

Ex4 P54

Partie A,

tension de vapeur = Pression
= Pression Saturante

$$A^{\alpha} = A^{\beta}$$

$$1) \begin{cases} \mu_A^{\alpha} = \mu_A^{\beta} \\ d\mu_A^{\alpha} = d\mu_A^{\beta} \end{cases} \rightarrow \begin{cases} H_m^{\alpha} - TS_m^{\alpha} = H_m^{\beta} - TS_m^{\beta} \\ V_m^{\alpha} dP - S_m^{\alpha} dT = V_m^{\beta} dP - S_m^{\beta} dT \end{cases}$$

$$\rightarrow \frac{dP}{dT} = \frac{\Delta S^{\alpha \rightarrow \beta}}{V_m^{\beta} - V_m^{\alpha}} = \frac{\Delta H^{\alpha \rightarrow \beta}}{V_m^{\beta} - V_m^{\alpha}}$$

2) a) $liq \rightleftharpoons vap$ $\Delta H_{vap} = \text{cste}$

$$\frac{dP}{dT} = \frac{\Delta H_{vap}}{T(V_m^{vap} - V_m^{liq})}$$

$$V_m^{vap} = \frac{RT}{P}$$

$$\rightarrow \int_{P_0}^P \frac{dP}{P} = \frac{\Delta H_{vap}}{R} \int_{T_0}^T \frac{dT}{T^2}$$

$$\ln \frac{P}{P_0} = \frac{\Delta H_{vap}}{RT_{eb}} - \frac{\Delta H_{vap}}{R \times T}$$

b) $\Delta H_{vap} = a + b \times T$

$$\frac{dP}{P} = \frac{(a + bT)}{R} \frac{dT}{T^2}$$

SP-1-

$$\int_{p_0}^P \frac{dP}{P} = \frac{a}{R} \int_{T_{eb}^0}^T \frac{dT}{T^2} + \frac{b}{R} \int_{T_{eb}^0}^T \frac{dT}{T}$$

$$\ln \frac{P}{p_0} = \frac{a}{RT_{eb}^0} - \frac{a}{R \times T} + \frac{b}{R} \ln \frac{T}{T_{eb}^0}$$

Partie B.

$$\text{on a } \log \frac{P}{p_0} \xrightarrow{\text{bar.}} = 5,8 - \frac{195714}{T \rightarrow K}$$

1) normale $\rightarrow P = P^0$

$$\rightarrow \log \frac{P^0}{p_0} = 5,8 - \frac{195714}{T_{eb}^0}$$

$$T_{eb}^0 = 337,48 K$$

$$2) \frac{dP}{dT} = \frac{\Delta_{vap} H}{T(V_m^{vap} - V_m^{liq})} \rightarrow \int_{p_0}^P \frac{dP}{P} = \frac{\Delta_{vap} H}{R} \int_{T_{eb}^0}^T \frac{dT}{T^2}$$

$V_m^{liq} \ll V_m^{vap} \approx \frac{RT}{P}$

$$\ln \frac{P}{p_0} = \frac{\Delta_{vap} H}{RT_{eb}^0} - \frac{\Delta_{vap} H}{R \times T}$$

↓

$$\log \frac{P}{p_0} = \frac{\Delta_{vap} H}{2,3 R T_{eb}^0} - \frac{\Delta_{vap} H}{2,3 R \times T}$$

P-2-

$$\Rightarrow \Delta H_{\text{vap}} = 2,3 \times 8,314 \times 10^{-3} \times 1957,4$$

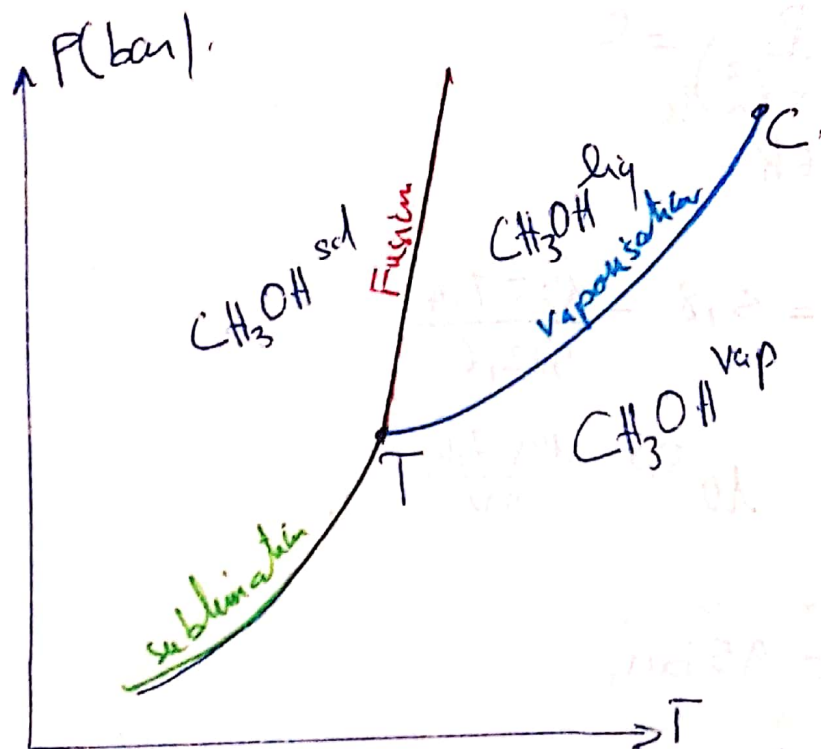
$$\Delta H_{\text{vap}} = 37,429 \text{ kJmol}^{-1}$$

Partie C.

Fusion. $\text{sol} \rightleftharpoons \text{liq.}$

$$\frac{dP}{dT} = \frac{\Delta_{\text{fus}} H}{T(V_m^{\text{liq}} - V_m^{\text{sol}})} \quad \text{or} \quad p^{\text{sol}} > p^{\text{liq}} \\ V_m^{\text{sol}} < V_m^{\text{liq}}$$

$$\Rightarrow \frac{dP}{dT} > 0$$



3) : T: pt triple : coexistence des 3 phases
sol, liq et vap en équilibre.

C: pt Critique : au delà de ce pt on ne peut plus distinguer entre la phase liq et Vap (il s'agit d'une seule phase fluide).

4) a) $F = 3 - f$ sur les courbes $f = 2$.

$$F = 1$$

b) T: $f = 3 \rightarrow F = 0$

au pt C: $F = (1 - 2 - 0) + (2 - 1) = 0$

$$r = 2 \begin{cases} \left(\frac{\partial P}{\partial V_m} \right)_T = 0 \\ \left(\frac{\partial^2 P}{\partial V_m^2} \right)_T = 0 \end{cases}$$

c) $T_C = 512,6 \text{ K}$.

$$\log \frac{P_C}{P^0} = 5,8 - \frac{1957,4}{912,6}$$

$$P_C = P^0 \cdot 10^{5,8 - \frac{1957,4}{912}}$$

$$P_C = 95 \text{ bar}$$

Partie D.

1) $P_C \text{ (exp)} = 81 \text{ bar} \neq P_C \text{ (theor)}$ car l'équation

$$\log P = 5,8 - \frac{1957,4}{T} \text{ valable entre } -20^\circ\text{C et } 100^\circ\text{C}$$

P-4-

$$b) \Delta H_{\text{vap}}^{\circ}(T_c) = 0 \text{ J mol}^{-1}$$

E_{x5}

$$\log P = 23,6 - \frac{2400}{T} - 5,45 \log T$$

$$1) \frac{dP}{dT} = \frac{\Delta H_{\text{vap}}^{\circ}}{T(V_m^{\text{vap}} - V_m^{\text{liq}})}$$

$$\frac{dP}{P} = \frac{\Delta H_{\text{vap}}^{\circ}}{RT^2} dT$$

$$\rightarrow \ln P = 23 \log P$$

$$= 54,28 - \frac{5520}{T} - 5,45 \ln T$$

$$\downarrow \frac{dP}{P} = \left(\frac{5520}{T^2} - \frac{5,45}{T} \right) dT$$

$$= \frac{\Delta H_{\text{vap}}^{\circ}}{RT^2} dT$$

$$\Rightarrow \Delta H_{\text{vap}}^{\circ} = RT^2 \left(\frac{5520}{T^2} - \frac{5,45}{T} \right)$$

$$= 5520 \times 8,314 \cdot 10^{-3} - 5,45 \times 8,314 \cdot 10^{-3} \times T$$

$$\Delta H_{\text{vap}}^{\circ} = 45,89 - 0,045 \times T \text{ (kJ mol}^{-1}\text{)}$$

P.5

$$\Delta H_{\text{vap}}^{\circ} = 32,48 \text{ kJ mol}^{-1}$$

$$2) P = 10^{23,6 - \frac{2400}{298} - 5,45 \log 298}$$

$$P = \text{mm Hg.}$$

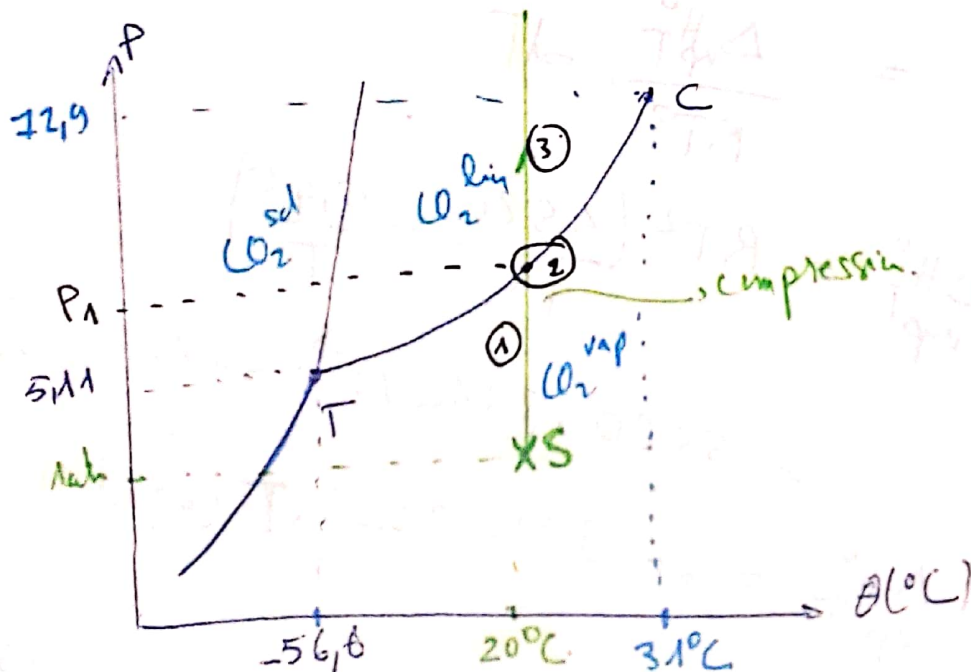
$$3) \log p^{\circ} = 23,6 - \frac{2400}{T_{\text{eb}}} - 5,45 \log T_{\text{eb}}$$

$$\Rightarrow \underbrace{\log p^{\circ} + \frac{2400}{T_{\text{eb}}}}_{f(T)} = \underbrace{23,6 - 5,45 \log T_{\text{eb}}}_{g(T)}$$

on représente $f(T)$ et $g(T)$, l'intersection donne T_{eb} .

Partie B. $p^{\text{sd}} > p^{\text{eq}} \Rightarrow V_m^{\text{sd}} < V_m^{\text{eq}}$

Pour la Fusion $\frac{dp}{dT} = \frac{\Delta H_{\text{fus}}}{T(V_m^{\text{eq}} - V_m^{\text{sd}})} > 0$



P-6-

3) $\text{CO}_2^{\text{sol}} \rightleftharpoons \text{CO}_2^{\text{vap}}$: sublimation

$\text{CO}_2^{\text{sol}} \rightleftharpoons \text{CO}_2^{\text{liq}}$: Fusion

$\text{CO}_2^{\text{liq}} \rightleftharpoons \text{CO}_2^{\text{vap}}$: Vaporisation

4) ds chaque domaine, on a un équilibre statique.

5) a) $F = 3 - \varphi$ $\varphi = 2$

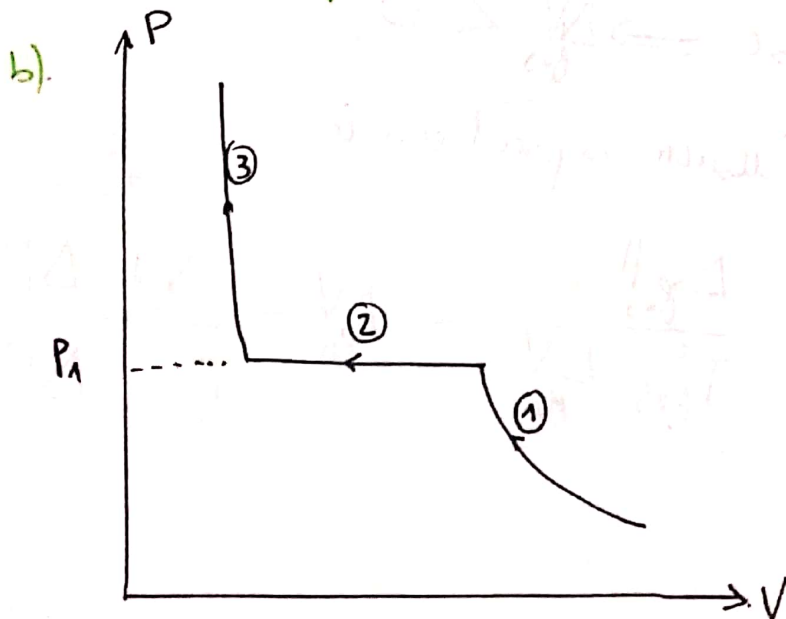
$F = 1$

b) T ($\varphi = 3$) $\rightarrow F = 0$

C ($\varphi = 1$) $\rightarrow F = 0$
 $r = 2$

6) a) $\text{S}_1 (20^\circ\text{C}, 1\text{atm}) \rightarrow \text{Vair} \rightarrow \text{vapeur}$

état : vapeur.



P-7-

① compression de la phase vapeur

$$P = \frac{nRT}{V} \quad P \uparrow, V \downarrow \Rightarrow \text{hyperbol.}$$

② vap $\rightarrow$ liq: condensation sous $P = \text{cte} = P_1$.

$$\text{car } V^{\text{liq}} < V^{\text{vap}}$$

③ Compression de phase la liq.
 la P n'influe pas sur le volume d'une phase (condensée).

Ex 4

Pour une $\uparrow$ de P de 1 atm ($\Delta P = 1 \text{ atm}$) on a obtenu
 $\rightarrow \Delta T = -3,5 \cdot 10^{-3} \text{ K}$

1) Fusion.

$$\frac{\Delta P}{\Delta T} = \frac{\Delta H_{\text{fus}}}{T(V_m^{\text{liq}} - V_m^{\text{sol}})} = \frac{\Delta H_{\text{fus}}}{T \Delta V_{\text{fus}}} < 0$$

$$\text{or } \Delta H_{\text{fus}} > 0 \Rightarrow \Delta V_{\text{fus}} < 0$$

2) pour la Fusion on peut écrire.

$$\frac{\Delta P}{\Delta T} = \frac{\Delta H_{\text{fus}}}{T_{\text{fus}}^0 \Delta V_{\text{fus}}} \rightarrow \Delta V_{\text{fus}} = \frac{\Delta H_{\text{fus}} \Delta T}{T_{\text{fus}}^0 \Delta P}$$

AN

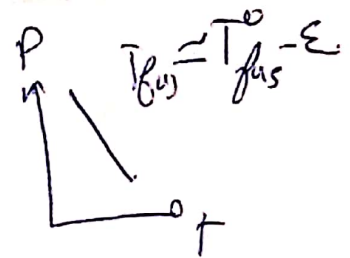
$$\Delta V_{fus} = \frac{11,3 \cdot 10^3 \times (-3,5 \cdot 10^{-3})}{(271 + 273) \times 10^5 \uparrow p_a}$$

$$\Delta V_{fus} = -7,24 \cdot 10^{-7} \text{ m}^3 \text{ mol}^{-1}$$

$$3) \int_{p^0}^p dp = \frac{\Delta H_{fus}}{\Delta V_{fus}} \int_{T_{fus}^0}^{T_{fus}} \frac{dT}{T}$$

$$\Delta p = \frac{\Delta H_{fus}}{\Delta V_{fus}} \ln \frac{T_{fus}}{T_{fus}^0}$$

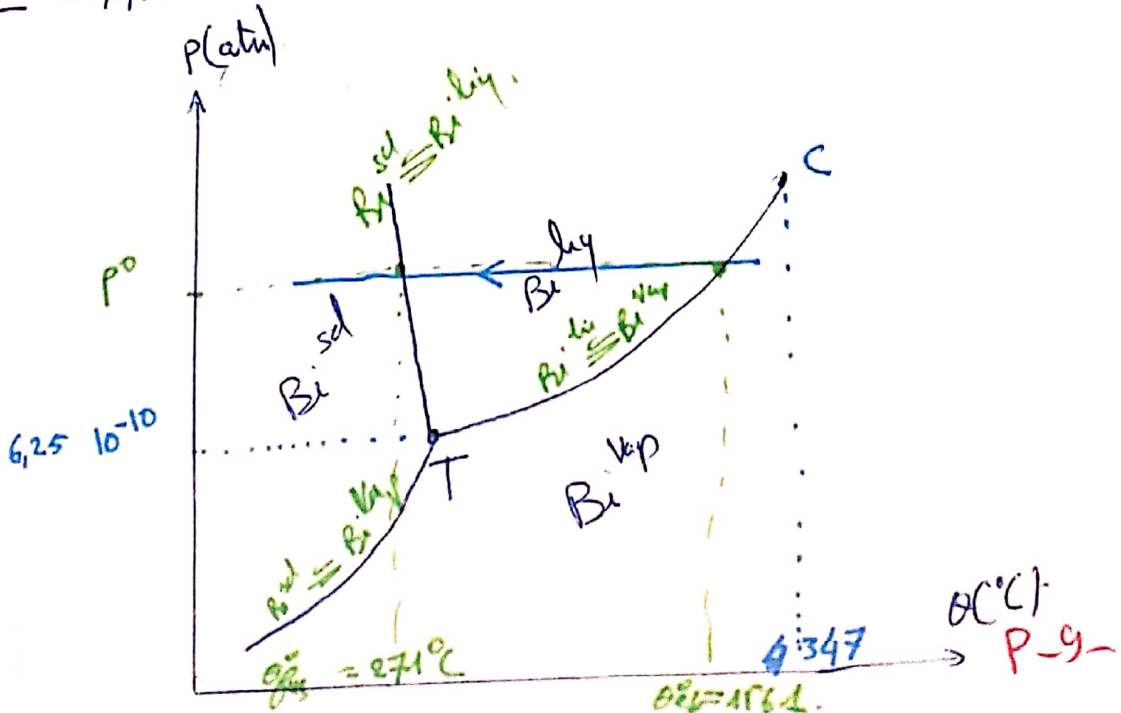
$$T_{fus} = T_{fus}^0 \exp \left[\frac{\Delta p \Delta V_{fus}}{\Delta H_{fus}} \right]$$



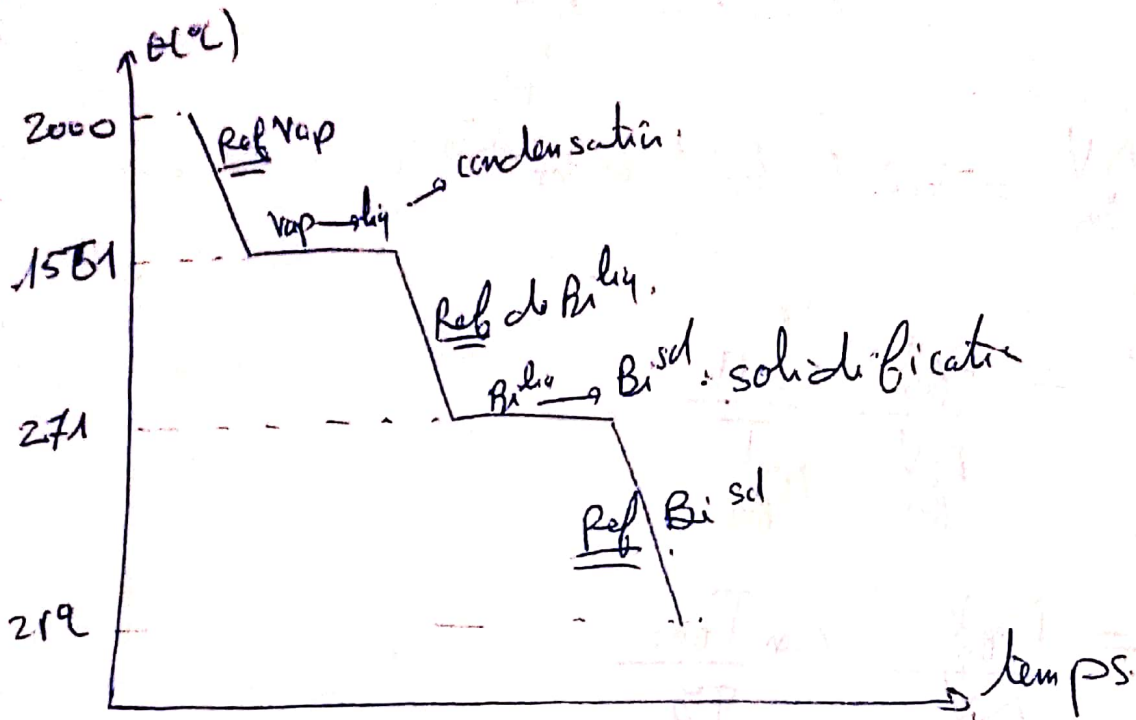
$$T_{fus} = 543,4 \text{ K}$$

$$T_{fus}^0 = 544 \text{ K}$$

4)



5) Ref $\rightarrow 2000^{\circ}\text{C} \rightarrow T_{\text{amb}} = 21^{\circ}\text{C}$



Serie Diagramme du corps pur

P^* : Pression
saturante :
ou tension de
vapeur.

Ex 1 P 52.

$$\ln \frac{P^*}{P^0} = 12,87 - \frac{3,19 \cdot 10^4}{T(K)} : \text{liq} \rightleftharpoons \text{vap.}$$

1) a) $T = 362^\circ\text{C} = 1235\text{K}$

$$P_{Ag}^* = P^0 \exp \left[12,87 - \frac{3,19 \cdot 10^4}{T} \right] / P^0 = 1 \text{ atm} = 10^5$$

$$= 10^5 \exp \left[12,87 - \frac{3,19 \cdot 10^4}{1235} \right]$$

$P_{Ag}^* = 0,25 \cdot \text{Pa.}$

b) Pt d'ébullition: (on prend le pt d'ébullition
standard c.a.d $P^* = P^0$).

$$\Rightarrow \ln \frac{P^0}{P^0} = 12,87 - \frac{3,19 \cdot 10^4}{T_{eb}^0}$$

$$T_{eb}^0 = \frac{3,19 \cdot 10^4}{12,87} \rightarrow T_{eb}^0 = 2478,63\text{K}$$

c) $\frac{dP}{dT} = \frac{\Delta H_{vap}}{T(V_m^g - V_m^{liq})}$

$$dV_m^g = \frac{RT}{P}$$

$$\int_{p_0}^{p^*} \frac{dp}{p} = \frac{\Delta H_{vap}}{R} \int_{T_{el}}^T \frac{dT}{T^2}$$

$$\ln \frac{p^*}{p_0} = \frac{\Delta H_{vap}}{RT_{el}} - \frac{\Delta H_{vap}}{R \times T}$$

$$= 12,87 - \frac{3,19 \times 10^4}{T} \Rightarrow \Delta H_{vap} = 3,19 \times 10^4 \times R$$

or $R = 8,314 \text{ J mol}^{-1} \text{ K}^{-1} \Rightarrow$

$$\Delta H_{vap} = 265,21 \text{ kJ mol}^{-1}$$

d). at pt triple.

$$\Rightarrow \Delta H_{sub} = 276,51 \text{ kJ mol}^{-1}$$

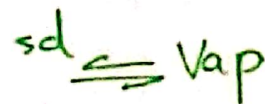
$$\Delta H_{sub} = \Delta H_{liq} + \Delta H_{vap}$$

direct
cycle

Ex 2

$$\log P \leftarrow \text{mm Hg} = 10,2 - \frac{24275}{T \rightarrow K}$$

$$\log P = 9,12 - \frac{22110}{T}$$



1) sd, liq et vap en equilibre $\Rightarrow$ pt triple.

$$10,2 - \frac{24275}{T_{tri}} = 9,12 - \frac{22110}{T_{tri}}$$

$$\Rightarrow T_{tri} = 2005 \text{ K}$$

P.2

$$P_{\text{tri}} = 10^{10,2 - \frac{24275}{2005}}$$

$$P_{\text{tri}} = 0,012 \text{ mmHg}$$

2) sublimation: $sd \rightleftharpoons \text{vap}$

$$\frac{dP}{dT} = \frac{\Delta_{\text{hb}}}{T(V_m^g - V_m^{\text{sd}})}$$

$$V_m^g = \frac{RT}{P}$$

$$\Rightarrow \int_{P_0}^P \frac{dP}{P} = \frac{\Delta_{\text{hb}}}{R} \int_{T_0}^T \frac{dT}{T^2} \quad \left\{ \begin{array}{l} \text{Len} = 2,3 \log x \end{array} \right.$$

$$\ln \frac{P}{P_0} = \frac{\Delta_{\text{sub}}}{RT_{\text{sub}}^0} - \frac{\Delta_{\text{sub}}}{R \times T}$$

$$\log \frac{P}{P_0} = \frac{\Delta_{\text{sub}}}{2,3 RT_{\text{sub}}^0} - \frac{\Delta_{\text{sub}}}{2,3 R \times T}$$

$$\log P = \log P_0 + \frac{\Delta_{\text{sub}}}{2,3 RT_{\text{sub}}^0} - \frac{\Delta_{\text{sub}}}{2,3 R \times T}$$

$$\Rightarrow \Delta_{\text{sub}} = 2,3 \times 8,314 \times 10^{-3} \times 24275$$

$$\Delta_{\text{sub}} = 454,16 \text{ kJ mol}^{-1}$$

de m $\Delta H_{\text{vap}} = 2,3 \times 9,314 \times 10^{-3} \times 22110$

$\Delta H_{\text{vap}} = 413,63 \text{ kJ mol}^{-1}$

apt triple $\Delta H_{\text{sub}} = \Delta H_{\text{fus}} + \Delta H_{\text{vap}}$

$\Rightarrow \Delta H_{\text{fus}} = 40,51 \text{ kJ mol}^{-1}$

3) standard $\Rightarrow P = P^\circ = 760 \text{ mmHg}$.

$\log P^\circ = 9,12 - \frac{22110}{T_{\text{eb}}^\circ}$

$\Rightarrow T_{\text{eb}}^\circ = \frac{22110}{9,12 - \log 760} \Rightarrow T_{\text{eb}}^\circ = 3543,7 \text{ K}$

4) sublimation valable entre 1150 et 2005

T(K)	1150	1500	2005
$\log P = 9,12 - \frac{22110}{T}$	-10,9	-5,98	-1,9

Vaporisation : 2005 $\rightarrow T_{\text{eb}}^\circ = 3543,7 \text{ K}$

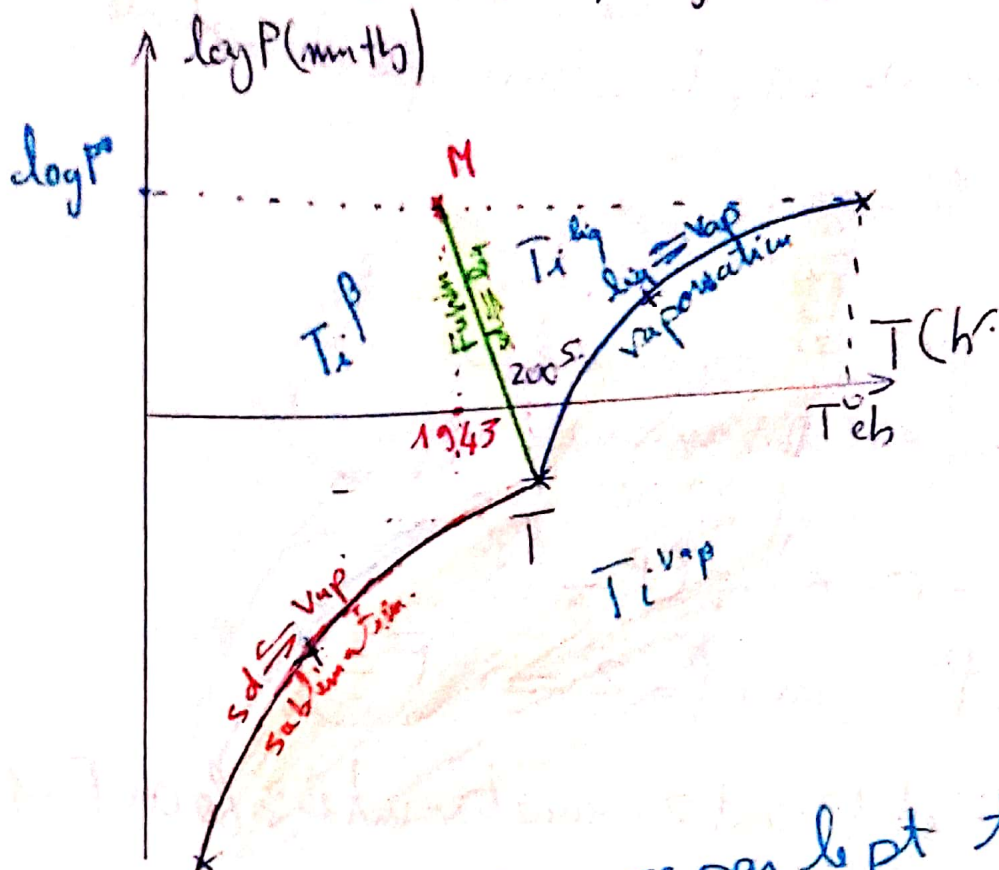
	2005	2500	3241
$\log P = 9,12 - \frac{22110}{T}$	-1,9	0,276	9,82

Pom la Fusion on a $T_{\text{fus}}^\circ \rightarrow P = P^\circ = 1670^\circ \text{C} = 1943 \text{ K}$



on a le **pt de Fusion standard.**

M (1943 ; log 760)



La courbe de Fusion passe par le pt triple et le pt M.

b) Fusion : $sd \rightleftharpoons liq$.

$$\frac{dP}{dT} = \frac{\Delta H_{fus}}{T(V_m^{liq} - V_m^{sd})}$$

d'après le diagramme la courbe de Fusion est ↘

$$\Rightarrow \frac{dP}{dT} < 0 \text{ or } \Delta H_{fus} > 0$$

$$\Rightarrow V_m^{liq} < V_m^{sd}$$

$$\rho^{liq} > \rho^{sd}$$

P.5

$$\alpha \quad d = \frac{\rho}{\rho_{eau}} \Rightarrow d^{liq} > d^{sd}$$

$\Rightarrow$ le liquide est plus dense que le solide.

$$5) \quad T_i^f \rightleftharpoons T_i^{liq}$$

a) peut-on choisir $\rightarrow$ il faut calculer la variance.

$$F = (C - r - k) + (P - f) \\ = 3 - f \quad \text{car } f = 2 \Rightarrow F = 1$$

Nm, car T et P sont 2 paramètres intensifs car $F = 1$

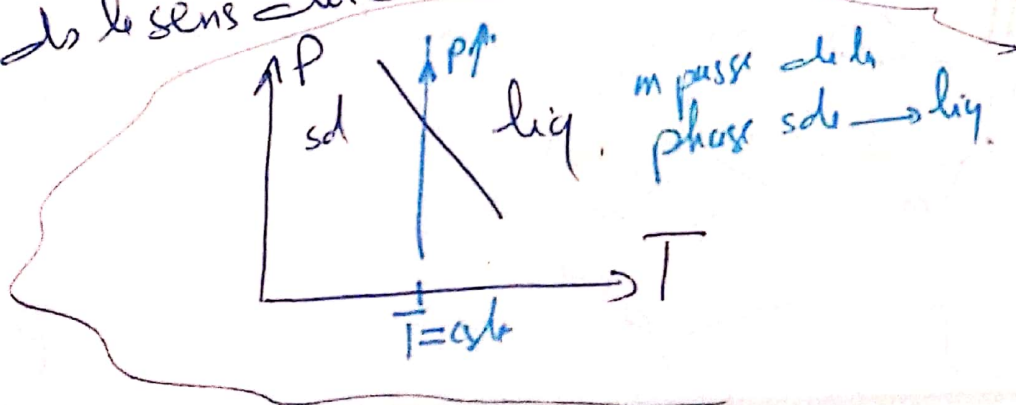
b) on a $dG = V dP - S dT$

$$\text{à } T = cste \quad V = \left. \frac{dG}{dP} \right|_T \Rightarrow \Delta V_{fus} = \left. \frac{d\Delta G_{fus}}{dP} \right|_T$$

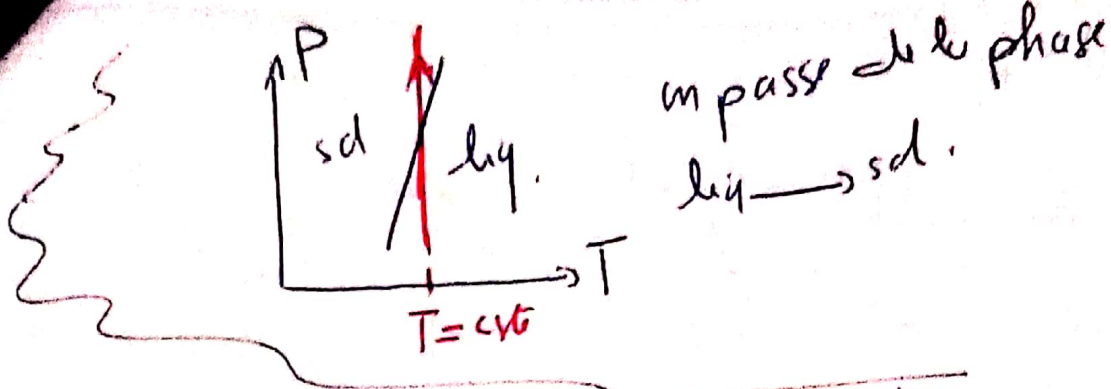
$$\text{car } \rho^{liq} > \rho^{sd} \Rightarrow V_m^{liq} < V_m^{sd} \Rightarrow \Delta V_{fus} < 0 \\ \Delta P > 0$$

$$\Rightarrow \Delta G_{fus} < 0 \quad \text{c.a.d. l'équilibre se déplace}$$

ds le sens direct : sens direct.



{P-G-}



Ex 3

1) on a à l'équilibre $\text{Br}_2 \rightleftharpoons \text{Br}_2^{\text{vap}}$

$$p^{\text{liq}} = p^{\text{vap}} \Rightarrow p^{\text{or liq}} = p^{\text{or vap}} + RT \ln \frac{p^{\text{or}}}{p^0}$$

$$\rightarrow p^{\text{or}} = p^0 \exp \frac{p^{\text{or liq}} - p^{\text{or vap}}}{RT} \quad p^0 = 1 \text{ atm}$$

A.N $p^{\text{or}} = 1 \times \exp \frac{-3010}{8,314 \times 298}$

$p^{\text{or}} = 0,286 \text{ atm pour } T = 298.$

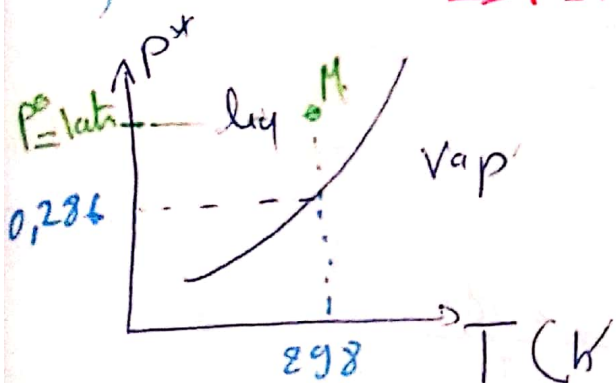
2) état standard de Br_2 à 298 K

$\rightarrow P = P^0$

$\rightarrow M(298, P^0)$

point d'ébullition

d'où Br_2 à l'état liq.



2^{ème} méthode.

ma à 298K $\mu^{\text{liq}} - \mu^{\text{vap}} < 0$.

et sous $p = p^0 = 1 \text{ atm}$.

$$\Rightarrow \mu^{\text{liq}} < \mu^{\text{vap}}$$

d'où Br_2^{liq} est stable à 298K et sous $p = 1 \text{ atm}$.

3) $\Delta S_{\text{vap}}^0 = \text{cste}$. $\text{Br}_2^{\text{liq}} \rightleftharpoons \text{Br}_2^{\text{vap}}$.

$$d\mu^{\text{liq}} = d\mu^{\text{vap}}$$

$$V_m^{\text{liq}} dp - S_m^{\text{liq}} dT = V_m^{\text{vap}} dp - S_m^{\text{vap}} dT$$

$$\Rightarrow \frac{dp}{dT} = \frac{\Delta S_{\text{vap}}}{V_m^{\text{vap}} - V_m^{\text{liq}}}$$

$\ll \frac{RT}{p}$

$$\int_{p^0}^{p^* = 0.286} \frac{dp}{p} = \frac{\Delta S_{\text{vap}}}{R} \int_{T_0 = 298}^{T = 298} \frac{dT}{T}$$

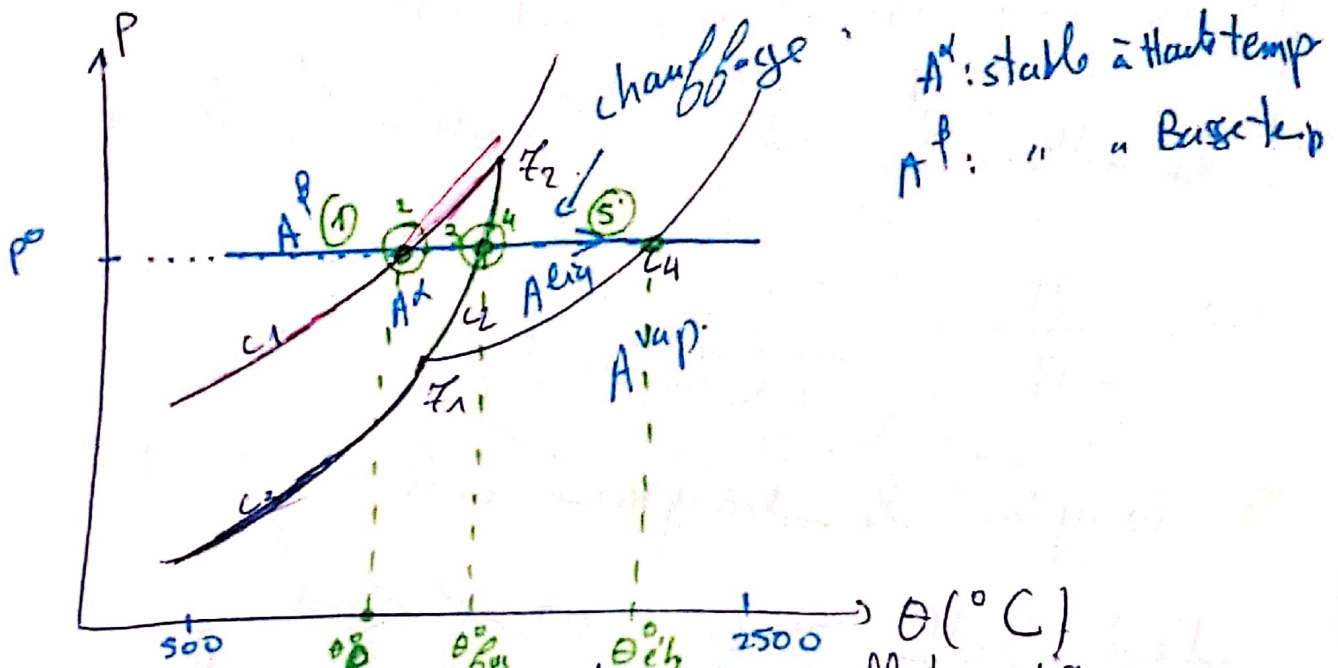
$$\ln \frac{0.286}{1} = \frac{\Delta S_{\text{vap}}}{R} \ln \frac{298}{T_{\text{eb}}}$$

$$\ln \frac{T_{eb}^0}{298} = \frac{R}{\Delta S_{vap}} \ln \frac{1}{0,286}$$

$$T_{eb}^0 = 298 \exp \frac{8,314}{(245,5 - 152)} \ln \frac{1}{0,286}$$

$$T_{eb}^0 = K$$

Ex 6



1) $c_1: A^\beta \rightleftharpoons A^\alpha$: transformation allotropique

$c_2: A^\alpha \rightleftharpoons A^{liq}$: Fusion $\rightarrow A^\alpha$

$c_3: A^\alpha \rightleftharpoons A^{vap}$: sublimation de A^α

$c_4: A^{liq} \rightleftharpoons A^{vap}$: Vaporisation

1) pt triple : coexistence de 3 phases A^{α}, A^{β}
 A^{vap} en équilibre

2) pt triple : " " " A^{β}, A^{α} et A^{vap}
 en équilibre

2) $\begin{cases} \mu^{\beta} = \mu^{\alpha} \\ d\mu^{\beta} = d\mu^{\alpha} \end{cases} \quad A^{\beta} = A^{\alpha}$

$$\begin{cases} H_m^{\beta} - T S_m^{\beta} = H_m^{\alpha} - T S_m^{\alpha} \\ V_m^{\beta} dP - S_m^{\beta} dT = V_m^{\alpha} dP - S_m^{\alpha} dT \end{cases}$$

$$\Rightarrow \frac{dP}{dT} = \frac{\Delta H^{\beta \rightarrow \alpha}}{T(V_m^{\alpha} - V_m^{\beta})}$$

3) D'après le diagramme la courbe C_1 est π .

d'où $\frac{dP}{dT} > 0$ car $d^{\alpha} < d^{\beta}$
 $V_m^{\alpha} > V_m^{\beta}$

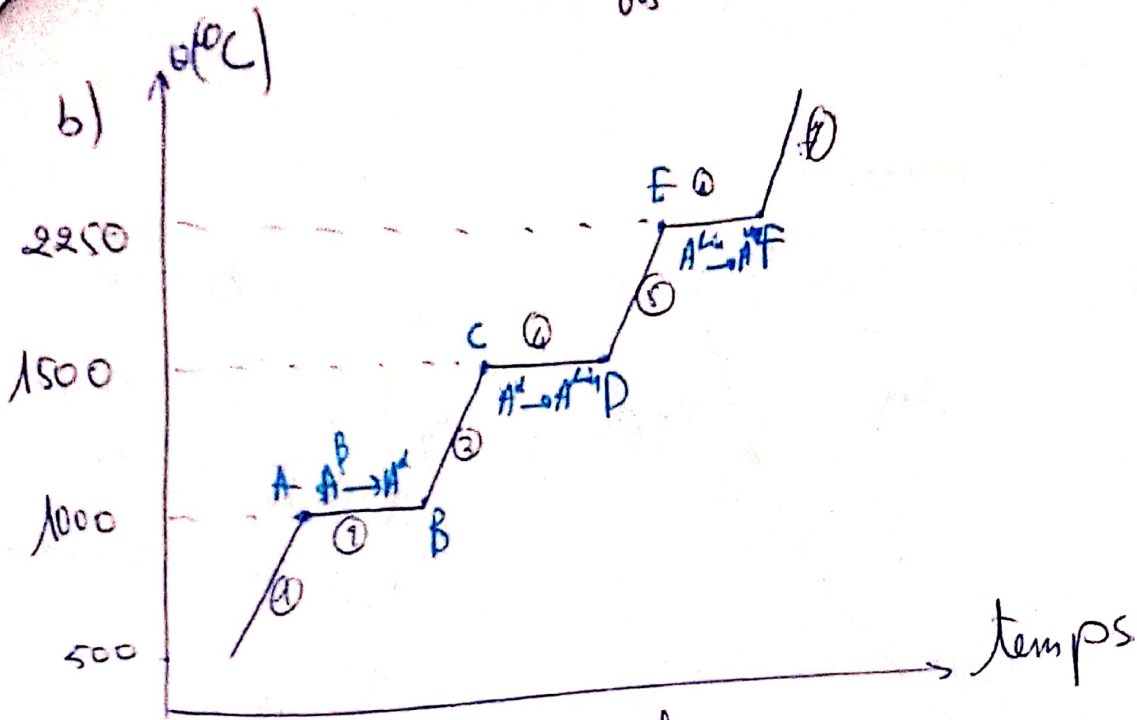
d'où $\Delta H^{\beta \rightarrow \alpha} > 0$

$\Rightarrow$ endo.

4) on a chauffage de $\theta_1 = 500^{\circ}\text{C} \rightarrow \theta_2 = 2500^{\circ}\text{C}$
 sous $P = P^0$.

a) $\theta_p = 1000^\circ\text{C}$

$\theta_{fus} = 1500^\circ\text{C}$ $\theta_{eb} = 2250^\circ\text{C}$



① chauffage $\rightarrow$ la phase A^{β} .

② transb. alloho. $A^{\beta} \rightarrow A^{\alpha}$. ($m^{\beta} \downarrow$, $m^{\alpha} \uparrow$)

③ chauff. de A^{α}

④ Fusion de A^{α} : ($m^{\alpha} \downarrow$, $m^{liq} \uparrow$)

⑤ chauff. de A^{liq}

⑥ vaporisation ($m^{liq} \downarrow$, $m^{vap} \uparrow$)

⑦ chauff. de la vap

A: Apparition du 1^{er} cristal de A^{α} .

B: disparition du dernier cristal de A^{β} .

C: App. du 1^{er} ytt de A^{β} .

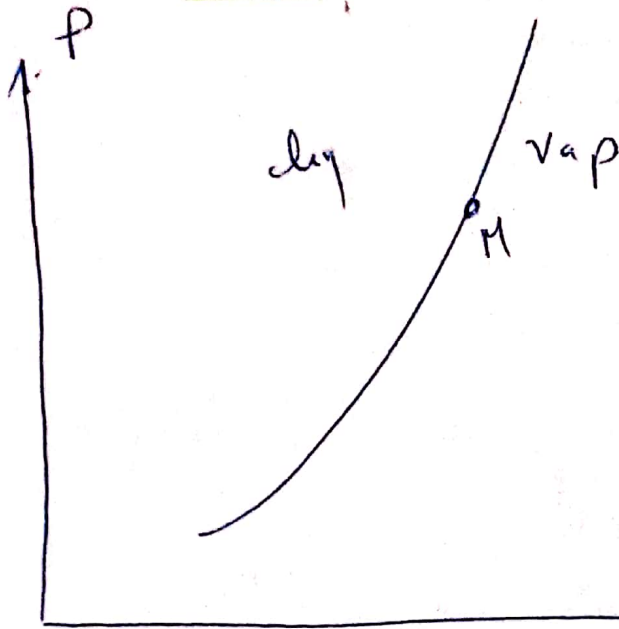
D: disp. du dernier crist de A^{α} .

E: App de la 1^{re} bulle de vap.

F: disp de la dernière bulle de liq.

Rq

du cours.



on considère un système fermé (M) de volume $V = 1\text{ l.}$ et de nombre de moles = 1 mole sachant que.

$$\begin{cases} V_m^{\text{liq}} = \\ V_m^{\text{vap}} = \dots \end{cases}$$

$$\begin{cases} V_t = V^{\text{liq}} + V^{\text{vap}} \\ n_t = n^{\text{liq}} + n^{\text{vap}} = 1 \end{cases}$$

$$\text{or } V_m^{\text{liq}} = \frac{V^{\text{liq}}}{n^{\text{liq}}}$$

$$V_m^{\text{vap}} = \frac{V^{\text{vap}}}{n^{\text{vap}}}$$

$$\begin{cases} V_t = n^{\text{liq}} V_m^{\text{liq}} + n^{\text{vap}} V_m^{\text{vap}} \\ n_t = n^{\text{liq}} + n^{\text{vap}} \end{cases}$$

$$V_t = \sum_i n_i V_{m,i}$$

$$G = \sum_i n_i G_{m,i} \quad \leftarrow N_i$$

$$H = \sum_i n_i H_{m,i}$$

$$\Rightarrow \begin{cases} n^{\text{liq}} = 0,2 \text{ mol} \\ n^{\text{vap}} = 0,8 \text{ mol} \\ V^{\text{liq}} = n^{\text{liq}} V_m^{\text{liq}} \\ V^{\text{vap}} = n^{\text{vap}} V_m^{\text{vap}} \end{cases}$$

{P-12}