Clase 53 24 Noviembre 2020

Título de la nota 24/11/2020

$$\boxed{PV = nRT}$$

$P \to 0$ cambio de Fase

$$\boxed{V = \frac{nRT}{P}}$$

$T \to 0$ $V \to 0$

$P \to \infty$

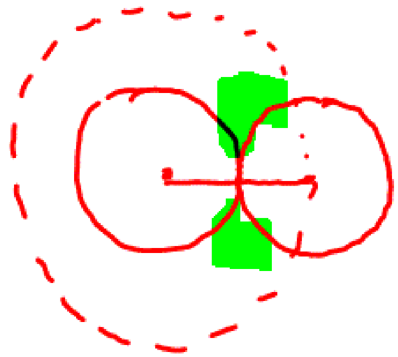
Tercera Ley Termodinámica

$T = 0K$ cristal perfecto $S = 0$

Van der Waals (1876)

Desviaciones

- volumen de exclusión



- presión no ejercida

$$V_{exclusión} = \frac{4}{3}\pi d^3 \quad \text{para 2 molecúlas}$$

$$\bar{V}_{exclusión} = \frac{2}{3}\pi d^3 \quad \text{por molécula}$$

$$\bar{V}_{exclusión} = \frac{2}{3}\pi d^3 N = b$$

$$b = \frac{L}{mol}$$

$$P = \frac{nRT}{V - nb} \qquad \lim_{T \to 0} \quad \boxed{V = nb}$$

$$P = \frac{RT}{\bar{V} - b}$$

$$\boxed{\begin{array}{l} V = nb = 0 \\ nb > V = - \\ \qquad\quad \times \end{array}}$$

$$F \propto C_1 C_2$$

$C_1 = C_2$ gas puro

$$F \propto C^2 \qquad C = M = \frac{n}{V}$$

$$F \propto \left(\frac{n}{V}\right)^2 \qquad P = \frac{F}{A}$$

$$F = \frac{a' n^2}{V^2} \qquad P = \frac{a' n^2}{V^2 A}$$

$$P = \frac{an^2}{V^2} = atm$$

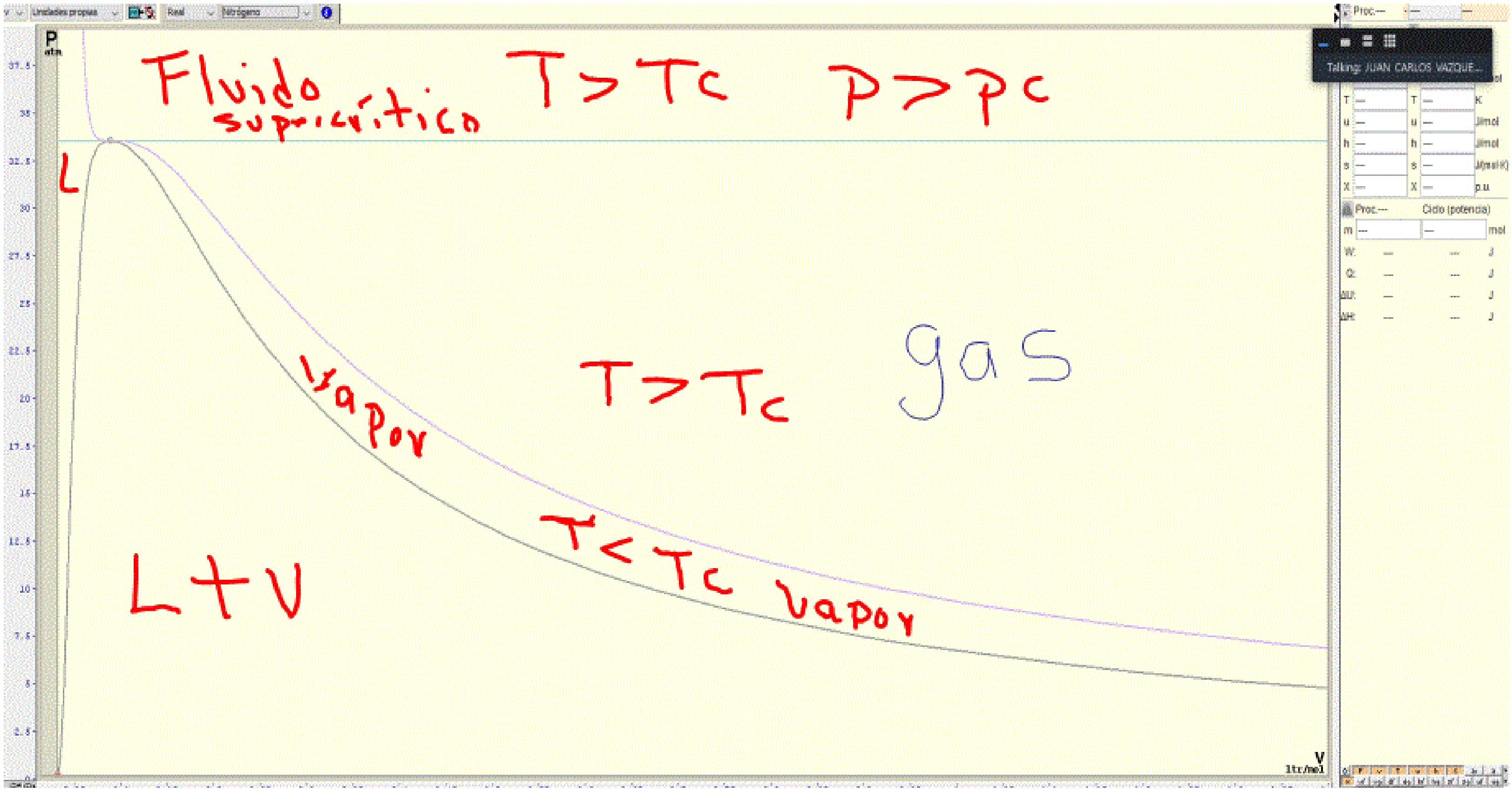
$$\boxed{a = \frac{atm\, L^2}{mol^2}}$$

$$P = \frac{nRT}{V-nb} - \frac{an^2}{V^2}$$

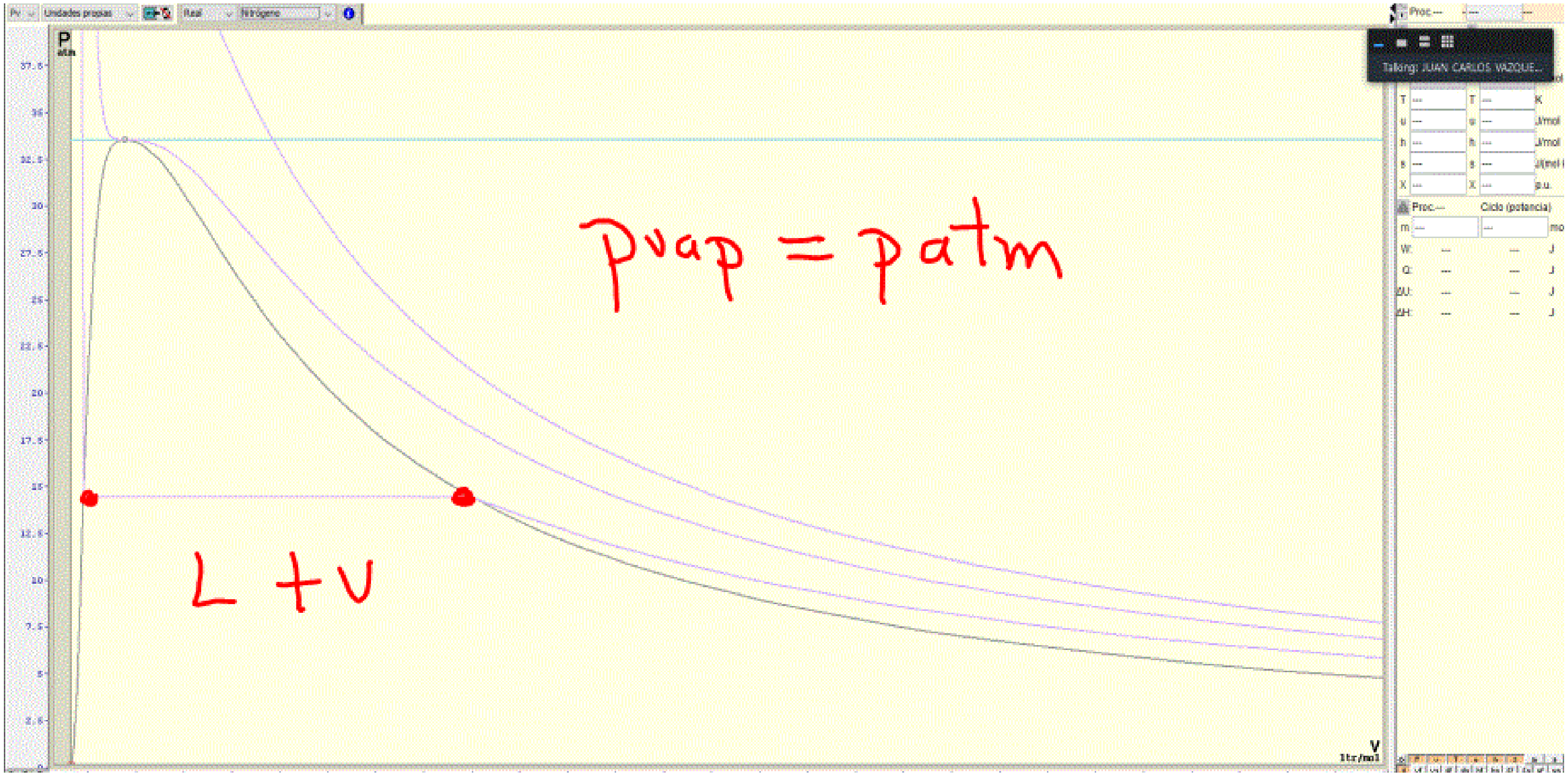
Extensivas e intensivas

$$P = \frac{RT}{\bar{V}-b} - \frac{a}{\bar{V}^2}$$

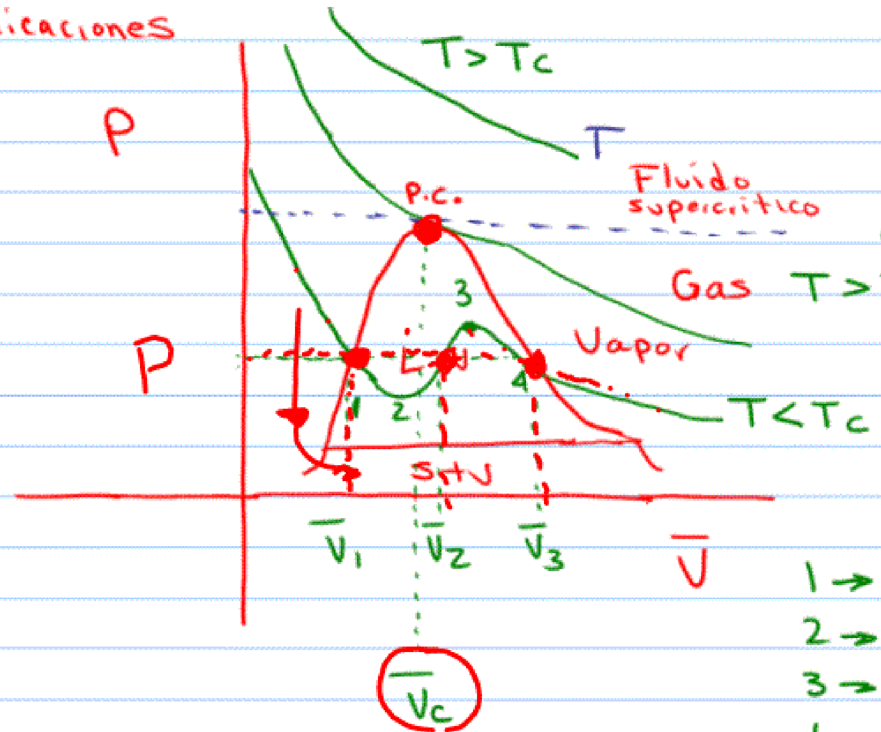
intensivas



$$\text{vapor}\begin{cases} T < T_c \\ p < p_c \end{cases} \qquad \text{gas}\begin{cases} T > T_c \\ p < p_c \end{cases}$$


P
atm
pvap = patm
L + V
V
ltr/mol

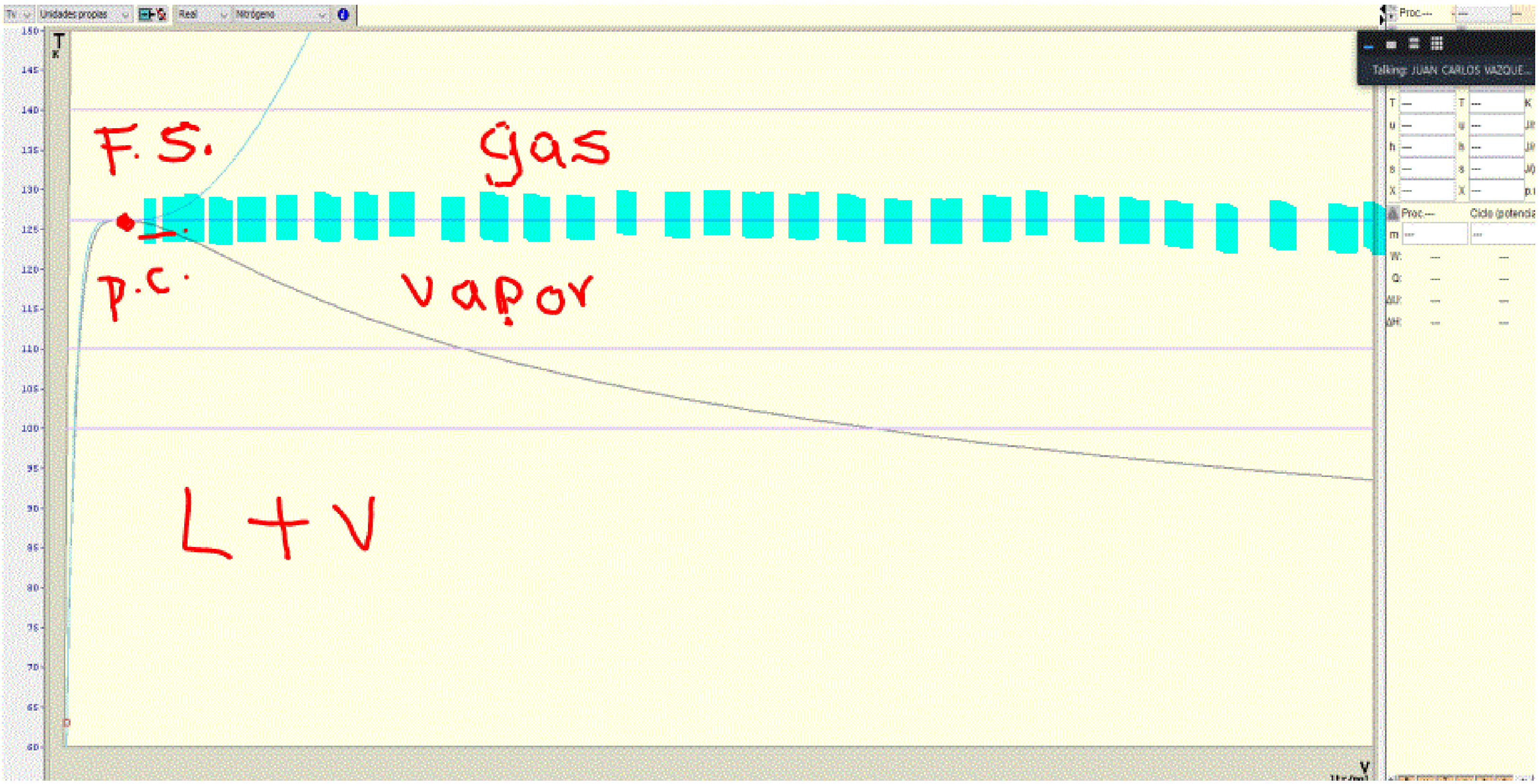
Implicaciones



esto implica que el volumen tiene:

- 3 raíces iguales reales
- 1 raíz real, 2 imaginarias
- 3 raíces reales ≠

1 → 2 metaestable
2 → 3 imposible
3 → 4 posible vapor condensado
1 → 4 transformación L→V


F.S.
gas
p.c.
vapor
L+V
T
Talking: JUAN CARLOS VAZQUE...

$$\left(\frac{\partial T}{\partial \bar{V}}\right)_{p.c.} = 0$$

$$\left(\frac{\partial^2 T}{\partial \bar{V}^2}\right)_{p.c.} = 0$$

$$P = \frac{nRT}{V-nb} - \frac{an^2}{V^2}$$

$$\boxed{P = \frac{RT}{\bar{V}-b} - \frac{a}{\bar{V}^2}}$$

$$\left(p + \frac{a}{\bar{V}^2}\right) = \frac{RT}{\bar{V} - b}$$

$$\left(p + \frac{a}{\bar{V}^2}\right)\left(\bar{V} - b\right) = RT$$

$$p\bar{V} - pb + \frac{a\bar{V}}{\bar{V}^2} - \frac{ab}{\bar{V}^2} = RT$$

$$T = \frac{p\bar{V}}{R} - \frac{pb}{R} + \frac{a}{\bar{V}R} - \frac{ab}{\bar{V}^2 R}$$

$$T_c = \boxed{\frac{P_c \bar{V}_c}{R}} \boxed{- \frac{P_c b}{R} + \frac{a}{\bar{V}_c R} - \frac{ab}{\bar{V}_c^2 R}}$$

$$\left(\frac{\partial T}{\partial \bar{V}}\right)_{p.c.} = \frac{P_c}{R} - \frac{a}{\bar{V}_c^2 R} + \frac{2\bar{V}_c ab}{\bar{V}_c^4 R}$$

$$= \boxed{\frac{P_c}{R}} - \boxed{\frac{a}{\bar{V}_c^2 R} + \frac{2ab}{\bar{V}_c^3 R}} = 0$$

$$\left(\frac{\partial T^2}{\partial \bar{V}^2}\right) = \frac{2a\bar{V}_c}{\bar{V}_c^4 R} - \frac{6\bar{V}_c^2 ab}{\bar{V}_c^6 R} = 0$$

$$= \frac{2a}{\bar{V}_c^3 R} - \frac{6ab}{\bar{V}_c^4 R} = 0$$

$$\left[= \frac{p_c}{R} - \frac{a}{\bar{V}_c^2 R} + \frac{2ab}{\bar{V}_c^3 R} = 0 \right] \frac{3}{\bar{V}_c}$$

$$\frac{3p_c}{\bar{V}_c R} - \frac{3a}{\bar{V}_c^3 R} + \frac{6ab}{\bar{V}_c^4 R}$$

$$\frac{3p_c}{\bar{V}_c R} - \frac{3a}{\bar{V}_c^3 R} + \cancel{\frac{6ab}{\bar{V}_c^4 R}} = 0$$

$$\frac{2a}{\bar{V}_c^3 R} - \cancel{\frac{6ab}{\bar{V}_c^4 R}} = 0$$

$$-$$

$$\frac{3p_c}{\bar{V}_c R} \quad \frac{a}{\bar{V}_c^3 R} = 0$$

$$\frac{3p_c}{\cancel{\bar{V}_c}\,\cancel{R}} = \frac{a}{\bar{V}_c^{\cancel{3}\,2}\,\cancel{R}}$$

$$\boxed{a = 3p_c\bar{V}_c^2 \quad \frac{\text{atm } L^2}{\text{mol}^2}}$$

$$\frac{2a}{\bar{V}_c^3 R} = \frac{6ab}{\bar{V}_c^4 R}$$

$$\frac{2(3p_c\bar{V}_c^2)}{\bar{V}_c^3 R} = \frac{6(3p_c\bar{V}_c^2)b}{\bar{V}_c^4 R}$$

$$\frac{6\cancel{p_c}\cancel{\bar{V}_c^2}}{\cancel{\bar{V}_c^3}\cancel{R}} = \frac{18\cancel{p_c}\cancel{\bar{V}_c^2}\,b}{\cancel{V_c^4}\cancel{R}}$$

$$\boxed{b = \frac{1}{3}\bar{V}_c = \frac{L}{mol}}$$

obtener V

$$P = \frac{nRT}{V-nb} - \frac{an^2}{V^2}$$

$$\left(P + \frac{an^2}{V^2}\right) = \frac{nRT}{V-nb}$$

$$\frac{PV^2 + an^2}{V^2} = \frac{nRT}{V-nb}$$

$$(PV^2 + an^2)(V-nb) = V^2 nRT$$

$$(pv^2 + an^2)(v - nb) = v^2 nRT$$

$$pv^3 - pv^2 nb + an^2 v - an^3 b = v^2 nRT$$

$$pv^3 - pv^2 nb - v^2 nRT + an^2 v - an^3 b$$

$$\frac{pv^3 - v^2(pnb + nRT) + v an^2 - an^3 b = 0}{p}$$

$$v^3 - v^2\left(nb + \frac{nRT}{p}\right) + \frac{v an^2}{p} - \frac{an^3 b}{p} = 0$$

$$L^3 - L^2\left(\frac{\cancel{mol}\,L}{\cancel{mol}} + L\right) + L\,\frac{\cancel{atm}\,L^2}{\cancel{mol^2}}\,\frac{\cancel{mol^2}}{\cancel{atm}} -$$

$$\boxed{L^3 - L^3 + L^3 - L^3} = 0$$

$$\frac{a n^3 b}{P} = \frac{\cancel{atm}\, L^2}{\cancel{mol^2}\, \cancel{atm}} \; \frac{\cancel{mol^3}\, L}{\cancel{mol}}$$

$$\boxed{V^3 - V^2\left(nb + \frac{nRT}{P}\right) + \frac{V a n^2}{P} - \frac{a n^3 b}{P} = 0}$$

$$P = \frac{RT}{\bar{V} - b} - \frac{a}{\bar{V}}$$