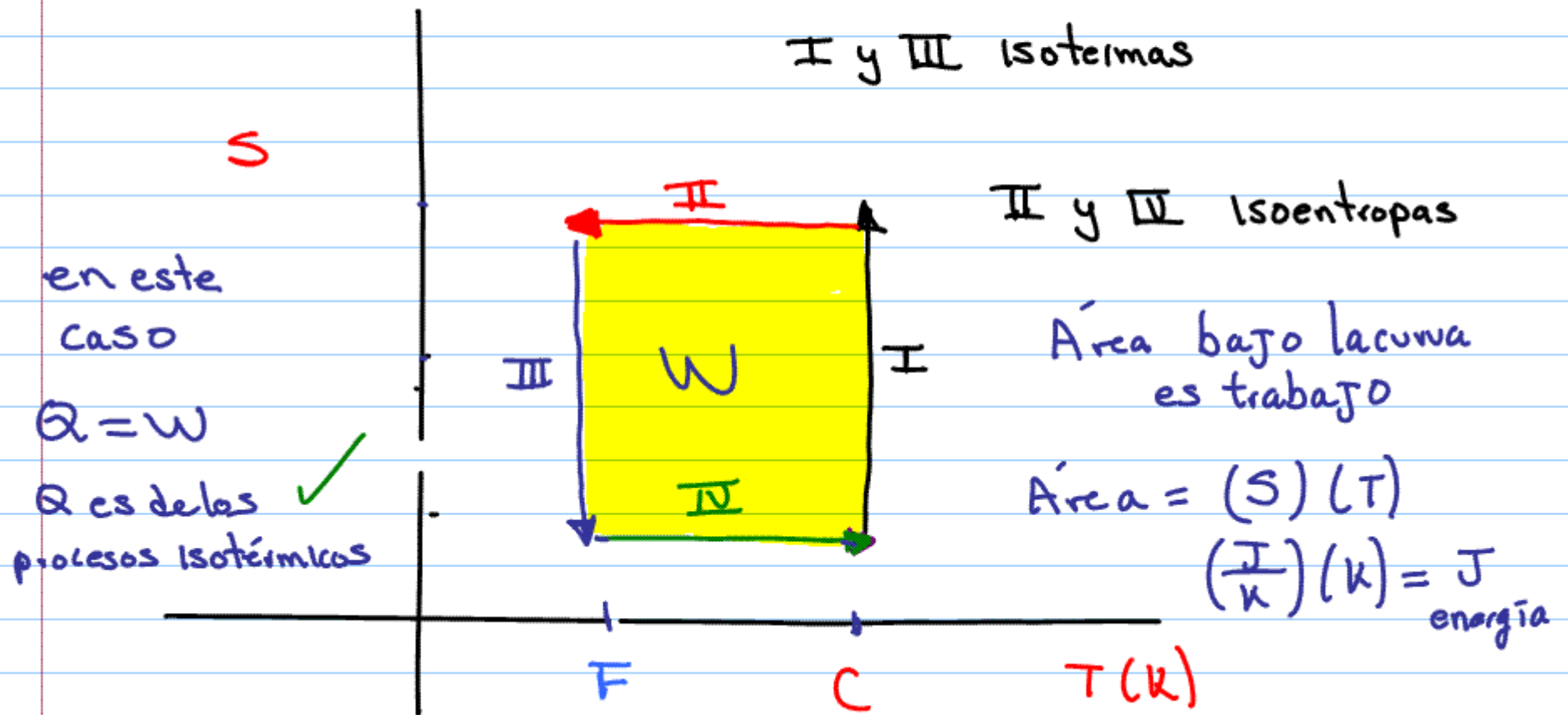
$v(L)$



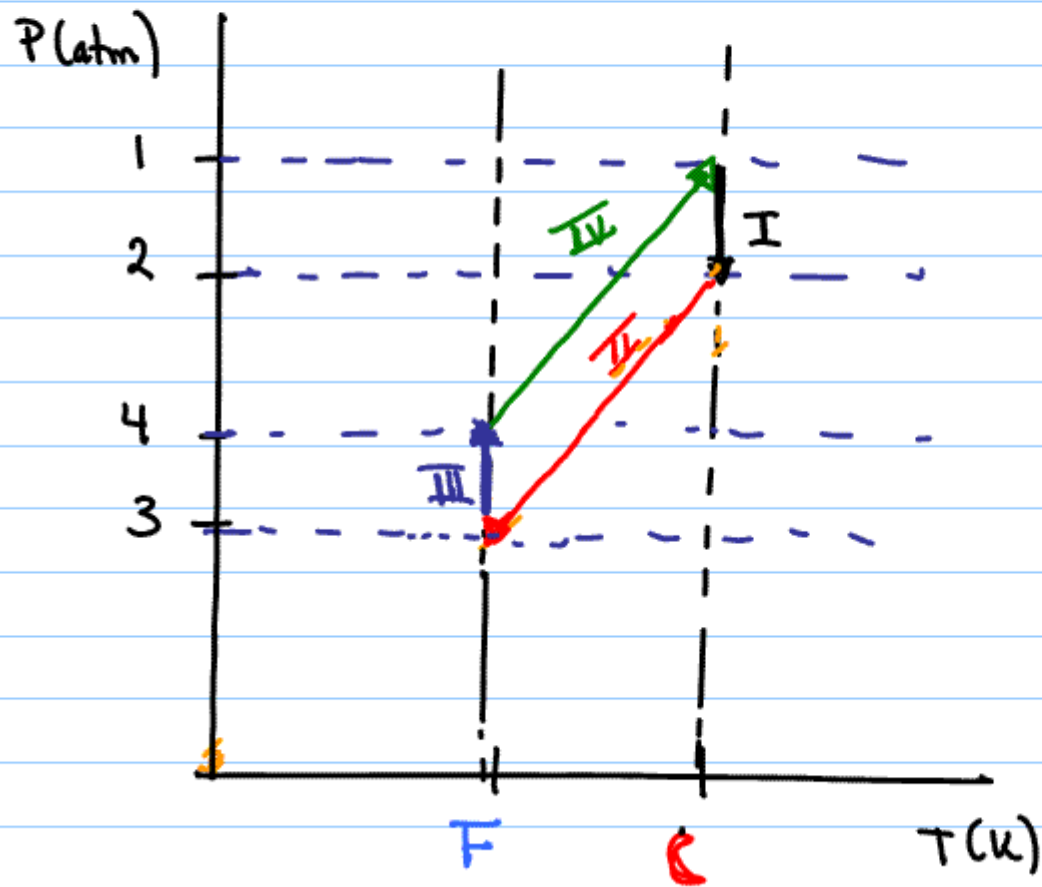
Gráficos de grado de avance



Gráfica S vs T



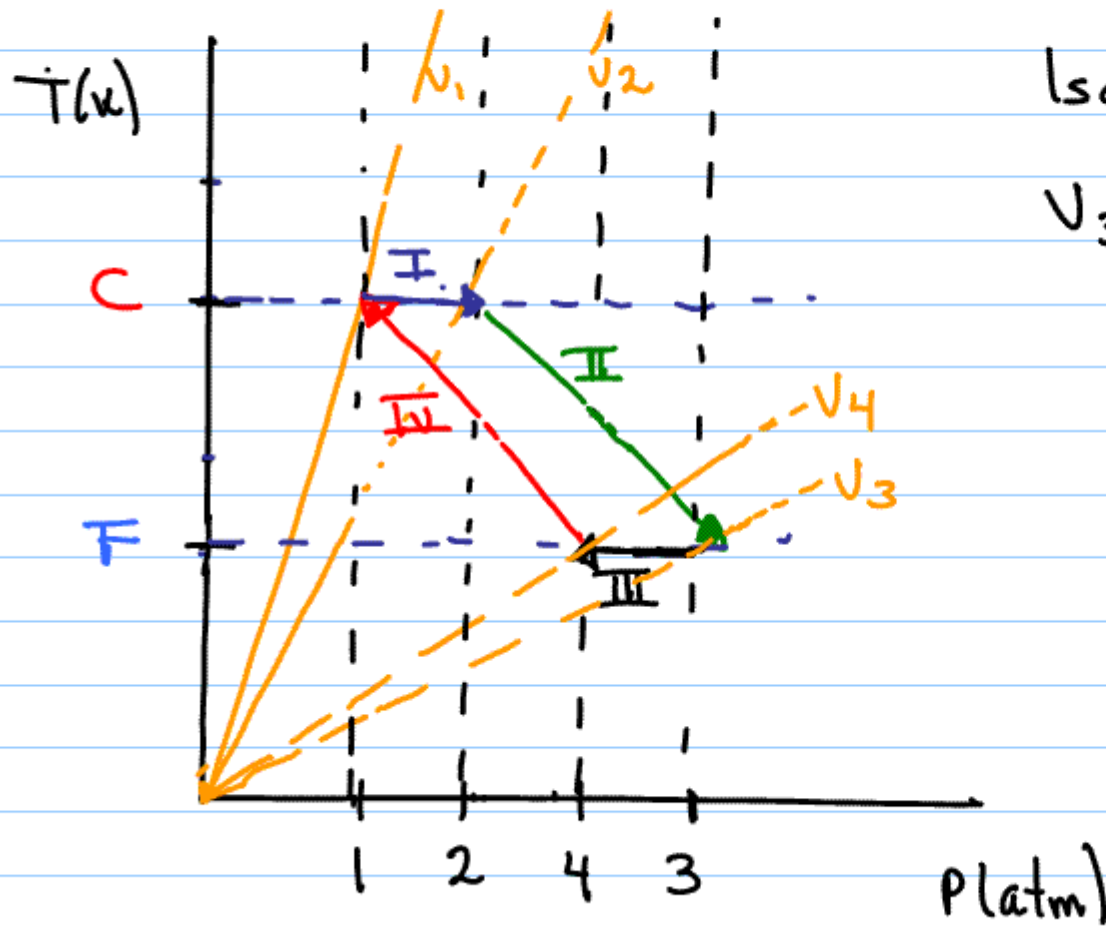
Ciclo de Carnot P vs T



Isocoras

$$V_3 > V_2 > V_4 > V_1$$

Ciclo de Carnot P vs T



Isocoras

$$V_3 > V_2 > V_4 > V_1$$

Tarea Ejemplo

Diseñar un ciclo de Carnot que pueda operar a condiciones de Laboratorio donde

$$T_C = 298.15\text{K} \quad T_F = 273.15\text{K} \quad p_1 = 0.771 \text{ atm (586 mmHg)}$$

$$n_1 = 1 \text{ mol gas diatómico } \gamma = 1.4$$

Resolución

I Cálculo de variables

$$V_1 = \frac{(1 \text{ mol}) (0.082 \text{ atm} \cdot \text{L} / \text{mol} \cdot \text{K}) (298.15 \text{ K})}{0.7710 \text{ atm}} = 31.709 \text{ L}$$

$$V_2 = 2V_1 = 2(31.709 \text{ L}) = 63.418 \text{ L}$$

$$T_1 = 298.15 \text{ K}$$

$$T_2 = T_1$$

$$T_3 = T_4 = 273.15 \text{ K}$$

$$V_3^{\gamma-1} = \frac{T_3}{T_2} V_2^{\gamma-1} = \frac{273.15 \text{ K}}{298.15 \text{ K}} (63.418 \text{ L})^{1.4-1}$$

$$V_3 = 78.940 \text{ L}$$

$$p_2 V_2 = p_1 V_1 = p_2 = p_1 \left(\frac{V_1}{V_2} \right) = 0.7710 \text{ atm} \left(\frac{31.709 \text{ L}}{63.418 \text{ L}} \right) = 0.3855 \text{ atm}$$

$$p_3 V_3^\gamma = p_2 V_2^\gamma$$

$$p_3 = p_2 \left(\frac{V_2}{V_3} \right)^\gamma = 0 = 0.3855 \text{ atm} \left(\frac{63.418 \text{ L}}{78.94 \text{ L}} \right) = 0.2837 \text{ atm}$$

De la relación

$$\frac{V_2}{V_1} = \frac{V_3}{V_4} = V_4 = \frac{V_1 V_3}{V_2} = \frac{(31.709 \text{ L})(78.940 \text{ L})}{(63.418 \text{ L})} = 39.47 \text{ L}$$

$$p_4 = \frac{p_3 V_3}{V_4} = 0.2837 \text{ atm} \left(\frac{78.94 \text{ L}}{39.47 \text{ L}} \right) = 0.5674 \text{ atm}$$

Tabla de variables

	P (atm)	V (L)	T (K)
I 1	0.7710	31.709	298.15
II 2	0.3855	62.418	298.15
III 3	0.2837	78.94	273.15
IV 4	0.5674	39.47	273.15

Tabla de Funciones termodinámicas


	ΔU (J)	ΔH (J)	ΔS (J/K)	Q (J)	w (J)
I	0	0	5.7628	1718.18	1718.18
II	-519.625	-727.475	0	0	519.625
III	0	0	-5.7628	-1574.115	-1574.115
IV	519.625	727.475	0	0	-519.625
total	0	0	0	144.06	144.06

Conclusiones

$$Q_{ciclo} = W_{ciclo} \checkmark$$

$$\Delta S_c = 0 \text{ ciclo reversible} \checkmark$$

ΔU_c y $\Delta H_c = 0$ Función de estado que regresa a la condición inicial \checkmark

Ciclo endotérmico (máquina térmica) \checkmark  $W \oplus \checkmark$

orden de las manecillas
del reloj

Cálculo de eficiencia

$$\% \eta = \frac{T_c - T_f}{T_c} \times 100 = \frac{298.15\text{K} - 273.15\text{K}}{298.15\text{K}} = 8.385\%$$

$$\% \eta = \frac{W_{\text{ciclo}}}{Q_{\text{caliente}}} \times 100 = \frac{144.0642\text{J}}{1718.18\text{J}} \times 100 = 8.385\%$$