Corrige serie 3

Trop des defauts

Exercice 1 : $\rho_{exp} = 2,698$, $a = 4,049 A^\circ$, $M_{Al} = 26,98 g/mole$

$$\rho_{th} = \frac{n \cdot M}{N_a a^3} = \frac{4(26,98)}{6,023\times10^{23}(4,049\times10^{-8})^3} = 2,699 \ g/cm^3$$

on remarque que $\rho_{exp} < \rho_{th}$ $\Rightarrow$ la densité d'Al diminue $\Rightarrow$ augmentation de volume $\Rightarrow$ Creation des lacunes.

$$\frac{\rho_{th}}{\rho_{exp}} = \frac{V(\text{volume final})}{V'(\text{volume initial})} = 1,00037 \Rightarrow V = V'(1,00037) = V'\left(1 + \frac{37}{10^5}\right).$$

Exercice 2 :

$T_1 = 500^\circ C \longrightarrow C_1 = \frac{1}{10^{10}}$, $K_B = 1,38\times10^{-23} J.K^{-1}$, $1eV = 1,6022\times10^{-19} J$.

$T_2 = 600^\circ C \longrightarrow C_2 = \frac{1}{10^9} = \frac{10}{10^{10}}$

a) $C_l = \exp -\frac{\Delta G_f}{K_B T} = \exp \frac{-(\Delta H_f - T\Delta S_f)}{K_B T} = \exp \frac{\Delta S}{K_B} \cdot \exp -\frac{\Delta H}{K_B T}$

$\Rightarrow \log C_l = \log \exp \frac{\Delta S}{K_B} + \log \exp -\frac{\Delta H_f}{K_B T} \Rightarrow \log C_l = K - \frac{\Delta H_f}{K_B T} = K - \frac{\Delta H_f}{K_B} \cdot \frac{1}{T}$

c'est une fonction de la forme $y = A - Bx$ où : $B = -\frac{\Delta H_f}{K_B}$ et $x = \frac{1}{T}$

(B : la pente)

$$\Rightarrow B = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\log C_2 - \log C_1}{\frac{1}{T_2} - \frac{1}{T_1}} = \frac{\log \frac{C_2}{C_1}}{\frac{T_1 - T_2}{T_1 T_2}} = -\frac{\Delta H_f}{K_B}$$

$$\Rightarrow -\Delta H_f = 1,38\times10^{-23}\left[\frac{(873\times773)\log\left(\frac{\frac{1}{10^9}}{\frac{1}{10^{10}}}\right)}{773 - 873}\right] \Rightarrow \Delta H_f = 2,14\times10^{-19} J = 1,33 eV$$

* $\exp \frac{\Delta S}{K_B}$?

Il faut trouver la valeur de $\frac{\Delta S}{K_B}$? pour trouver C_l à 700°C.

on prend : $T_1 = 773 K$, $C_1 = 10^{-10}$

ona : $C_1 = \exp \frac{\Delta S}{K_B} \cdot \exp -\frac{\Delta H_f}{K_B T} \Rightarrow \log C_1 = \frac{\Delta S}{K_B} - \frac{\Delta H_f}{K_B T}$.

$$\Rightarrow \frac{\Delta S}{K_B} = \log 10^{-10} + \frac{2,14\times10^{-19}}{1,38\times10^{-23}\times773} \Rightarrow \frac{\Delta S}{K_B} = -2,9688$$

$\Rightarrow \exp \frac{\Delta S}{K_B} = 0,05$

b) $T = 700^\circ C = 973K \Rightarrow C_3 = ?$

$C_3 = \exp \frac{\Delta S}{K_B} \cdot \exp -\frac{\Delta H_f}{K_B T} = 0,05 \cdot \exp -\left(\frac{2,14\times10^{-19}}{1,38\times10^{-23}\cdot 973}\right)$

$C_3 = \frac{60\times10^{-10}}{10^{10}} = \frac{60}{10^{10}}$.

* la même chose pour $T = 800^\circ C \longrightarrow C_4 = ?$ - —

Exercice 03 :

$T_1 = 800°C \Rightarrow C_1 = 1/10^{10}$

$T_2 = 900°C \Rightarrow C_2 = 1/10^{7}$

a) ΔH_f : ?

on a : $C_e = \exp \frac{-\Delta G_f}{K_B T} = \exp \frac{\Delta S}{K_B} \cdot \exp \frac{-\Delta H_f}{K_B T}$.

$\Rightarrow -\Delta H_f = K_B \cdot \frac{\log C_2/C_1}{\frac{T_1 - T_2}{T_1 T_2}} = -3,99 \times 10^{-19}\ J \Rightarrow \Delta H_f = 3,99 \times 10^{-19}\ J$

on a : $1\ cal = 4,18\ J \Rightarrow \Delta H_f = \frac{3,99 \times 10^{-19}}{4,18} = 9,56 \times 10^{-20}\ cal$

pour 1 mole $\Rightarrow \Delta H_{f\ mole} = \Delta H_f \cdot N_a = 5,76 \cdot 10^{4}\ cal/mole$.

b) pour chercher T_3 il faut trouver $\frac{\Delta S}{K_B}$.

pour $T_1 = 800°C = 1073\ K$, $C_1 = 1/10^{10}$

$\log C_1 = \frac{\Delta S}{K_B} - \frac{\Delta H_f}{K_B (1073)} \Rightarrow \frac{\Delta S}{K_B} = \log 10^{-10} + \frac{3,99 \times 10^{-19}}{1,38 \times 10^{-23} (1073)}$

$\Rightarrow \frac{\Delta S}{K_B} = 3,90$

Alors : pour : $C_3 = 1/10^{8} \rightarrow T_3$.

$\log C_3 = \frac{\Delta S}{K_B} - \frac{\Delta H_f}{K_B T_3} \Rightarrow T_3 = \frac{\Delta H_f / K_B}{\frac{\Delta S}{K_B} - \log C_3} \Rightarrow T_3 = 1294°K = 1021°C$

Exercice 04 :

$T_1 = 600°C \rightarrow C_1$

$T_2 = 800°C \rightarrow C_2$

$C_2 - C_1 = 1\ atome/cm^3$

$C_e = \frac{n_e}{N}$, $N = ?$

on a : $\rho = \frac{\text{Masse d'un mole}}{\text{Volume d'un mole}} \Rightarrow \rho = \frac{M}{V} \Rightarrow V = \frac{M}{\rho} = 10,25\ cm^3$

$10,27\ cm^3 \rightarrow N_a$.

$1\ cm^3 \rightarrow N \Rightarrow N = 5,86 \times 10^{22}\ atome$.

$C = \frac{1}{5,86 \times 10^{22}} = C_2 - C_1 = 1,7 \times 10^{-23}$

d'autre part : $C_e = \exp \frac{-\Delta G_f}{K_B T} \Rightarrow -\frac{\Delta H}{K_B} = \frac{\log C_2/C_1}{\frac{1}{T_2} - \frac{1}{T_1}}$

$\Rightarrow \log \frac{C_2}{C_1} = -\frac{\Delta H}{K_B} \left(\frac{T_1 - T_2}{T_2 T_1} \right) = 7,64 \Rightarrow \frac{C_2}{C_1} = 2079$.

on a : $C_2 - C_1 = 1{,}7 \times 10^{-23} \Rightarrow C_2 = 1{,}7 \times 10^{-23} + C_1$

$\frac{C_2}{C_1} = \frac{1{,}7 \times 10^{-23} + C_1}{C_1} = \frac{1{,}7 \times 10^{-23}}{C_1} + 1 = 2078$

$\Rightarrow C_1 = \frac{1{,}7 \times 10^{-23}}{2078} = 8{,}18 \times 10^{-27}$ et $C_2 = 170 \times 10^{-23}$.

$C_1 = \frac{n_e}{N} \Rightarrow n_e = C_1 \cdot N = 8{,}18 \times 10^{-27} \times 5{,}86 \times 10^{22} \Rightarrow$

$n_{e_1}(60°C) = 4{,}79 \times 10^{-4}$ atome/cm³.

$n_{e_2}(300°C) = C_2 \cdot N = 9{,}96 \times 10^{-1}$ atome/cm³.

b) Il faut trouver la valeur de $\frac{\Delta S}{K_B}$?

on a : $C_1 = \exp\frac{\Delta S}{K_B} \cdot \exp\frac{-\Delta H_f}{K_B T_1} \Rightarrow \frac{C_1}{\exp\left(\frac{\Delta H_f}{K_B T_1}\right)}$

$\Rightarrow \exp\frac{\Delta S}{K_B} = 1{,}8 \times 10^{-20}$

$\Rightarrow C_{e_2} = 1{,}8 \times 10^{-20} \cdot \exp -\left(\frac{1{,}7 \times 10^{-19}}{1{,}38 \times 10^{-23} \cdot 1233}\right)$

$C_{e_2} =$ ~~~~