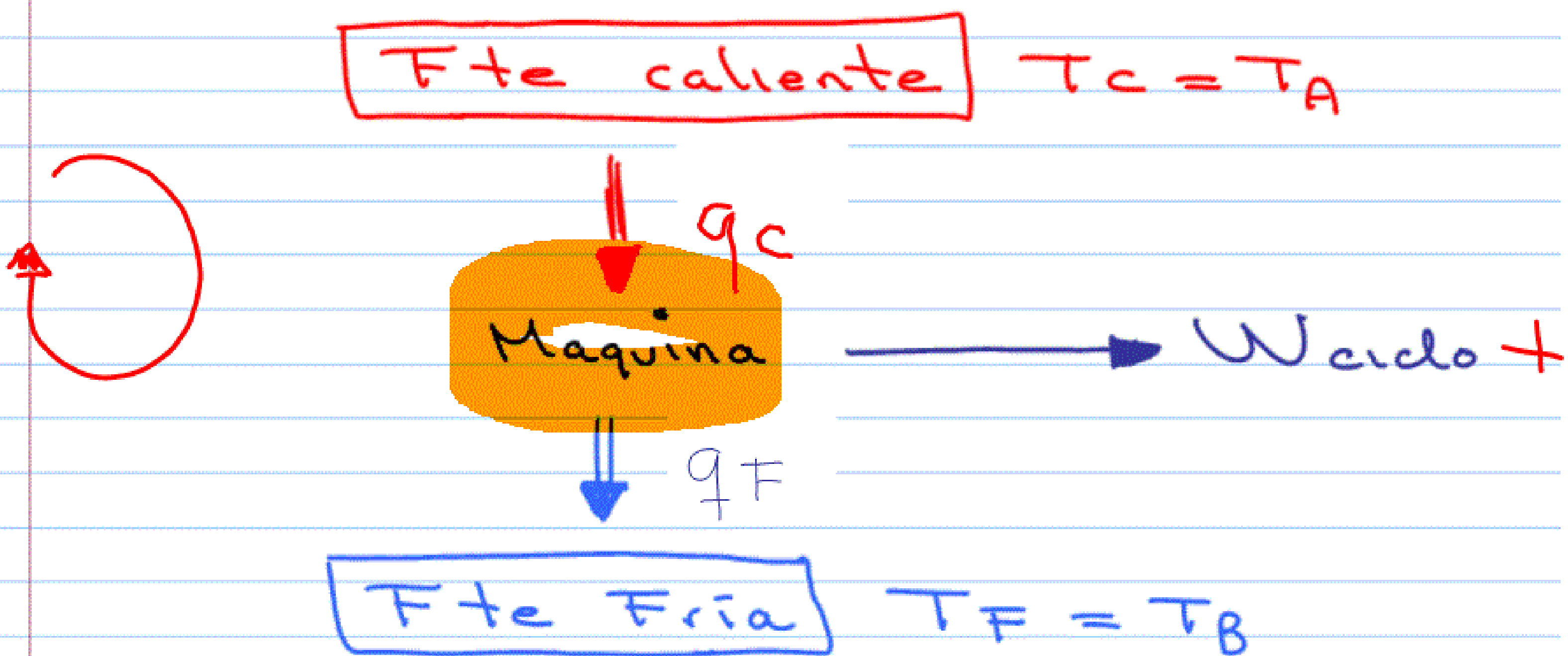
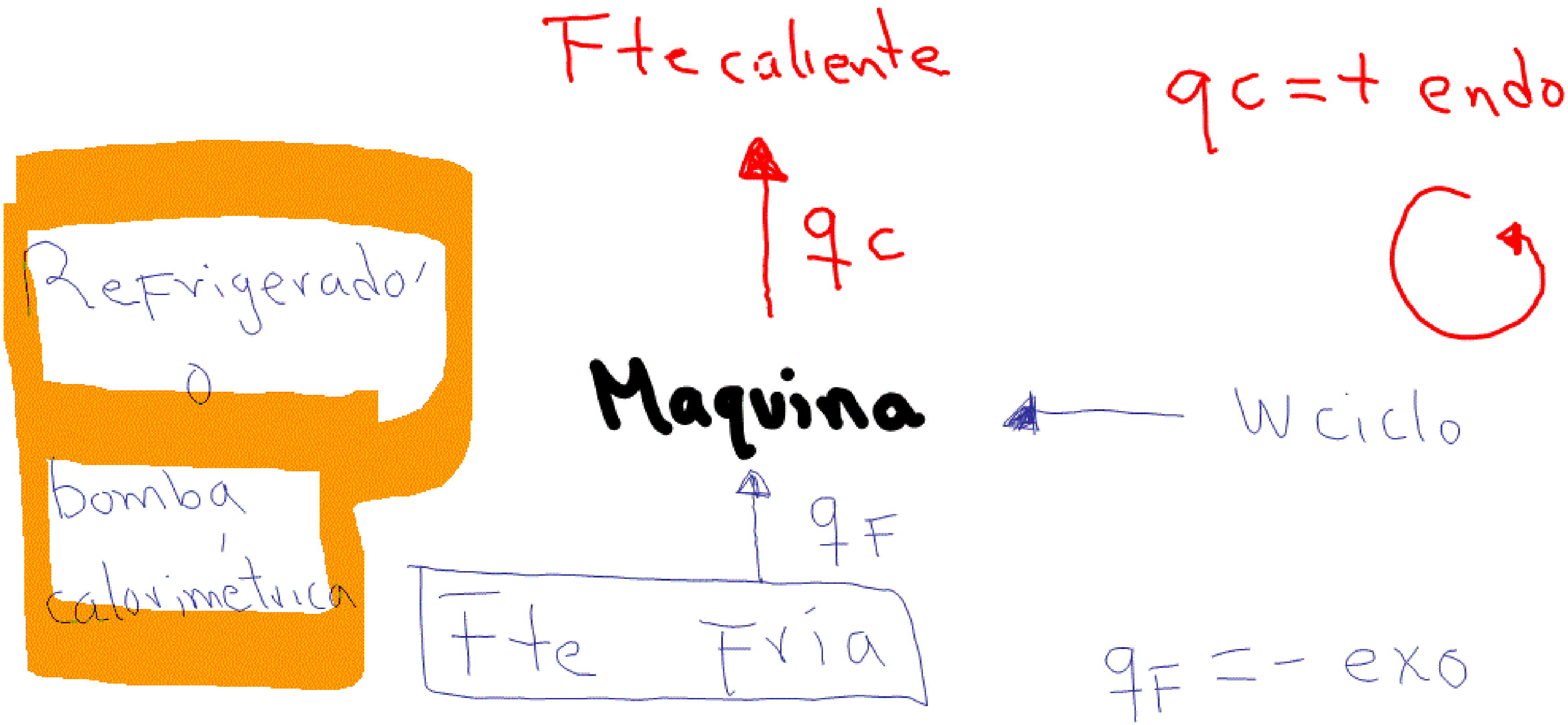
Clase 42 11 noviembre 2020

Título de la nota 11/11/2020

Maquina Tipo Carnot (Térmica)




Fte caliente
qc
qc = + endo
Refrigerador
o
bomba calorimétrica
Maquina
W ciclo
qF
Fte Fría
qF = - exo

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

$T_C = 298.15 K$ $T_F = 273.15 K$ $P_1 = 0.771$ atm (586 mmHg)

$n_1 = 1$ mol gas diatómico $\gamma = 1.4$

Exp. Isotérmica es el doble del volumen inicial.

A) Cálculo de variables

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

$$V_2 = 2V_1 = 2(31.709\,L) = 63.418\,L$$

$T_1 = 298.15\,K$ $\quad T_2 = T_1$ $\quad T_3 = T_4 = 273.15\,K$

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

$$V_3 = 78.940\,L$$

	P (atm)	V (L)	T (K)
1	0.771	31.709	298.15
2	0.3855	63.418	298.15
3	0.2837	78.94	273.15
4	0.5674	39.47	273.15

•

$V_3 =$ adiabático

$$T_1 = T_2$$

$$T_2 = T_1 \left(\frac{V1}{V2}\right)^{\gamma-1}$$

$$T_3 = T_4$$

$$T_3 = T_2 \left(\frac{V_2}{V3}\right)^{\gamma-1}$$

$$\frac{T_3}{T_2} = \left(\frac{V2}{V3}\right)^{\gamma-1}$$

$$V_3 = \frac{V_2}{\left(\frac{T_3}{T2}\right)^{\frac{1}{\gamma-1}}}$$

$$\left(\frac{T_3}{T2}\right)^{\frac{1}{\gamma-1}} = \frac{V2}{V3}$$

$$\gamma = 1.4$$

$$V_3 = \frac{63.418}{\left(\frac{273.15\,K}{298.15\,K}\right)^{\frac{1}{1.4-1}}}$$

$$V_3 = 78.94\ L$$

- $P_3 V_3^{\gamma} = P_2 V_2^{\gamma}$

$$P_3 = P_2\left(\frac{V_2}{V_3}\right)^{\gamma} = 0.2837$$

$$=$$

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

$$V_4 = \frac{V_1 V_3}{V_2} = 39.47\ L$$

$$p_4 V_4^{\gamma} = p_1 V_1^{\gamma}$$

$$p_1 = p_4 \left(\frac{V_4}{V_1}\right)^{\gamma} = 0.771\ atm$$

I Exp. Isot. Rev.

$\Delta U = 0 \qquad \Delta H = 0$

$$q = w = nRT_1 \ln \frac{V_2}{V_1} = (1\,mol)(8.314\,J/mol\,K)(298.15\,K)\ln 2$$

$$= 1718.18\,J$$

$$\Delta S = \frac{q}{T_1} = \frac{1718.18\,J}{298.15\,K} = 5.76\,J/K$$

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

Checar cálculos

II Exp. Adiab. Rev.

$q = 0$ $\Delta S = 0$ $T_1 = T_2$

$T_3 = T_4$

$\Delta H = n\bar{C}_p (T_3 - T_2) = -727.47\ J$

$\Delta U = n\bar{C}_v (T_3 - T_2) = -519.62\ J$

$\bar{C}_p = \frac{7}{2} R$ $R = \frac{8.314\ J}{mol\ K}$

$\bar{C}_v = 5/2 R$ $w = -\Delta U$

$w = -(-519.62\ J)$

III Comp. Isot. Rev.

$\Delta U = 0 \quad \Delta H = 0 \quad T_3 = T_4 = T_F$

$$q = w = nRT_3 \ln \frac{V_4}{V_3} = nRT_F \ln \frac{V_4}{V_3}$$

$$= -1574.11\,J$$

$$\Delta S = \frac{q}{T_3} = \frac{-1571.11\,J}{273.15\,K} = -5.76\,\frac{J}{K}$$

IV Comp. Adiab. Rev.

$q = 0 \qquad \Delta S = 0$

$\Delta H = n\bar{C}_p (T_1 - T_4)$

$\Delta U = n\bar{C}_v (T_1 - T_4)$

$w = -\Delta U$

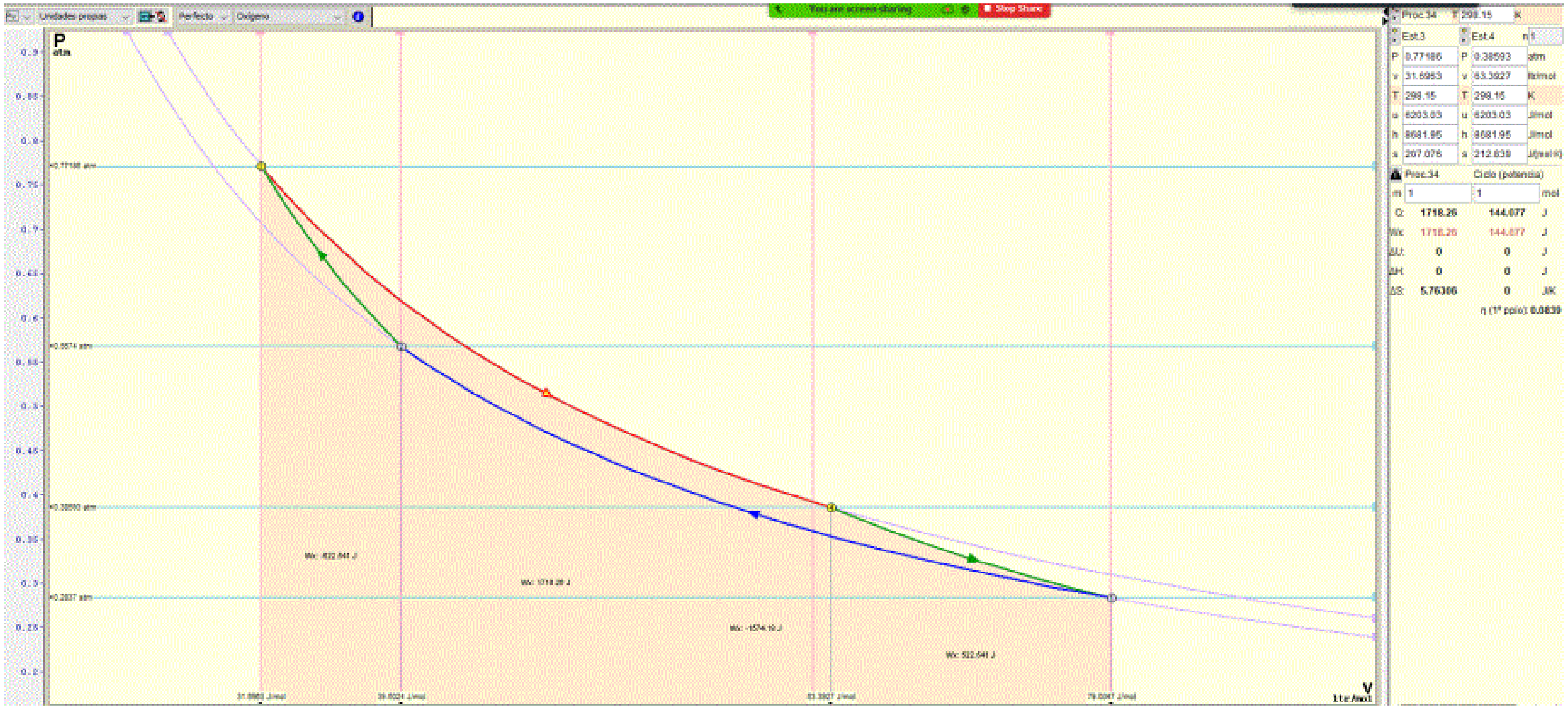
Eficiencia

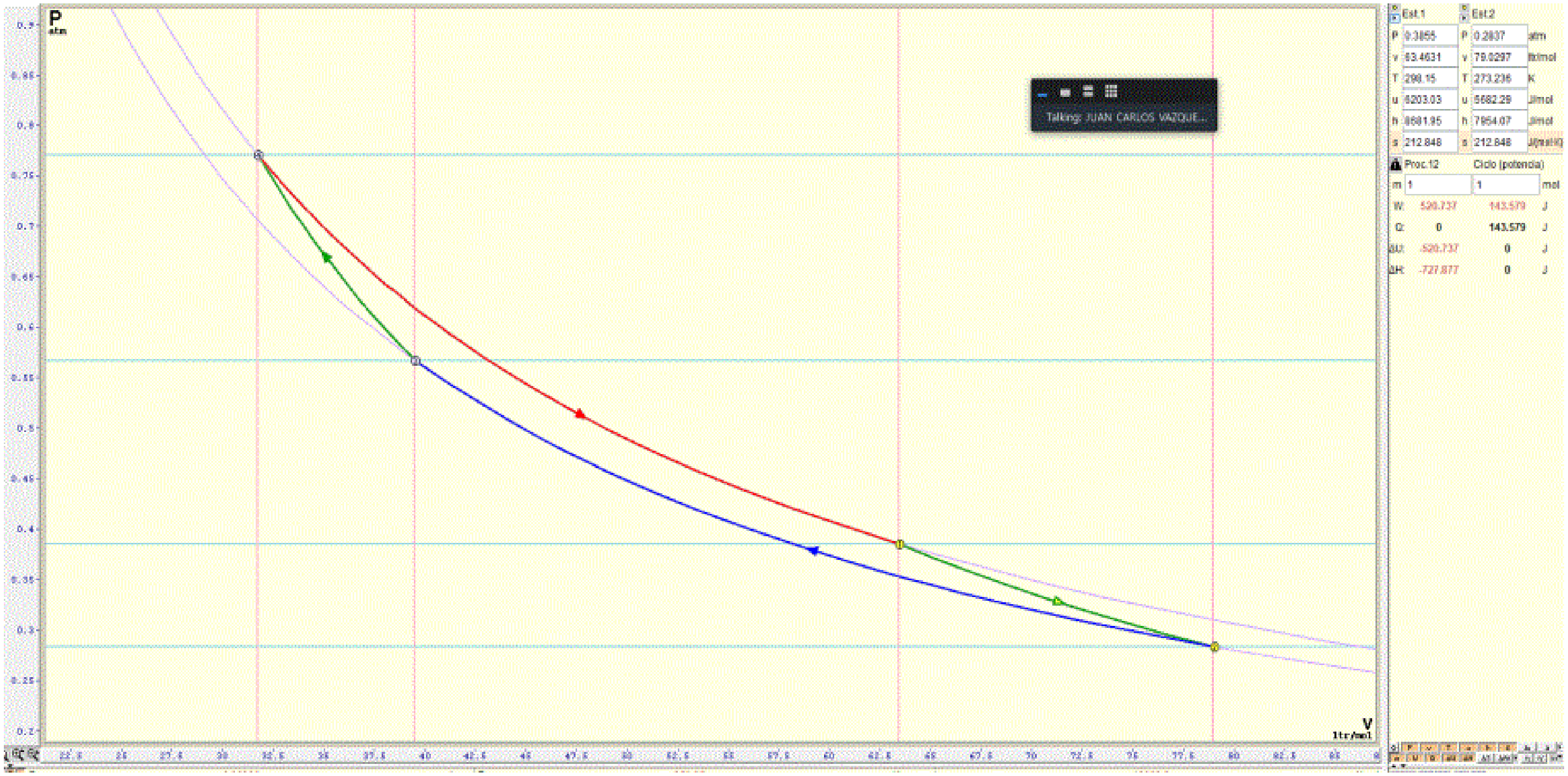
$$\%\eta = \frac{W_{ciclo}}{q_c} \times 100$$

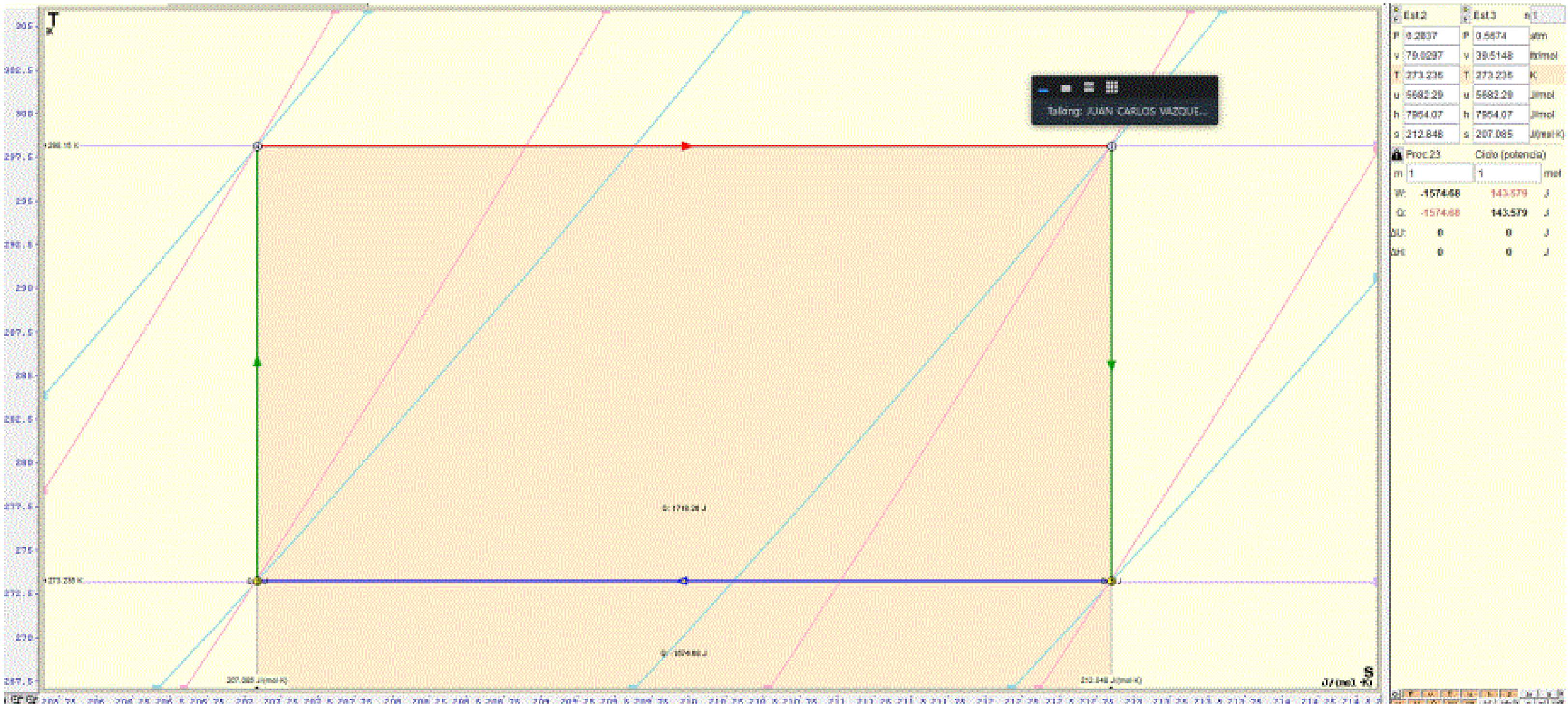
$$= \frac{144.06\,J}{1718.18\,J} \times 100 = 8.38\%$$

$$\%\eta = \frac{T_c - T_F}{T_c} \times 100$$

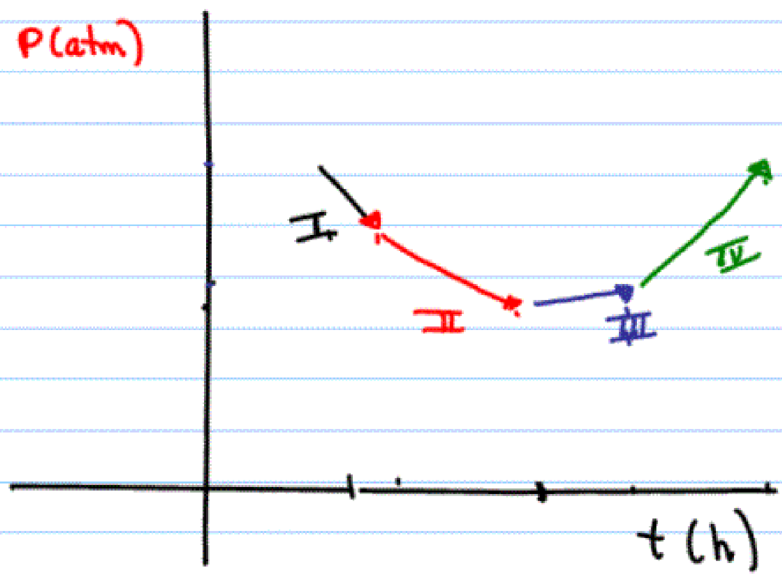
$$= \frac{298.15\,K - 273.15}{298.15\,K} \times 100 = 8.38\%$$


P
atm
V
ltr/mol
Proc.34
Est.3
Est.4
Ciclo (potencia)

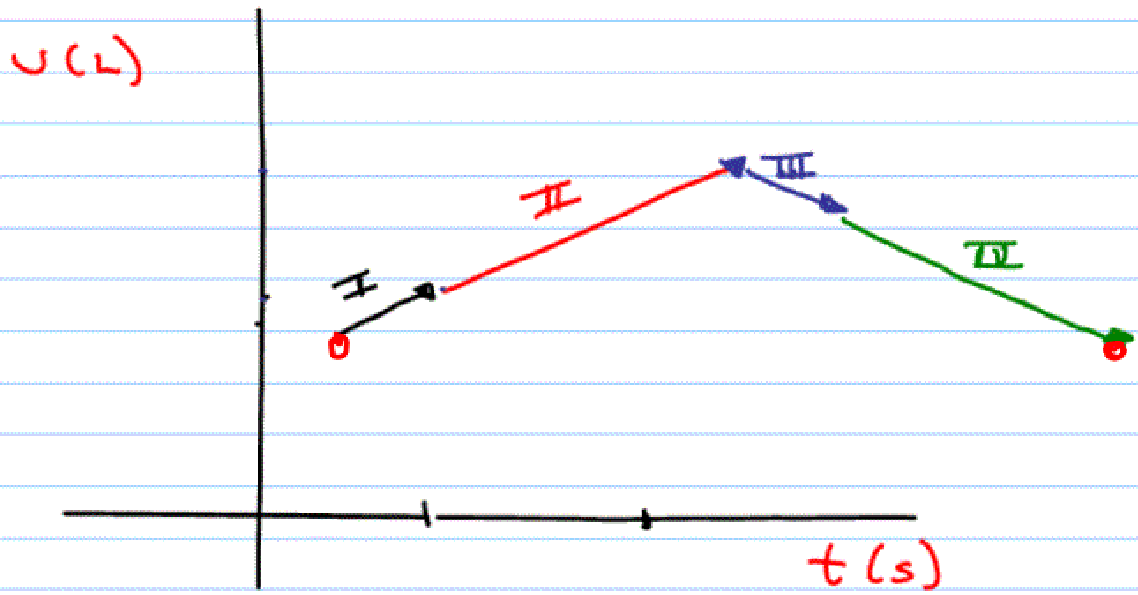

P
atm
V
ltr/mol
Talking: JUAN CARLOS VAZQUE...
Est.1
Est.2
P 0.3855
P 0.2837 atm
v 63.4631
v 79.0297 ltr/mol
T 298.15
T 273.236 K
u 6203.03
u 5682.29 J/mol
h 8681.95
h 7954.07 J/mol
s 212.848
s 212.848
Proc.12
Ciclo (potencia)
m 1
1 mol
W: 520.737 143.579 J
Q: 0 143.579 J
ΔU: -520.737 0 J
ΔH: -727.877 0 J


T
K
298.15 K
273.236 K
207.085 J/(mol·K)
212.848 J/(mol·K)
S
J/(mol·K)
Est.2
Est.3
P 0.2837
P 0.5674
atm
v 79.0297
v 39.5148
T 273.236
T 273.236
K
u 5682.29
u 5682.29
J/mol
h 7954.07
h 7954.07
J/mol
s 212.848
s 207.085
J/(mol·K)
Proc.23
Ciclo (potencia)
m 1
1
mol
W: -1574.68
143.579
J
Q: -1574.68
143.579
J
ΔU: 0
0
J
ΔH: 0
0
J

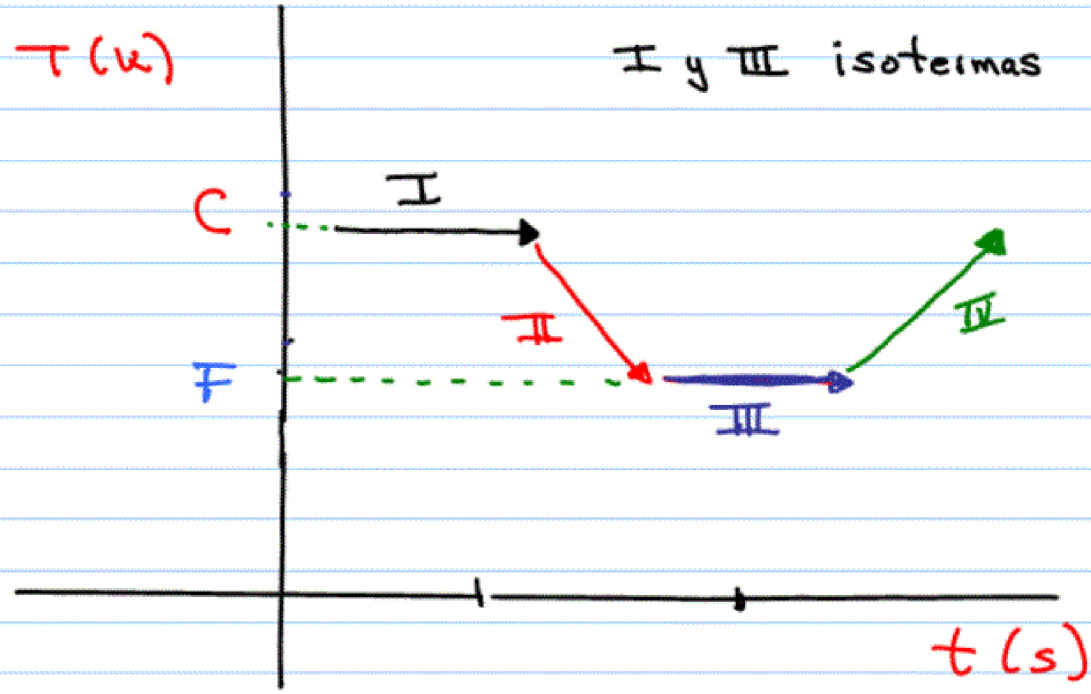
Diagramas Adicionales grado de avance

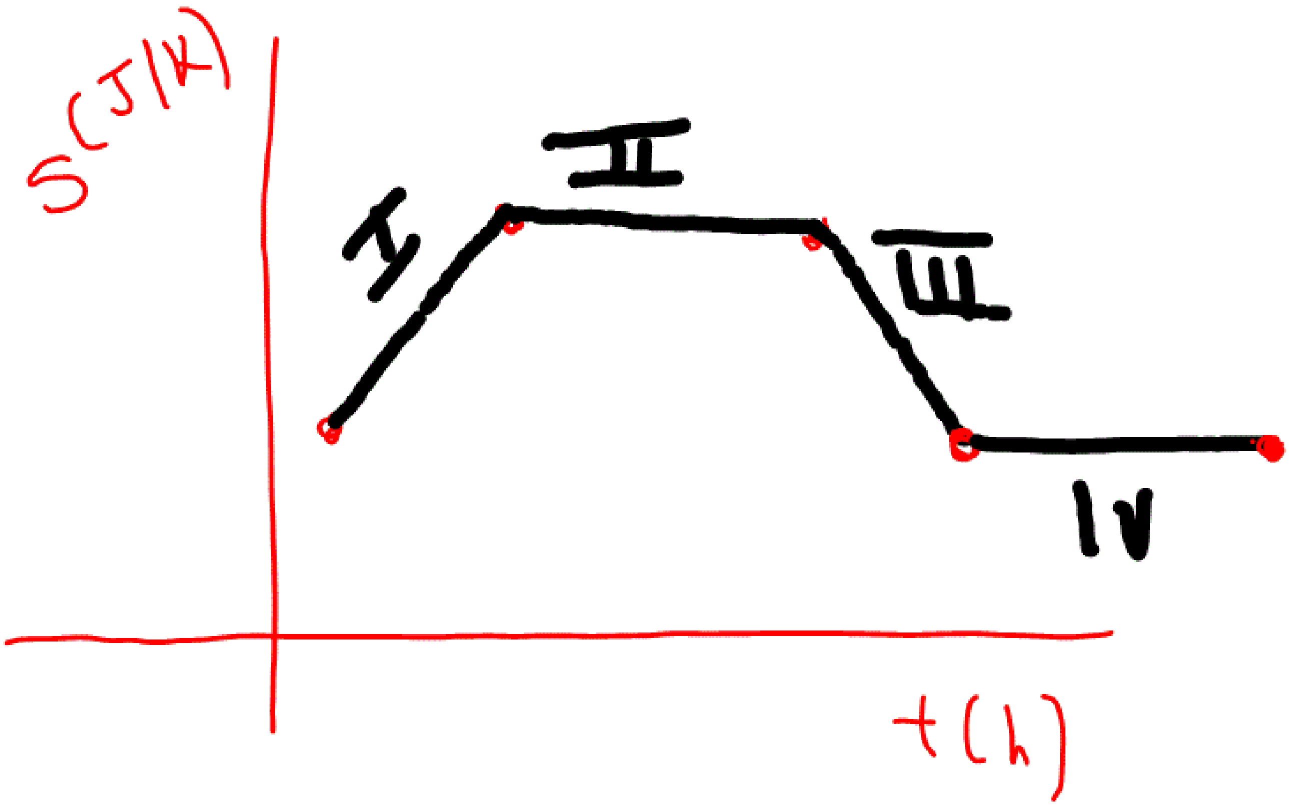


Gráficos de grado de avance



Gráficos de grado de avance




S(J/K)
I
II
III
IV
t(h)