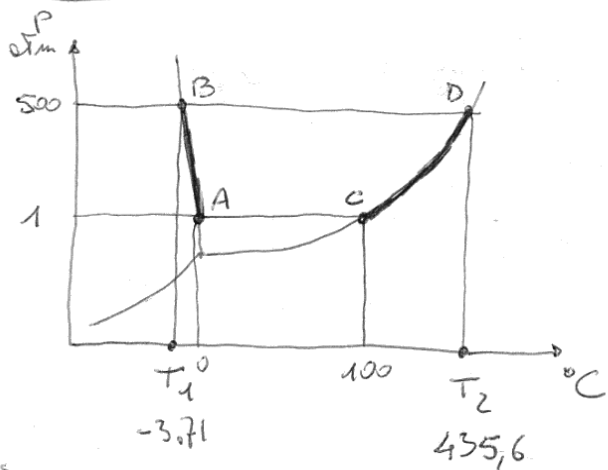


23-3-2015 VI I COMPLETO DI TCI

- 1) 15 g di ghiaccio sono portati a 500 atm. Calcolare a quale temperatura (T_1) fondono. Calcolare la temperatura di ebollizione (T_2) a quella pressione. Calcolare il calore che deve essere fornito per portare il ghiaccio da T_1 al fusione fino a vapore alla temperatura T_2 .
 $\Delta H_{fus} = 6010 \text{ J/mol}$ $\Delta H_{eb.} = 40670 \text{ J/mol}$ $C_{H_2O} = 1 \text{ cal/g K}$ $d_{GH} = 0.917 \text{ g/cm}^3$



Ricordo la Clausius Clapeyron

$$G = H - TS$$

$$H = U + PV$$

$$U = Q - L$$

$$dS = \frac{dQ}{T}$$

$$dQ = T dS$$

$$G = U + PV - TS$$

$$G = Q - L + PV - TS$$

$$dG = dQ - dL + PdV + VdP - TdS - SdT$$

$$dG = TdS - PdV + PdV + VdP - TdS - SdT$$

$$\boxed{dG = VdP - SdT}$$

Nel processo p.p. di stato (1 \rightarrow 2) $dG = 0$ $\boxed{V_1 dP - S_1 dT = V_2 dP - S_2 dT}$
 $(V_2 - V_1) dP = (S_2 - S_1) dT$ $\Delta V dP = \Delta S dT$ $\frac{dP}{dT} = \frac{\Delta S}{\Delta V_m}$ $\boxed{\frac{dP}{dT} = \frac{\Delta H}{T \Delta V_m}}$ CLAUDIUS CLAPEYRON

$$\int_A^B \frac{dP}{dT} = \frac{\Delta H}{\Delta V_m} \int_A^B \frac{dT}{T}$$

$$\boxed{\Delta P = \frac{\Delta H}{\Delta V_m} \ln \frac{T_B}{T_A}}$$
 (GHIACCIO - ACQUA)

$$d = \frac{m}{V} \quad V = \frac{m}{d} \quad V_m(GH) = \frac{18 \text{ g/mol}}{0.917 \text{ g/cm}^3} \quad V_{vap}(GH) = 19.629 \text{ cm}^3/\text{mol} = 19.629 \cdot 10^{-6} \frac{\text{m}^3}{\text{mol}}$$

$$V_{H_2O} = \frac{18 \text{ g/mol}}{1.0 \text{ g/cm}^3} = 18 \text{ cm}^3/\text{mol} \quad \Delta V_m = V_{H_2O} - V_{GH} = 18 - 19.629 = -1.629 \text{ cm}^3/\text{mol}$$

$$\Delta P = 500 - 1 = 499 \text{ atm} = 499 \cdot 1.013 \cdot 10^5 \text{ Pa} \quad \Delta H = 6010 \text{ J/mol} \quad T_A = 273 \text{ K}$$

$$\ln \frac{T_B}{T_A} = \frac{\Delta P \Delta V_m}{\Delta H} = \frac{499 \cdot 1.013 \cdot 10^5 (-1.629 \cdot 10^{-6})}{6010} = \frac{-82.34}{6010} = -0.01370$$

$$T_B = 0.9864 \cdot T_A = 0.9864 \cdot 273 \Rightarrow \boxed{T_B = 269.3 \text{ K}} \quad \boxed{T_B = -3.71^\circ \text{C}} \quad T_1$$

Nel passaggio $H_2O \rightarrow V_{ap}$. $V_{vap} \gg V_{H_2O} \Rightarrow \Delta V \approx V_{vap}$ $\frac{dP}{dT} = \frac{\Delta H}{T V_{gas}} = \frac{\Delta H}{T RT} \frac{1}{P}$

$$\frac{dP}{dT} = \frac{\Delta H \cdot P}{R T^2} \quad \int_C^D \frac{dP}{P} = \frac{\Delta H}{R} \int_C^D \frac{dT}{T^2}$$

$$\boxed{\ln \frac{P_D}{P_C} = \frac{\Delta H}{R} \left(\frac{1}{T_C} - \frac{1}{T_D} \right)}$$
 LIQ - VAPORE

$$P_D = 500 \text{ atm} \quad P_C = 1 \text{ atm} \quad \Delta H = 40670 \text{ J/mol} \quad R = 8.31 \quad T_C = 373 \text{ K}$$

$$\frac{1}{T_C} - \frac{1}{T_D} = \ln \frac{P_D}{P_C} \cdot \frac{R}{\Delta H} \Rightarrow \frac{1}{T_D} = \frac{1}{T_C} - \ln \frac{P_D}{P_C} \frac{R}{\Delta H} = \frac{1}{373} - \ln \frac{500}{1} \cdot \frac{8.31}{40670}$$

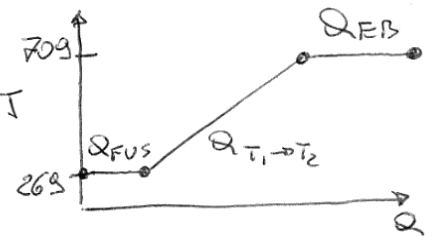
$$\frac{1}{T_D} = 2,681 \cdot 10^{-3} - 1,2698 \cdot 10^{-3} = 1,411 \cdot 10^{-3} \quad \boxed{T_D = 708.6 \text{ K}} \quad \boxed{T_D = 435.6^\circ \text{C}}$$

$$Q = Q_{\text{FUS}} + Q_{(T_1 \rightarrow T_2)} + Q_{\text{EBOLL.}} \quad \Delta T = 708.6 - 269.3 = 439.3^\circ$$

$$Q_{\text{FUS}} = \frac{15 \text{ g}}{18 \text{ g/mol}} \cdot 6010 \text{ J/mol} = 5008 \text{ J} \quad Q_{\text{EB}} = \frac{15}{18} \text{ mol} \cdot 40670 = 33892 \text{ J}$$

$$Q_{T_1, T_2} = m \cdot C \cdot \Delta T = 15 \cdot 1.439,3 \cdot 4,184 = 27570 \text{ J}$$

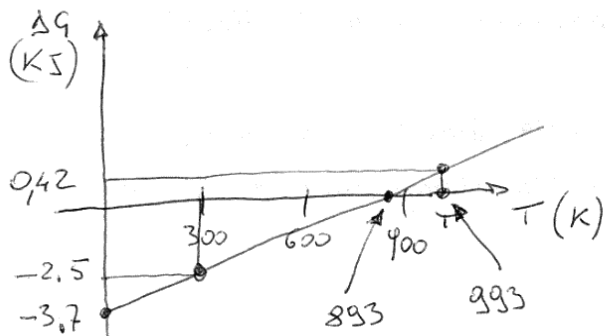
$$Q = 5008 + 33892 + 27570 = 66,47 \text{ KJ}$$



2) Dato la reazione $A+B \rightarrow C$ $\Delta H^\circ = -3,75 \text{ KJ/mol}$ $\Delta S^\circ = -4,2 \text{ J/mol}$
 Calcolari le T alle quali c'è equilibrio. Calcolari ΔG° e K_{eq} a 25° e $T_E + 100\text{K}$.

$$\Delta G^\circ = \Delta H^\circ - T \Delta S^\circ \quad \text{all'eq} \quad \Delta G = 0 \quad T \Delta S^\circ = \Delta H^\circ \quad T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{3,75 \cdot 10^3}{4,2}$$

$$\boxed{T_{\text{eq}} = 893 \text{ K}}$$



$$\Delta G^\circ = -3,75 \cdot 10^3 - 298 \cdot (-4,2) = \boxed{-2498 \text{ J}} \quad (25^\circ \text{C})$$

$$\Delta G^\circ = -3750 - 993 \cdot (-4,2) = \boxed{420,6 \text{ J}} \quad (993 \text{ K})$$

$$K(25^\circ \text{C}) \Rightarrow \Delta G^\circ = -RT \ln K$$

$$\ln K = \frac{-\Delta G^\circ}{RT} = \frac{2498}{8,31 \cdot 298} = 1,00873$$

$$\boxed{K = 2,74 \quad (25^\circ \text{C})}$$

$$K(993 \text{ K}) \Rightarrow \ln K = \frac{-\Delta G^\circ}{RT} = \frac{-420,6}{8,31 \cdot 993} = -0,050898 \quad \boxed{K = 0,95 \quad (993 \text{ K})} \quad (720^\circ \text{C})$$

A 993 K (720°C) la reazione $A+B \rightarrow C$ è sfavorevole mentre è favorita la reazione inversa. Infatti $\Delta G^\circ = 420,6 \text{ J} (> 0)$ e $K_{\text{eq}} = 0,95$. A 25°C la reazione $A+B \rightarrow C$ è favorita dato che ha $\Delta G^\circ < 0$ e $K > 1$ ($\Delta G^\circ = -2498 \text{ J}$ e $K_{\text{eq}} = 2,74$)