Total Grade 55/100

Thermodynamics

002

2a Gibbs Thompson Equation derivation.

Question 2. 80/100

$$T_m(H) = T_T^b + \frac{2(\gamma_{LW} - \gamma_{SW})}{\rho_s \Delta_m H}$$

$$\Delta T_m(x) = T_{m_0} - T_m(x)$$

$$\Rightarrow \mu_s(T_m) = \mu_l(T_m)$$

$$\rightarrow d\mu = -S\,dT + V\,dp$$

$$\rightarrow \mu = TS - pA_w H + 2\gamma A_w + \mu N$$

Part a is done below

Considering No width influence wco

$$\Rightarrow \Delta p \Rightarrow P_L - P_S = \frac{2(\gamma_{LW} - \gamma_{SW})}{H}$$

$$\left\{ \begin{aligned} \Omega &= U - TS - \mu N \\ &= -pA_w H + 2\gamma A_w \end{aligned} \right\}$$

$$\rightarrow \mu_l(T_m) + \int_{T_m}^{T_m'} -S_l\,dT = \mu_s(T_m) + \int_{T_m}^{T_m'} -S_s\,dT + \int_{P_0}^{P} V_s\,dp.$$

$$\Rightarrow -\int_{T_m}^{T_m'} (S_l - S_s)\,dT = \int_{P_0}^{P} V_s\,dp.$$

$$\Rightarrow \quad -\Delta_{fus} S \, (T_m' - T_m) = V_s \, \Delta P$$

$$\Rightarrow \quad -\Delta S \, (T_m' - T_m) = V_s \left(\frac{2(\gamma_{Lw} - \gamma_{Sw})}{H} \right)$$

~~$\frac{T_m' - T_m}{[illegible]}$~~

$$\Rightarrow \quad \frac{T_m - T_m'}{T_m'} = \frac{2(\gamma_{Lw} - \gamma_{Sw})}{H \rho_m h}$$

* this accomodates the γ of nanoparticle with the fluid.

ⓑ2b $\Omega = U - TS - \mu N = -PA_w H + 2\gamma A_w$

$\therefore \quad U = TS - PA_w H + 2\gamma A_w + \mu N$

From thermodynamic Square

$-S \quad U \quad V$

$H \qquad\quad F$

$-P \quad G \quad T$

$\underline{\underline{U = F + TS}}$ | $dU = -PdV + TdS + \mu dN$

$F = \underline{\underline{U}} - TS$

$-S \quad U \quad V$

$H \qquad\quad F$

$-P \quad G \quad T$

$dH = TdS + VdP$

$\Omega = U - TS - \mu N$

Helmholtz

②c

$$\frac{dP}{dT} = \frac{P.L}{T^2 R} \quad \Big| \quad \ln\left(\frac{p(r)}{p}\right) = \frac{2 \gamma V_{molecule}}{k_B T_r}$$

$$\frac{1}{P} \frac{dP}{dT} = \frac{\Delta H}{RT^2}$$

$$\Updownarrow$$

$$\cancel{\int \frac{\ln p \, dp}{dT}} = \cancel{\int \frac{\Delta H}{RT^2}}$$

$$\cancel{\ln p} = \cancel{\frac{\Delta H}{RT}}$$

$$\frac{1}{p} dp = \frac{\Delta H}{RT^2} \times dt$$

$$\int \frac{1}{p} dp = \int \frac{\Delta H}{RT^2} \times dT$$

$$\underline{\underline{\ln p = \frac{\Delta H}{RT}}}$$

$$\ln\left(\frac{p(r)}{p}\right) = \frac{2 \gamma V_{molecule}}{k_B T_r}$$

$$\frac{\Delta H}{RT} = \frac{\Delta p \, 2 \gamma V}{k_B T_r} \Rightarrow \Delta T_m = \underline{\underline{\frac{T_m' \, 2\gamma}{HR}}}$$

Ostwald - Freundich Equation

$$x_{app} = x_0 \cdot e^{\left(\frac{2 \cdot V_m \cdot \sigma_{SL}}{R \cdot T \cdot r}\right)}$$

x_0 = thermodynamic mole fraction

x_{app} = appant mole fraction

σ_{SL} = Interfacial Energy between Solid and liquid

r = particle radius

V_m = molar ~~[illegible]~~ Volume

R = universal gas constant

T = temperature.

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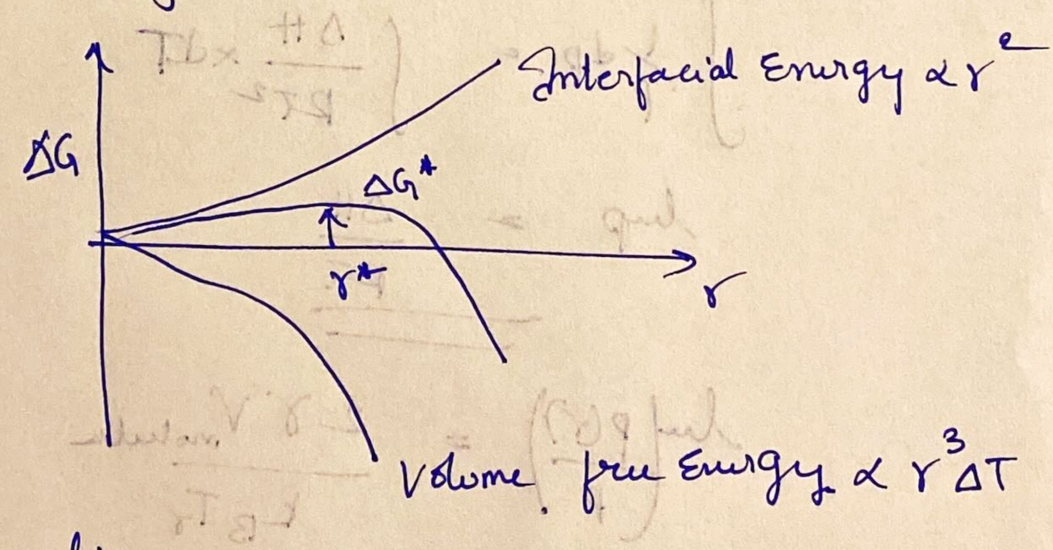
②Ⓔ Homogenous nucleation.



$G_1 \Rightarrow$ liq

$G_2 \Rightarrow$ liq + particle

$$\Rightarrow \quad G_1 = (V_S + V_L)\cdot G_L$$

$$\Rightarrow \quad G_2 = V_S \cdot G_S + V_L \cdot G_2 + A_{SL}\cdot \gamma_{SL}$$

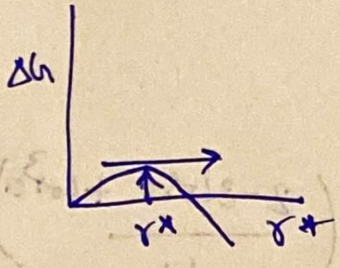
$$\Delta G = G_2 - G_1 = V_S(\Delta G_V) + A_{SL}\cdot \gamma_{SL}$$

If the Solid forme is Sphere "Radio"

$$\Rightarrow \quad \Delta G_{Hom} = \underbrace{\tfrac{4}{3}\pi R^3}_{V_S} \Delta G_V + \underbrace{4\pi R^2}_{A_{SL}} \gamma_{SL}$$

This is part "a" and "e"

term1 term2



If $r \approx 0 \quad r^2 > r^3$

at max ΔG $\frac{dG}{dr} = 0 \Rightarrow r^*$

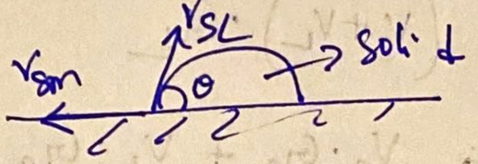
$$0 = \tfrac{4}{3}\pi \times 3R^2 \Delta G_V + 4\pi \times 2R\gamma_{SL}$$

$$r^* = -\frac{2\gamma_{SL}}{\Delta G_V}$$

$$\Delta G^* = \tfrac{4}{3}\pi\left(-\frac{2\gamma_{SL}}{\Delta G_V}\right)^3 \Delta G_V + 4\pi\left(-\frac{2\gamma_{SL}}{\Delta G_V}\right)^2 \Delta G_V$$

$$\Delta G^* = \frac{16}{3}\pi\frac{\gamma_{SL}^3}{\Delta G_V^2}$$

Heterogeneous



$$\gamma_{Sm} + \gamma_{LS}\cos\theta = \gamma_{Lm}$$

$$\Delta G_{Het} = V_S \Delta G_V$$

$$\Delta G_{Het} = V_S \Delta G_V + A_{SL}\gamma_{SL} + A_{Sm}(\gamma_{Sm} - \gamma_{Lm})$$

Sphere

$$V_S = \frac{\pi R^3}{3}(2 - 3\cos\theta + \cos^3\theta)$$

$$A_{SL} = 2\pi R^2(1 - \cos\theta)$$

$$A_{Sm} = \pi R^2 \sin^2\theta$$

$$\Delta G_{Het} = \left(\frac{4}{3}\pi R^3 \Delta G_V + 4\pi R^2 \gamma_{LS}\right)\left(\frac{2 - 3\cos\theta + \cos^3\theta}{4}\right)$$

$$\Delta G_{Het} = \Delta G_{Hom}\, S(\theta)$$

Here the influence of Solid Surfaces like walls Effect the morphology of the particle thus bringing a change in the free Energy.

Part “d” is missing -20

①

Question 1 30/100

ⓐ * A State function is a property whose value doest depend on the path taken to reach a value.

Knows state function and Hess's law but didn't apply it -5

* Hess Law :- the heat of reaction ΔH°_{f} for a Specific reaction is Equal to the Sum of the heats of reaction for any set of reactions which are Equivalent to the reaction.

ⓑ Second-order transitions have discontinous Second derivative.

Repeats definition of second order but can't apply it. -5

ⓒ

cde missing -60