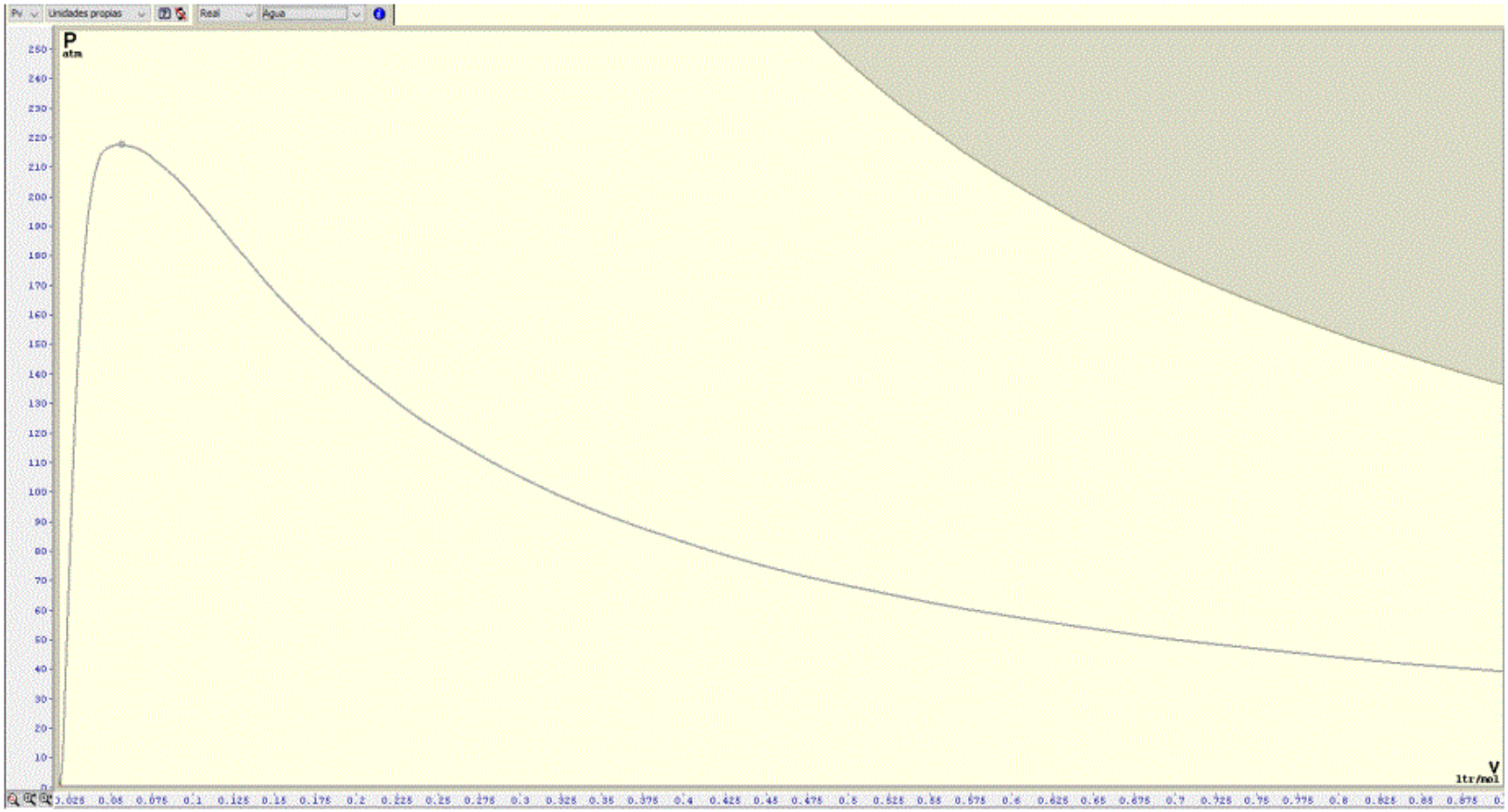
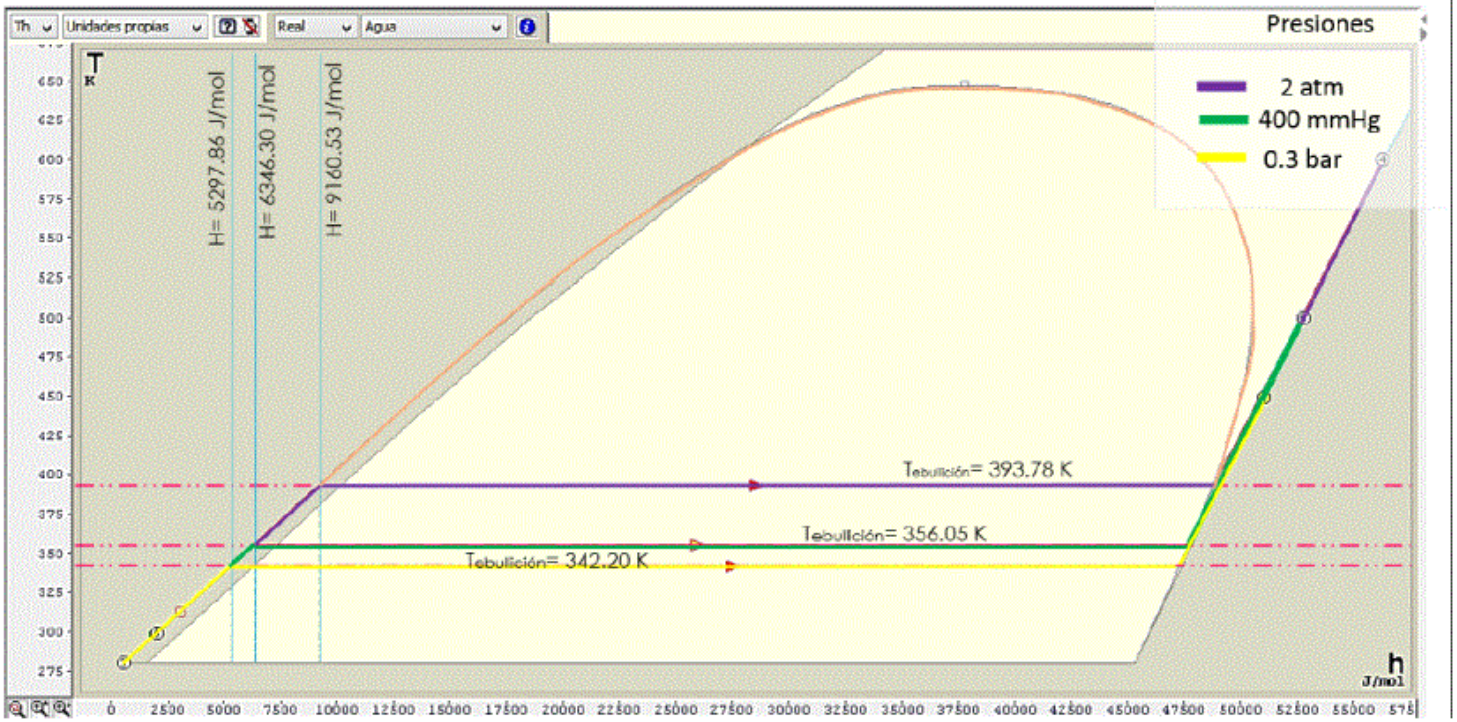
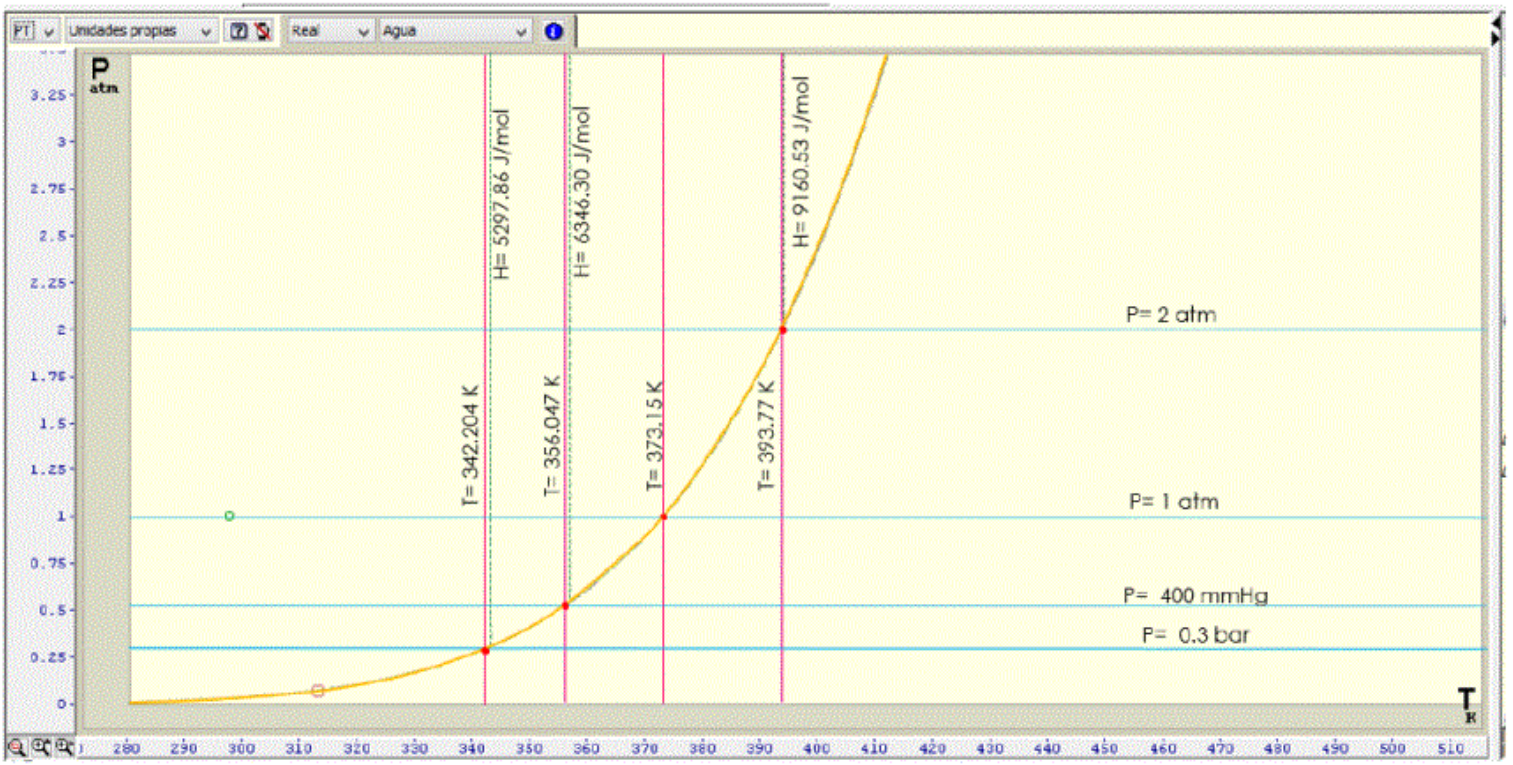
Clase 83 19 Enero 2021

Título de la nota 18/01/2021

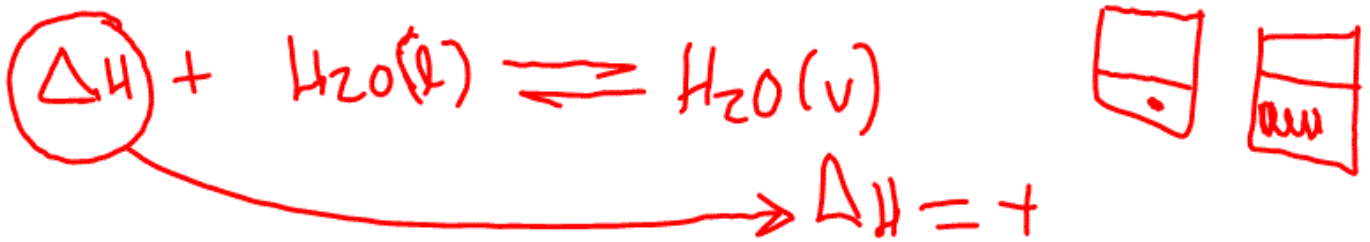


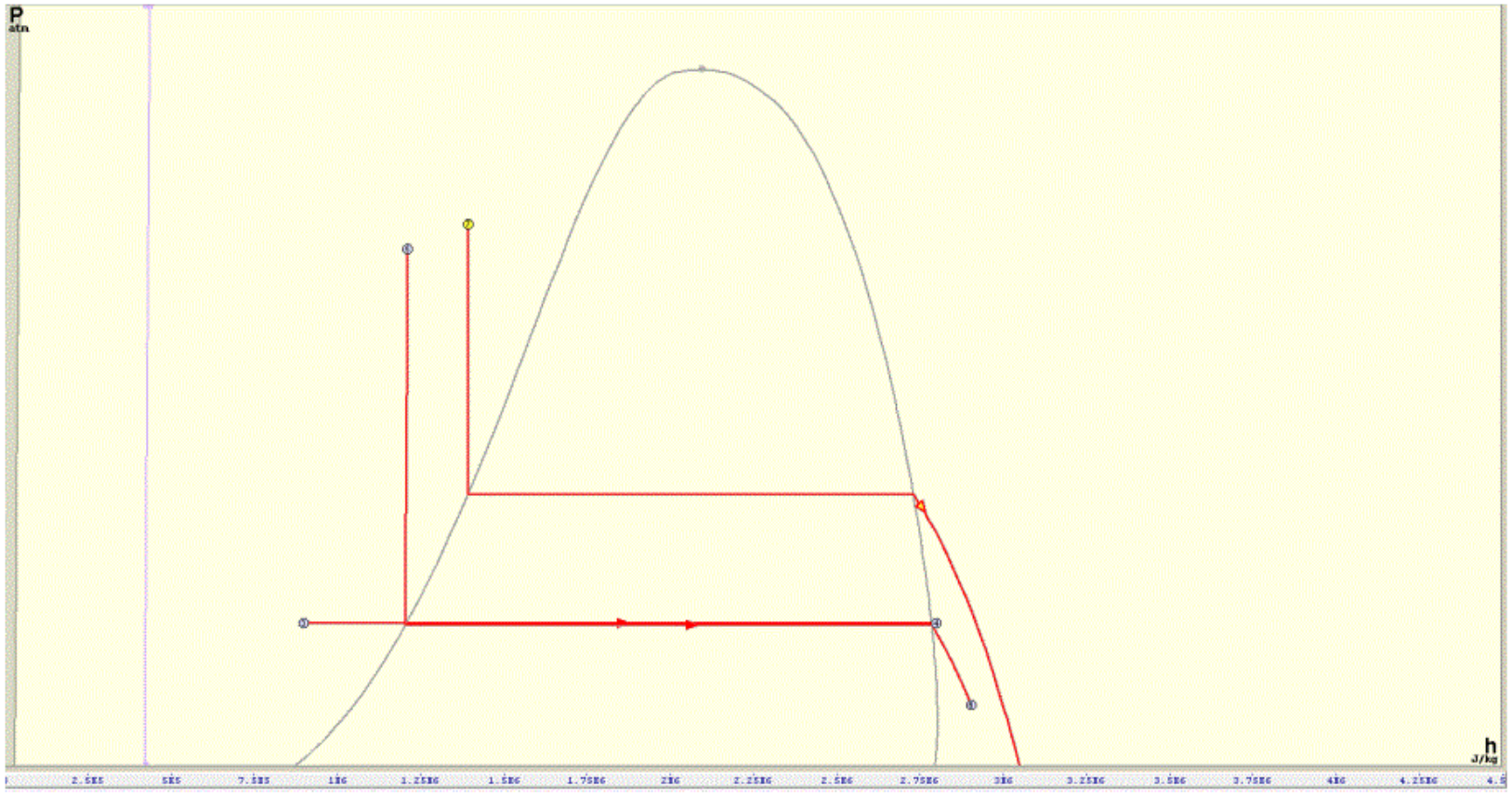
Puntos de ebullición del agua a distintas presiones



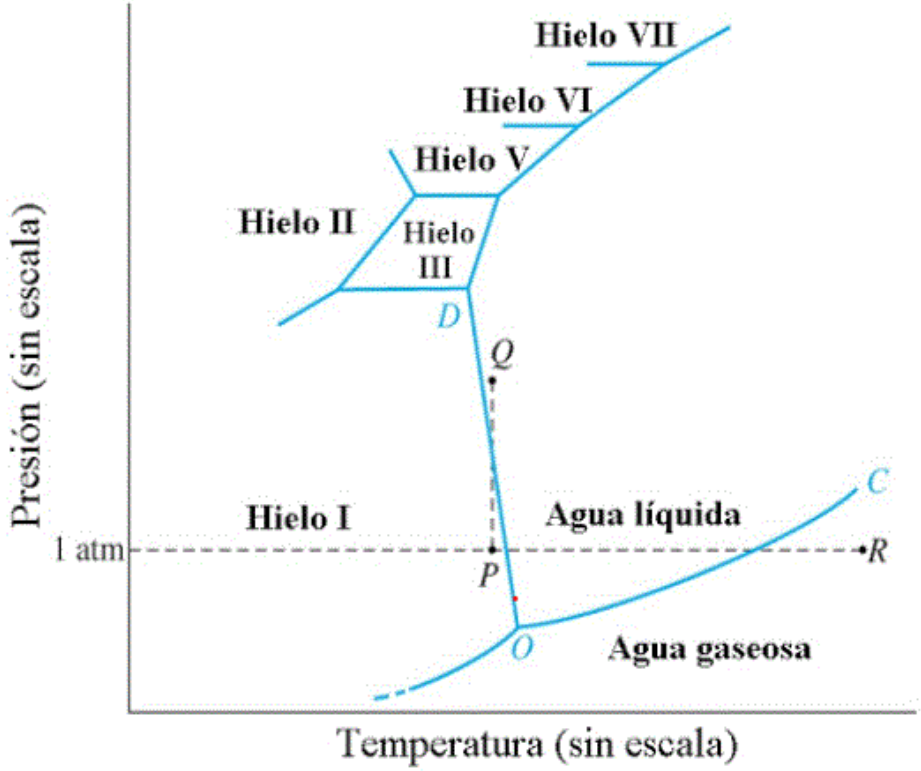

PT
Unidades propias
Real
Agua
P
atm
H= 5297.86 J/mol
H= 6346.30 J/mol
H= 9160.53 J/mol
P= 2 atm
P= 1 atm
P= 400 mmHg
P= 0.3 bar
T= 342.204 K
T= 356.047 K
T= 373.15 K
T= 393.77 K
T
K

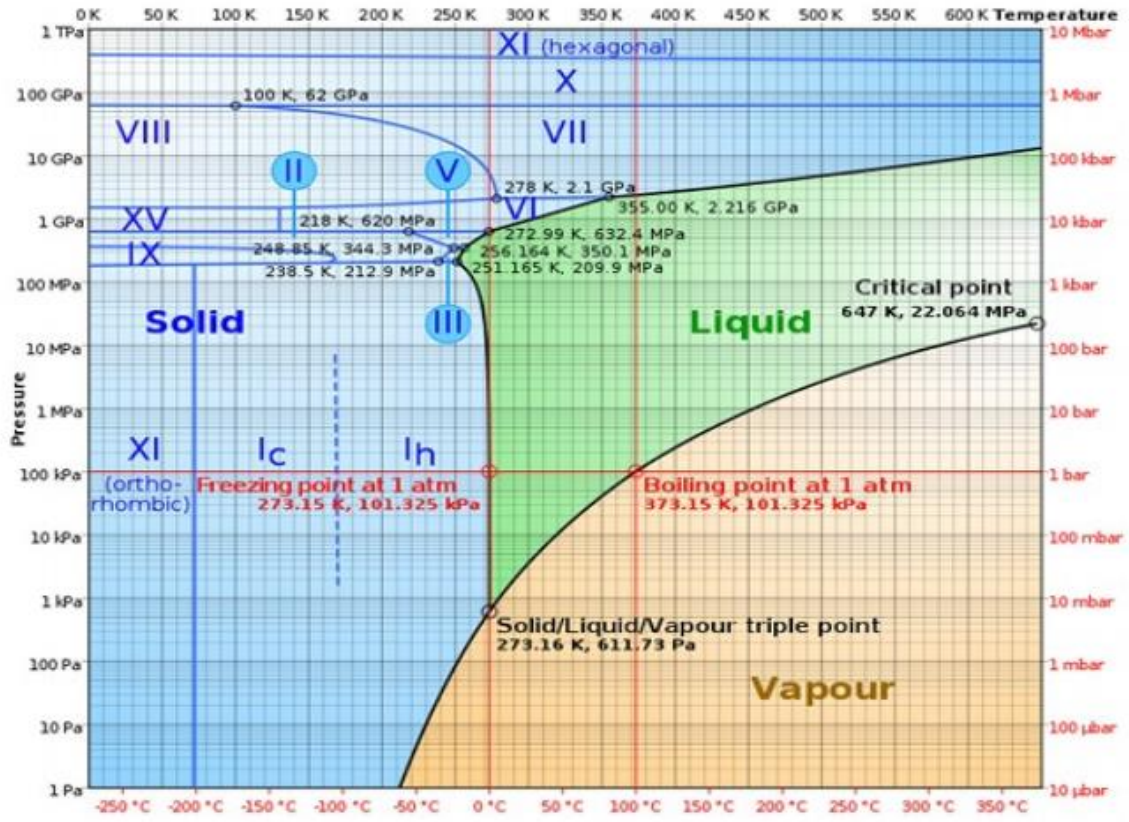
Presión	Punto de ebullición del agua(K) Simulador	Punto de ebullición del agua(K) Termograf	Diferencia (K)
2 atm	394.00	393.78	0.22
0.3 bar	341.42	342.20	0.78
400mmHg	355.72	356.05	0.33




P
atm
h
J/kg

Presión (atm)	Temperatura de fusión del agua(K)
1000	266.054
1	273.150
0.5	273.154




0 K
50 K
100 K
150 K
200 K
250 K
300 K
350 K
400 K
450 K
500 K
550 K
600 K
Temperature
1 TPa
100 GPa
10 GPa
1 GPa
100 MPa
10 MPa
1 MPa
100 kPa
10 kPa
1 kPa
100 Pa
10 Pa
1 Pa
Pressure
10 Mbar
1 Mbar
100 kbar
10 kbar
1 kbar
100 bar
10 bar
1 bar
100 mbar
10 mbar
1 mbar
100 µbar
10 µbar
-250 °C
-200 °C
-150 °C
-100 °C
-50 °C
0 °C
50 °C
100 °C
150 °C
200 °C
250 °C
300 °C
350 °C
XI (hexagonal)
X
VIII
VII
VI
XV
IX
II
V
III
100 K, 62 GPa
278 K, 2.1 GPa
355.00 K, 2.216 GPa
218 K, 620 MPa
272.99 K, 632.4 MPa
248.85 K, 344.3 MPa
256.164 K, 350.1 MPa
238.5 K, 212.9 MPa
251.165 K, 209.9 MPa
Solid
Liquid
Critical point
647 K, 22.064 MPa
XI
(ortho-
rhombic)
Ic
Ih
Freezing point at 1 atm
273.15 K, 101.325 kPa
Boiling point at 1 atm
373.15 K, 101.325 kPa
Solid/Liquid/Vapour triple point
273.16 K, 611.73 Pa
Vapour

T ebullición y p vapor | T fusión | Curva

Curva de calentamiento

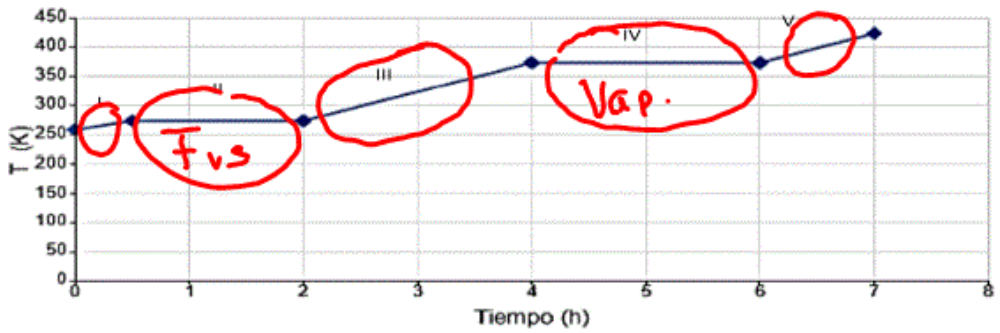
Insertar en las celdas de color amarillo los valores correspondientes

T_1	(K)	258.15	Cp Hielo	(cal/gK)	0.50	Cp vapor	Constantes	cal/molK
T_2	(K)	273.15	ΔH_f	(cal/g)	80.00		(300-2500)K	
T_3	(K)	373.15	Cp agua	(cal/gK)	1.00		a	7.70e+0
T_4	(K)	423.15	ΔH_v	(cal/g)	540.00		b	4.60e-4
m	(g)	1.00e+6	n	(mol)	5.56e+4		c	2.52e-6
M	(g/mol)	18.00					d	-8.59e-10

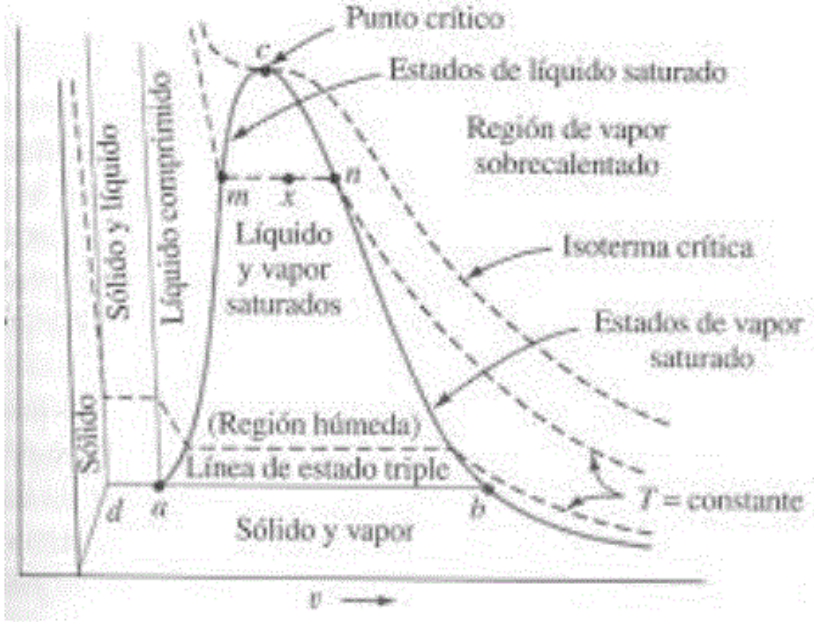
ΔH_1	(cal)	7.50e+6
ΔH_2	(cal)	8.00e+7
ΔH_3	(cal)	1.00e+8
ΔH_4	(cal)	5.40e+8
ΔH_5	(cal)	2.29e+7
ΔH total	(cal)	7.50e+8

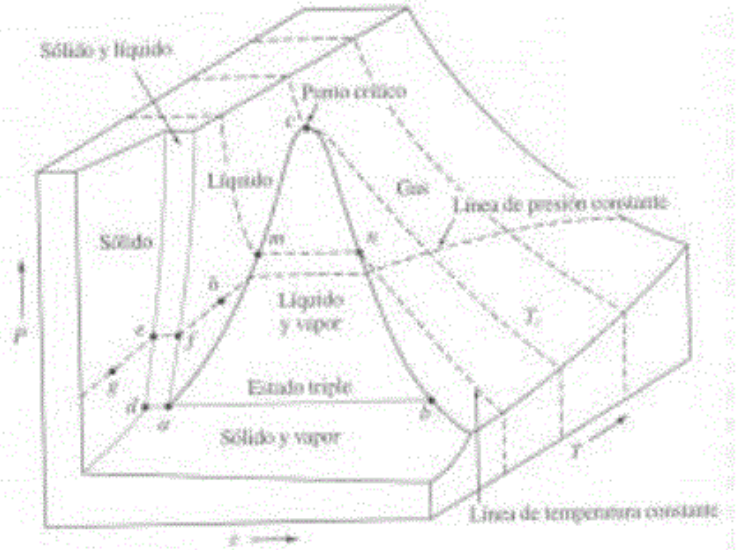
	Tiempo (h)	T (K)
Etapa I	0	258.15
	0.5	273.15
Etapa II	0.5	273.15
	2	273.15
Etapa III	2	273.15
	4	373.15
Etapa IV	4	373.15
	6	373.15
Etapa V	6	373.15
	7	423.15

Curva de Calentamiento



P = cte


Punto crítico
Estados de líquido saturado
Región de vapor sobrecalentado
Isoterma crítica
Estados de vapor saturado
Líquido y vapor saturados
(Región húmeda)
Línea de estado triple
Sólido y vapor
T = constante
Sólido
Sólido y líquido
Líquido comprimido
c
m
x
n
d
a
b
v


Sólido y líquido
Punto crítico
Líquido
Gas
Línea de presión constante
Sólido
Líquido y vapor
Estado triple
Sólido y vapor
Línea de temperatura constante
P
T
v

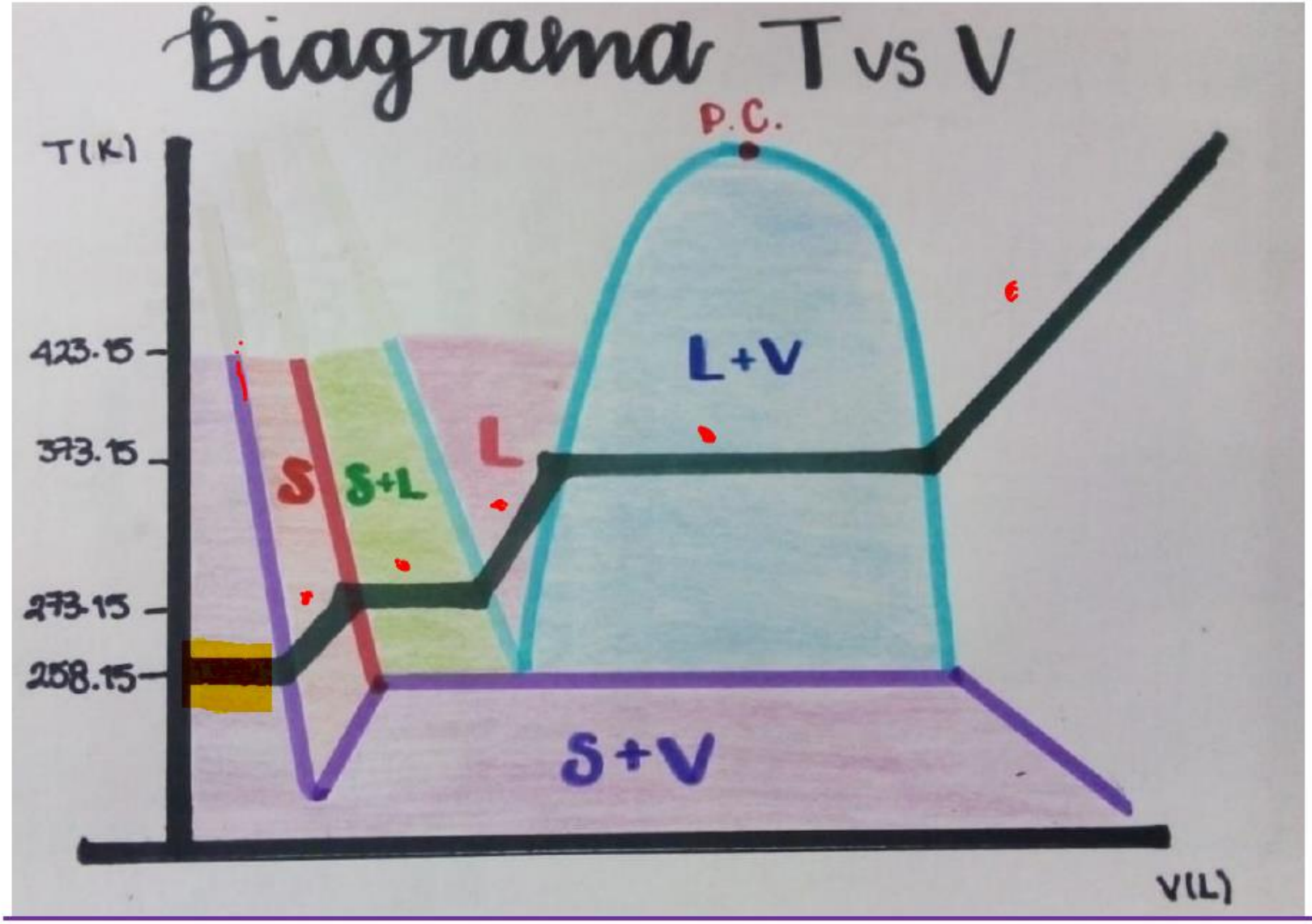


Diagrama T vs V
P.C.
T(K)
423.15
373.15
273.15
258.15
S
S+L
L
L+V
S+V
V(L)

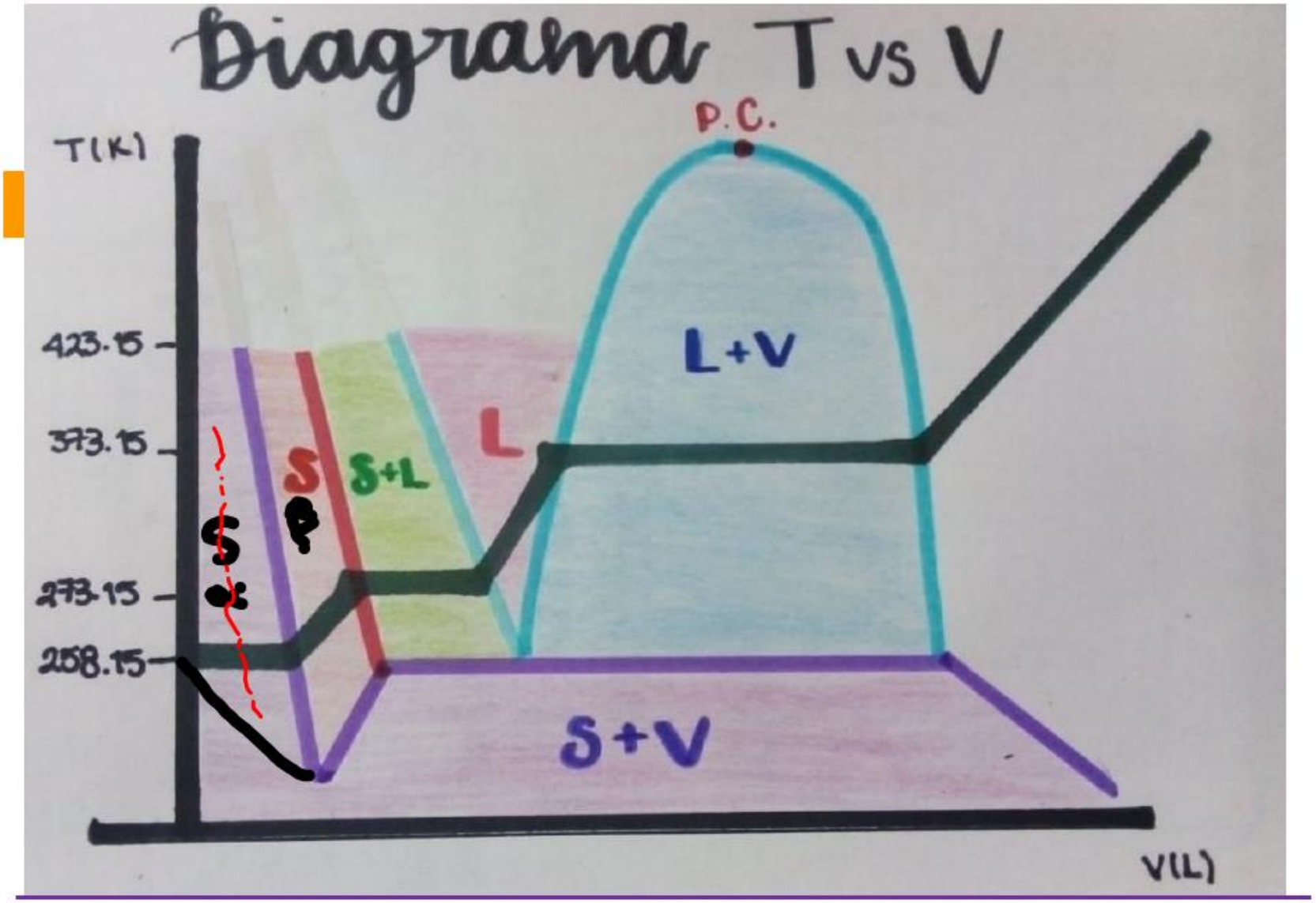


Diagrama T vs V
P.C.
T(K)
423.15
373.15
273.15
258.15
L+V
L
S
S+L
S+V
V(L)

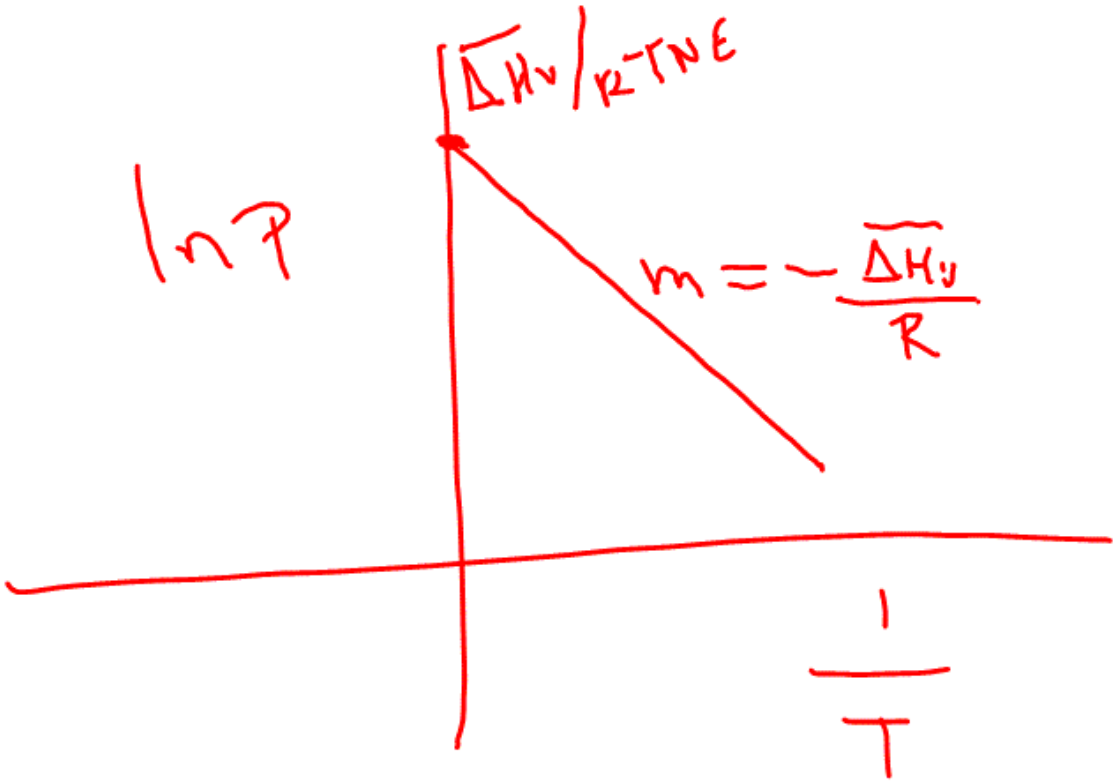
Temperatura			
[°C]	[K]	1/T	mmHg
60	333.15	0.00300165	149.4
70	343.15	0.00291418	233.7
80	353.15	0.00283166	355.1
90	363.15	0.00275368	525.28
100	373.15	0.00267989	760

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\overline{\Delta H_V}}{R}\left[\frac{1}{T_{NE}} - \frac{1}{T_2}\right]$$

$$\ln P = \frac{\overline{\Delta H_V}}{R T_{NE}} - \frac{\overline{\Delta H_V}}{R T_2}$$

$$y = b - mx \qquad x = \frac{1}{T}$$

$$m = -\frac{\overline{\Delta H_V}}{R}$$


$\overline{\Delta H_v}/R\cdot T\,N\,\varepsilon$
ln P
$m = -\frac{\overline{\Delta H_v}}{R}$
$\frac{1}{T}$

$$m = -\frac{\Delta \bar{H}_v}{R} = \frac{cal/mol}{cal/molK} = K$$

$$b = \frac{\Delta \bar{H}_v}{RTNE} = \frac{cal/mol}{(cal/molK)(K)} = \text{a dimensional.}$$

Obtención de la Entalpía de vaporización de una sustancia pura

Insertar en las celdas de color amarillo los valores correspondientes

Temperatura			Presion		
[°C]	[K]	1/T	mmHg	atm	ln p
60	333.15	0.0030017	149.4	0.1965789	-1.6266912
70	343.15	0.0029142	233.7	0.3075	-1.1792802
80	353.15	0.0028317	355.1	0.4672368	-0.760919
90	363.15	0.0027537	525.28	0.6911579	-0.369387
100	373.15	0.0026799	760	1	0

R(cal/molK)	1.9889

m	-5054.4574
b	13.548254
r	-0.9999915

ΔH exp	10052.8102	[cal/mol]
ΔH teorico	9720.00	[cal/mol]
TNE	373.07076	K

Modelo

$$\ln p = -\frac{\Delta Hv}{R}\left[\frac{1}{T}\right] + C$$

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$$m = -5054.4574\ K$$

$$-5054.4574\ K = -\frac{\overline{\Delta H_v}}{R}$$

$$\overline{\Delta H_v} = mR = (5054.4574\ K)\left(1.9889\ \frac{cal}{mol\ K}\right)$$

$$= \frac{10052.81\ cal}{mol}$$

$$b = \frac{\overline{\Delta H_v}}{R\,T_{NE}} = 13.548254$$

$$T_{NE} = \frac{\overline{\Delta H_v}}{R\,b} = \frac{5059.4574\ K}{13.548254} = 373.07\ K$$

$$\ln p = \frac{\Delta H_V}{RTN\varepsilon} - \frac{\Delta H_V}{RT_2}$$

$$\ln p_{vap} = A - \frac{B}{T}$$

Ecuación Antoine

$$\ln p_{vap} = A - \frac{B}{T+C} \qquad T = K$$

$$\ln p_{vap} = A - \frac{B}{t+C} \qquad t = {}^{o}C$$

$$\log p_{vap} = A - \frac{B}{T + C}$$

$$\log p_{vap} = A - \frac{B}{t + C}$$

$$p_{vap} = \begin{cases} mmHg \\ Atm \\ kPa \end{cases}$$

Clausius = 365.84 K

Antoine {

Ecuación de Antoine

Insertar en las celdas de color amarillo los valores correspondientes

Constantes de Antoine			
A	B [K]	C [K ó °C]	
18.30360	3816.4400	-46.13	Modelo 1
7.94897	1657.7000	227.03	Modelo 2

Obtención de temperatura de ebullición y presión de vapor

Modelo 1

$$\ln p = A - \frac{B}{T+C} \quad \therefore \quad T = \frac{B}{A - \ln p} - C$$

$$p = e^{\left[A - \frac{B}{T+C}\right]}$$

T [K]	365.979
T [°C]	92.829

p [mmHg]	584.99

p [mm Hg]	585.00
T [K]	365.98
T [°C]	92.829

Modelo 2

$$\log p = A - \frac{B}{t+C} \quad \therefore \quad t = \frac{B}{A - \log p} - C$$

$$p = 10^{\left[A - \frac{B}{t+C}\right]}$$

T [K]	366.027
T [°C]	92.877

p [mmHg]	585.00

p [mm Hg]	585.00
T [K]	366.027
T [°C]	92.877

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Ecuación de Antoine

Insertar en las celdas de color amarillo los valores correspondientes

Constantes de Antoine			
A	B [K]	C [K ó °C]	
18.30360	3816.4400	-46.13	Modelo 1
7.94897	1657.7000	227.03	Modelo 2

Obtención de temperatura de ebullición y presión de vapor

Modelo 1

$$\ln p = A - \frac{B}{T+C} \quad \therefore \quad T = \frac{B}{A - \ln p} - C$$

$$p = e^{\left[A - \frac{B}{T+C}\right]}$$

T [K]	373.152
T [°C]	100.002

p [mmHg]	759.99

p [mm Hg]	760.00
T [K]	373.152
T [°C]	100.002

Modelo 2

$$\log p = A - \frac{B}{t+C} \quad \therefore \quad t = \frac{B}{A - \log p} - C$$

$$p = 10^{\left[A - \frac{B}{t+C}\right]}$$

T [K]	373.201
T [°C]	100.051

p [mmHg]	760.00

p [mm Hg]	760.00
T [K]	366.027
T [°C]	92.877

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A	B [K]	C [K ó °C]	
18.30360	3816.4400	-46.13	Modelo 1
7.94897	1657.7000	227.03	Modelo 2

$\ln 5 = 1.6094 \qquad \log 5 = 0.6989$

$$\frac{1.6094}{0.6989} = 2.303$$

$$\frac{18.30306}{2.303} = 7.9477 \qquad \frac{3816.44}{2.303} = 1657.16$$

$$C = -46.13 + 273.15 = 227.02$$