① 3L 2 moles y 25°C.

a) $P_c = 72'9$ atm $\quad T_c = 304'2$ K $\quad \Delta P$ (real-ideal)

gas real de Van der Waals.

$$\left(P + \frac{a}{v^2}\right)(v - b) = RT.$$

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

$$\left(\frac{\partial P}{\partial v}\right)_{T_c} = 0 \Rightarrow -\frac{RT}{(v-b)^2} + \frac{2a}{v^3} = 0$$

$$\frac{2a}{v^3} = +\frac{RT}{(v-b)^2}$$

$$\left(\frac{\partial^2 P}{\partial v}\right)_{T_c} = 0 \qquad \frac{2RT}{(v-b)^3} - \frac{6a}{v^4} = 0$$

$$\begin{cases} \dfrac{2a}{v^3} = \dfrac{RT_c}{(v-b)^2} \\[2mm] \dfrac{6a}{v^4} = \dfrac{2RT_c}{(v-b)^3} \end{cases}$$

$$\frac{\frac{2\cancel{a}}{v^3}}{\frac{6\cancel{a}}{v^4}} = \frac{\frac{\cancel{R}T_c}{\cancel{(v-b)^2}}}{\frac{2\cancel{R}T_c}{(v-b)^{\cancel{3}}}} \Rightarrow \frac{v}{3} = \frac{(v-b)}{2} \Rightarrow v - b = \frac{2}{3}b$$

$$b = v - \frac{2}{3}v \Rightarrow \quad 3b = v_c \Rightarrow \boxed{b = \frac{v_c}{3}}$$

$$\frac{2a}{v^3} = \frac{RT}{(v - \frac{v}{3})^2} \Rightarrow \frac{2a}{27b^3} = \frac{RT}{(3b-b)^2} = \frac{2a}{27b^3} = \frac{RT}{4b^2}$$

$$\boxed{\frac{8a}{27bR} = T_c}$$

$$P_c = \frac{RT_c}{(v-b)} - \frac{a}{v^2} \Rightarrow \frac{\cancel{R}\cdot 8a}{27b\cancel{R}(2b)} - \frac{9a}{b^2} = \frac{4a}{27b^2} - \frac{9a}{b^2} =$$

$$\left.\frac{a}{27b^2}\right]$$

$$\frac{T_c}{P_c} = \frac{\frac{8a}{27bR}}{\frac{a}{27b^2}} = \frac{8b}{R} \Rightarrow$$

$$\frac{T_c}{P_c} = \frac{8b}{R} \Rightarrow b = \frac{R\,T_c}{8\,P_c} = \frac{8'314\cdot 304'2}{8\cdot 72'9\cdot 101325} = 4'27\cdot 10^{-5}\ m^3/mol.$$

$$P_c = \frac{a}{27b^2} \Rightarrow 27b^2\cdot P_c = a \Rightarrow a = 27(4'27\cdot 10^{-5})^2\cdot 72'9\cdot 101325 =$$

$$= 0'365\ \text{Pa}\ \frac{m^6}{mol^2} \ //$$

[Pa]

$a = 0'365$ y $b = 4'27\cdot 10^{-5}$

$$P^{real}_{3L/2mol} = \frac{8'31\cdot 298'15}{\left(\frac{3\cdot 10^{-3}}{2} - 4'27\cdot 10^{-5}\right)} - \frac{0'365}{\left(\frac{3\cdot 10^{-3}}{2}\right)^2} = 1'53\cdot 10^6\ Pa.$$

v molar

$$P^{ideal} = \frac{nRT}{V} = \frac{2\cdot 8'314\cdot 298'15}{3\cdot 10^{-3}} = 1'65\cdot 10^6\ Pa$$

$$\Delta(P^{id} - P^{real}) = 12\cdot 10^4\ Pa.$$

b) gas ideal!!! se expande de $V_1 \to 2V_1$;

ΔU, Q y W.

1) isotermo; $T = cte$ $\Delta U = 0$

$$W = -Q \Rightarrow dW = -\int_{V_1}^{V_2} P\,dV = -nRT \int_{V_1}^{V_2} \frac{dV}{V} = -nRT \ln\left(\frac{V_2}{V_1}\right) =$$

$$= 2 \cdot 8'31 \cdot 298'15 \ln(2) = -3434'71\ J$$

$$Q = 3434'71\ J$$

2) adiabático; $dQ = 0$

$\Delta U = W;$ gas diatónico $c_V = \frac{5}{2}R$

$PV^{\gamma} = cte$

$$\boxed{\gamma = \frac{c_P}{c_V} = \frac{7}{5}}$$

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$P_1 = 1'65 \cdot 10^6\ Pa$

$V_2 = 6L$

$$P_2 = P_1 \cdot \left(\frac{V_1}{V_2}\right)^{\gamma} = 1'65 \cdot 10^6 \cdot \left(\frac{3}{6}\right)^{7/5}$$

$$P_2 = 6'25 \cdot 10^5\ Pa$$

$$\frac{P_2 V_2}{R\,n} = T_2 \Rightarrow T_2 = \frac{6'25 \cdot 10^5 \cdot 6 \cdot 10^{-3}}{8'31 \cdot 2} = 225'71\ K.$$

$$\Delta U = n C_v \Delta T = 2 \cdot \frac{5}{2}\, 8'31 \cdot (225'71 - 298'15) =$$

$$= 3009'63\ J$$

3) Politrópico orden 2.

$$P_1 V_1^{n} = P_2 V_2^{n}$$

$$P_1 V_1^{n} = cte \Rightarrow PV^{n} = cte \Rightarrow P = \frac{cte}{V^n}$$

$$W = -\int_{V_1}^{V_2} P\,dV = -\int_{V_1}^{V_2} \frac{cte\,dV}{V^n} = -cte \int_{V_1}^{V_2} dV\,V^{-n} =$$

$$-Cte \cdot \frac{V^{-n+1}}{(-n+1)}\Bigg|_{V_2}^{V_1} = -Cte \left(\frac{V^{-1}}{-1}\right)\Bigg|_{V_1}^{V_2} \Rightarrow$$

$$+ Cte\,(V_2^{-1} - V_1^{-1}) = Cte\,V_2^{-1} - Cte\,V_1^{-1} =$$

$$(P_2 V_2^2 V_2^{-1} - P_1 V_1^2 V_1^{-1}) = P_2 V_2 - P_1 V_1 =$$

$$P_2 V_2^n = P_1 V_1^n$$

$$P_2 = 1'65 \cdot 10^6 \left(\frac{3}{6}\right)^2 = 4'125 \cdot 10^5 \ Pa$$

$$= 4'125 \cdot 10^5 \cdot 6 \cdot 10^{-3} - 1'65 \cdot 10^6 \cdot 3 \cdot 10^{-3} = -2475 \ J$$

$$T_2 = \frac{4'125 \cdot 10^5 \cdot 6 \cdot 10^{-3}}{2 \cdot 8'314} = 148'84 K$$

$$\Delta U = 2 \cdot \frac{5}{2} \cdot 8'314\,(148'84 - 298'15) = -6206'81 \ J$$

$$Q = \Delta U - W = -6206'81 + 2475 = -3731'81 \ J$$

②

Curva vap; $\log_{10} P = 7'540 - \frac{1511}{T}$

Curva subl; $\log_{10} P = 10'648 - \frac{2559}{T}$

a) P y T en T_3

$$7'540 - \frac{1511}{T_3} = 10'648 - \frac{2559}{T_3} \Rightarrow$$

$$\frac{2559 - 1511}{T_3} = 10'648 - 7'540$$

$$T_3 = \frac{2559 - 1511}{10'648 - 7'540} = 337'19\ K.$$

Calculamos la presión;

$$\log_{10}(P_3) = 10'648 - \frac{2559}{337'19} \Rightarrow$$

$$P_3 = 10^{3'0588} = 1145\ mmHg$$

b) $P = 760\ mmHg \rightarrow$ a que T? Se produce el equilibrio?

Vaporización; líquido - gas;

$$\log_{10}(760) = 7'540 - \frac{1511}{T}$$

$$T_{vap} = \frac{1511}{7'540 - \log_{10}(760)} = 324'30 K.$$

sublimación; sólido - gas:

$$T_{sub}: \frac{2559}{10'648 - \log_{10}(760)} = 329'46 K.$$

* El equilibrio se encuentra en la fase líquido gas porque la substancia llega antes a 324'30 K que a 329'46 K!!

c) Calores latentes en J/g de fusión, vaporización y sublimación.

$M(UF_6) = 352 g/mol$

La ecuación de Clausius Clapeyron establece

$$\frac{dP}{dT} = \frac{l}{T\Delta v}$$

y que en los cercanías del punto triple;

$$l_{s,3} = l_{f,3} + l_{v,3}$$

-> otra forma de llegar a la fórmula.

$$h_3^{cv} - h^{cl} = (h_3^{cv} - h^{cs}) + (h^{cs} - h^{cl})$$

$$\parallel$$

$$l_{v_3} = l_{s,3} - l_{f,3}$$

$$\boxed{l_{v_3} + l_{f,3} = l_{s,3}}$$

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vaporización;

$$\frac{d(\log_{10} P)}{dT} = \frac{1}{P\ln(10)}\frac{dP}{dT} = \frac{1511}{T^2}$$

$$\frac{dP}{dT} = \frac{l_{vap}}{T(v^{cg} - v^{cl})} \overset{v^{cg} \gg v^{cl}}{\simeq} \frac{l_{vap}}{T(v^{cg})}$$

$$\frac{dP}{dT} = \frac{1511}{\cancel{T^2}} P\ln(10) = \frac{l_{vap}}{T \cdot v} = \frac{l_{vap}\, P}{RT^2}$$

$$P \cdot v = RT \Rightarrow v = \frac{RT}{P}$$

$l_{vap} = 1511 \ln(10) \cdot 8'31 \, J/mol = 28926 \, J/mol \cdot \frac{1 \, mol}{352 \, g} = 82' \, J/g.$

Sublimación; El procedimiento es el mismo; Por ello

$l_{sub} = 2559 \cdot \ln(10) \cdot 8'31 = 48965'14 \, J/mol = 139'10 \, J/g$

$l_{s_3} = l_{f_3} + l_{v,3}$

$\boxed{l_{f_3} = 139'10 - 82 = 57'10 \, J/g}$

Parte Keta:

$V = 10 \, m^3$ $n = 2K$ mol de A y 1K mol de B

$A(g) + 2B(g) \rightleftarrows C(g)$ $T = 500 K$

$P_{eq} = 10 atm$

a) K_p y K_c

$n = n^0 + \xi \cdot \nu_i$

$n_A = 2 \cdot 10^3 - \xi$

$n_B = 1 \cdot 10^3 - 2\xi$

$n_C = \xi$

$n_t = 3 \cdot 10^3 - 2\xi$

$x_A = \frac{2 \cdot 10^3 - \xi}{3 \cdot 10^3 - 2\xi}$

$$x_B = \frac{1\cdot10^3 - 2\xi}{3\cdot10^3 - 2\xi}$$

$$x_C = \frac{\xi}{3\cdot10^3 - 2\xi}$$

$$K_p = \prod^{r+p} P_i^{v_i} = P^{\Delta v} \prod x_i^{v_i} = K_x \cdot P^{\Delta v}$$

$$PV = nRT$$

$$PV = n_T RT \Rightarrow n_T = \frac{PV}{RT} \Rightarrow n_T = \frac{10\cdot 101325\cdot 10}{8'31\cdot 500} =$$

$$2'438\cdot10^3 \text{ mol}$$

$$n_T = 3\cdot10^3 - 2\xi \Rightarrow \xi = \frac{3\cdot10^3 - 2'438\cdot10^3}{2} = 280'69 \text{ mol}$$

$$n_A = 2\cdot10^3 - \xi = 1719'31 \text{ mol}$$

$$n_B = 1\cdot10^3 - 2\xi = 438'62 \text{ mol}$$

$$n_C = 280'69 \text{ mol}$$

$$x_A = \frac{1719'31}{2438} = 0'705$$

$$x_B = \frac{438'62}{2438} = 0'18$$

$$x_C = \frac{280'69}{2438} = 0'115$$

$$P_A = x_A P_T$$
$$P_B = x_B P_T$$
$$P_C = x_C P_T$$

$$K_p = \frac{0'115 P_T}{0'705 P_T \cdot (0'18\cdot P_T)^2} = 4'903\cdot10^{-12}$$

$$K_p = (RT)^{\Delta v} K_c \Rightarrow K_c = \frac{4'903\cdot10^{-12}}{(8'31\cdot500)^{-2}} = 8'46\cdot10^{-5}$$

b) Si $K_c \uparrow$ al elevar la temperatura suponiendo H escte.

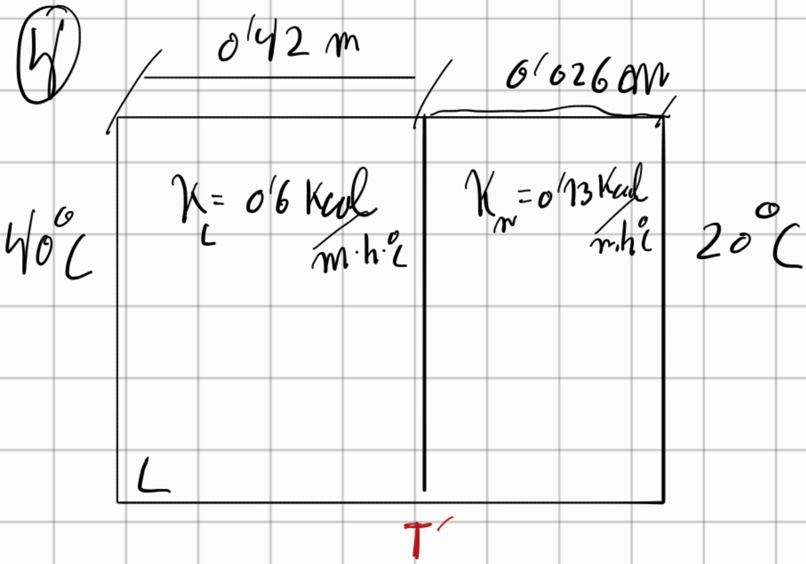
Van't Hoff: $$\frac{\partial \ln K_p}{\partial T} = \frac{\widetilde{\Delta H^0}}{RT^2}$$

$$\ln\left(\frac{K_{c_2}}{K_{c_1}}\right) = \frac{\Delta \tilde{H}_0}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)$$

$$\ln(2) = \frac{\Delta \tilde{H}_0}{R}\overbrace{\left(\frac{1}{T_1}-\frac{1}{T_2}\right)}^{>0}$$

$$\ln(2)\cdot R = \widetilde{\Delta H_0} > 0$$ endotérmica.

4)



a) J a través del muro por m².

de las ecuaciones fenomenológicas sabemos:

$$J_u = J_a + \bar{\mu}\,\cancel{J_n}^{\to 0}$$ no hay carga eléctrica.

$$J_u = J_a \Rightarrow \nabla\cdot J_u = -\cancel{\frac{\partial u}{\partial t}}^{\to 0} = \nabla\cdot J_a = -K\nabla^2 T = 0 \Rightarrow$$

$$\nabla^2 T = 0 \Rightarrow \frac{dT}{dx} = a \Rightarrow T(x) = ax + b$$

Para la primera región

$$T(x) = ax + b$$

$$T(0) = T_1 = b$$

$$T(42 \cdot 10^{-2}) = T' = a\, 42 \cdot 10^{-2} + T_1 \Rightarrow \frac{T' - T_1}{42 \cdot 10^{-2}} = a$$

$$T^{R_1} = \frac{T' - T_1}{42 \cdot 10^{-2}} x + T_1$$

$$T^{R_2} = a' x + b' \qquad T^{R_2}(0) = T' = b' \qquad a' = \frac{T_2 - T'}{2'6 \cdot 10^{-2}}$$

$$T^{R2} = \frac{T_2 - T'}{2'6 \cdot 10^{-2}} x + b$$

$$J_{Q_1} = J_{Q_2} = J_Q$$

$$J_{Q_1} = -K \frac{T' - T_1}{42 \cdot 10^{-2}} \Rightarrow$$

$$\frac{T_1 - T'}{42 \cdot 10^{-2}} K_1 = J_{Q_1}$$

$$\frac{T' - T_2}{2'6 \cdot 10^{-2}} K_2 = J_{Q_2}$$

$$T_1 - T' = \frac{J_Q\, 42 \cdot 10^{-2}}{K_1}$$

$$T' - T_2 = \frac{J_Q \cdot 2'6 \cdot 10^{-2}}{K_2}$$

$$T_1 - T_2 = J_Q \left(\frac{42 \cdot 10^{-2}}{K_1} + \frac{2'6 \cdot 10^{-2}}{K_2} \right)$$

$$J_Q = \frac{T_1 - T_2}{\left(\frac{42 \cdot 10^{-2}}{K_1} + \frac{2'6 \cdot 10^{-2}}{K_2} \right)}$$

$$K_1 = 0'6 \frac{\text{Kcal}}{\text{m h °C}} \cdot \frac{1000\ \text{cal}}{1\ \text{Kcal}} \cdot \frac{4'18\ \text{J}}{1\ \text{cal}} \cdot \frac{1\ \text{h}}{60\ \text{min}} =$$

$$41'8 \frac{\text{J}}{\text{m} \cdot \text{min} \cdot °\text{C}}$$

$$K_2 = 0'13 \frac{Kcal}{m h\,{}^{o}C} \cdot \frac{1000 cal}{1 Kcal} \cdot \frac{4'18 J}{1 cal} \cdot \frac{1h}{60 min} = 9'056 \frac{J}{m \cdot min\,{}^{o}C}$$

$$J_a = \frac{40 - 20}{\left(\frac{42 \cdot 10^{-2}}{41'8} - \frac{26 \cdot 10^{-2}}{9'056}\right)} = 1548'15 \frac{J}{min \cdot m^2}$$

b) T?

$$J_a = K_1 \frac{T_1 - T'}{42 \cdot 10^{-2}} \Rightarrow \frac{J_a\, 42 \cdot 10^{-2}}{K_1} = T_1 - T' \Rightarrow T' = T_1 - \frac{J_a \cdot 42 \cdot 10^{-2}}{K_1}$$

$$T' = 40^{o}C - \frac{1548 \cdot 42 \cdot 10^{-2}}{41'8} = 24'45\,{}^{o}C$$

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3 Parte; (Pepa)

$$\langle v \rangle = \int_0^{\infty} v\, G(v)\, dv = 4\pi \left(\frac{B}{\pi}\right)^{3/2} \int_0^{\infty} v^3 e^{-Bv^2} dv =$$

$$B = \frac{m}{2 K_B T}$$

$$4\pi \left(\frac{B}{\pi}\right)^{3/2} \frac{1}{2B^2} = \frac{2}{\sqrt{\pi}} \sqrt{\frac{1}{B^{-1}}} = 2\sqrt{\frac{2 K_B T}{\pi m}} = \sqrt{\frac{8 K_B T}{\pi m}}$$

$$\langle v^2 \rangle = \int_0^{\infty} v^2 G(v)\, dv = 4\pi \left(\frac{B}{\pi}\right)^{3/2} \int_0^{\infty} v^4 e^{-Bv^2} dv =$$

$$4\pi \cdot \frac{3}{8} \left(\frac{B}{\pi}\right)^{3/2} \cdot \sqrt{\frac{\pi}{B^5}} = \frac{3}{2} \frac{\pi^{3/2}}{\pi^{3/2}} \frac{B^{3/2}}{B^{5/2}} = \frac{3}{2} \frac{1}{B} =$$

$$\frac{3}{2} \frac{2 K_B T}{m} = \frac{3 K_B T}{m} = \langle v^2 \rangle$$

$$\sqrt{\langle v^2 \rangle} = \sqrt{\frac{3 K_B T}{m}}$$

$$\langle v \rangle = \sqrt{\frac{8 K_B T}{\pi m}}$$

$$\frac{\langle v \rangle}{\sqrt{\langle v^2 \rangle}} = \frac{\sqrt{\frac{8 \cancel{K_B T}}{\pi \cancel{m}}}}{\sqrt{\frac{3 \cancel{K_B T}}{\cancel{m}}}} = \sqrt{\frac{8}{3\pi}} =$$

$0'921 \rightarrow$ similitud $\Rightarrow$ error $= 1 - 0'921 = 0'0787 \Rightarrow$

el error será: $7'87\%$

b) Demuestra que $\langle v \rangle \cdot \langle \frac{1}{v} \rangle = \frac{4}{\pi}$

$$\langle v \rangle = \sqrt{\frac{8 K_B T}{\pi m}}$$

$$\langle \frac{1}{v} \rangle = 4\pi \left(\frac{B}{\pi}\right)^{3/2} \cdot \int_0^\infty v \cdot e^{-Bv^2} dv = 4\pi \cdot \left(\frac{B}{\pi}\right)^{3/2} \cdot \frac{1}{2B}$$

$$\frac{2}{\sqrt{\pi}} \cdot B^{1/2} \qquad \frac{2}{\sqrt{\pi}} \cdot B^{1/2} = 2 \sqrt{\frac{m}{2\pi K_B T}}$$

$$\langle v \rangle \cdot \langle \frac{1}{v} \rangle = 2 \sqrt{\frac{\cancel{m}}{2\pi \cancel{K_B T}}} \cdot \sqrt{\frac{8 \cancel{K_B T}}{\pi \cancel{m}}} = \frac{4}{\pi} //$$

② $D = 0'19 \, cm^2/s$ del O_2 a $T = 273K$. $P = 1 atm$

$$D = 0'19 \, \cancel{cm^2}/s \cdot \frac{1 m^2}{10000 \cancel{cm^2}} = 0'19 \cdot 10^{-4} \, m^2/s$$

$$D = \frac{2}{3 \sigma n} \sqrt{\frac{K_B T}{m \cdot \pi}}$$

$$P \cdot V = N K_B T$$

$$P = n K_B T$$

$$n = \frac{P}{K_B T}$$

$$D = \frac{2 K_B T}{3 \sigma P} \sqrt{\frac{K_B T}{m \cdot \pi}}$$

a) D a $0^o C$ y P 1000 atm

$$\frac{D(1atm)}{D(1000\,atm)} = \frac{\frac{\cancel{2 K_B T}}{\cancel{3\sigma} P_1} \cancel{\sqrt{\frac{K_B T}{m \pi}}}}{\frac{\cancel{2 K_B T}}{\cancel{3\sigma} P_2} \cancel{\sqrt{\frac{K_B T}{m \pi}}}} = \frac{P_2}{P_1}$$

$$D(1000\,atm) = \frac{D(1atm) \cdot P_1}{P_2} = \frac{0'19 \cdot 10^{-4} \cdot 1}{1000} = 0'19 \cdot 10^{-7}\ m^2/s$$

b) $\nabla P = 0'2026\ atm/m$ a $0^o C$ y 1 atm $\Rightarrow D = 0'19 \cdot 10^{-4}\ m^2/s$

J?

De la ley de fick sabemos; $J = -D\,\nabla n = -D \frac{\partial n}{\partial z} =$

nosotros sabemos el gradiente de presión y sabemos que;

$$n = \frac{P}{K_B T} \Rightarrow \nabla n = \frac{\nabla P}{K_B T}$$

$$\Rightarrow J = -D(1atm) \frac{\nabla P}{K_B T} = -0'19 \cdot 10^{-4} \cdot \frac{20528'44}{1'38 \cdot 10^{-23} \cdot 273} =$$

$$0'2026\ atm/m \cdot \frac{101325\ Pa}{1\ atm} = 20528'44\ Pa/m$$

$= (+)\ 1'0381 \cdot 10^{19}\ \frac{molec}{m^2 \cdot s}$

Da igual el signo

$[D] = \frac{m^2}{s}$

$\left[\nabla n = \frac{\partial n}{\partial z}\right] = \frac{molé\acute{c}}{m^3 \cdot m}$

$[J] = [D]\left[\frac{\partial n}{\partial z}\right] = \frac{molé\acute{c}}{m^2 \cdot s}$ ✓

ben feito.