Meg Noah
Stat Mech

10 @ 10

8.2 $T = 291K$ grey and white tin $P = 1atm$

Δ enthalpy $= 2238 \frac{J}{mol}$ $\rho_{gray} = 5.75 \frac{g}{cm^3}$ $\rho_{white} = 7.30 \frac{g}{cm^3}$

atomic weight of tin is 118.7

What is the change in transition temperature if the system is at a pressure of 100atm?

$$dQ = dE + PdV = dH - VdP$$

$$\Delta H = T\Delta S$$

$$\frac{\Delta P}{\Delta T} = \frac{\Delta S}{\Delta V} = \frac{\Delta H}{T\Delta V}$$

$$\Delta H = 2238 \frac{J}{mol} \qquad \Delta V = \left(\frac{118.7g}{mol}\frac{cm^3}{5.75g}\right) - \left(\frac{118.7g}{mol}\frac{cm^3}{7.30g}\right)$$

$$\Delta V = \left(20.64\frac{cm^3}{mol} - 16.26\frac{cm^3}{mol}\right)$$

$$\Delta V = 4.38\frac{cm^3}{mol}\left(\frac{1m}{100cm}\right)^3 = 4.38\cdot10^{-6}\frac{m^3}{mol}$$

$$\frac{\Delta H}{T\Delta V} = \frac{2238\ J\ mol^{-1}}{(291)4.38\cdot10^{-6}\ m^3\ mol^{-1}} = -1.756\cdot10^{-6}\ \frac{N}{Km^2}$$

$$\Delta P = 99atm\ \frac{101325N}{atm\ m^2} = 1.003\cdot10^7\frac{N}{m^2}$$

$$\Delta T = \frac{\Delta P}{\frac{\Delta H}{T\Delta V}} = -5.7K$$

8.3 $\frac{dP}{dT} = \frac{L_{12}}{T\Delta V}$

$\ln P = \left(-\frac{2500}{T} + 8.6\right)\ln 10$ ✓

$\frac{1}{P}\frac{dP}{dT} = \ln(10)\left(\frac{7500}{T^2}\right)$

$L_{12} = RT^2 \ln 10\left(\frac{7500}{T^2}\right) = 7500\ 8.31\ \ln(10) = 1.44\cdot 10^5 \frac{J}{mol}$

8.4 $\Delta S_{13} = \Delta S_{12} + \Delta S_{23}$

$\Delta S_{23} = \frac{L_{23}}{T} = \frac{1803\ J\,mol^{-1}}{24.57K} = 73.4\frac{cal}{K}$

$\Delta S_{12} = \frac{335\ J/mol}{24.57K} = 13.63\frac{cal}{K}$

$\Delta S_{13} = 87.03\ cal/K$ ✓

$L_{13} = \Delta S_{13} = 2138\ J/mol$

8.5 $L_{12} = A + BT$ & eq 8.36

$\frac{dP}{dT} = \frac{PL_{12}}{RT^2} \Rightarrow \frac{dP}{P} = \frac{A+BT}{RT^2}dT$

$\ln P_2/P_1 = -\frac{A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) + \frac{B}{R}\left(\ln T_2/T_1\right)$

$L_{12} = L_i - \frac{\Delta L}{\Delta T}(T_i - T_f)$

$B = \frac{\Delta L}{\Delta T} = \frac{-1058K}{\Delta T} \sim 42,337$

$L_{12} = 43991 - B(298.15 - 273.16)K = 4293 J$

$A = L_{12} - BT = 55,555.8$

$R = 8.314 \frac{J}{mol\,K}$

$\frac{P_2}{P_1} = e^{-\frac{A}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)} + e^{B/R \ln T_2/T_1} \Rightarrow \frac{P_2}{P_1} = 4.912$

$P_1 = \frac{P_2}{4.912} = \frac{27.75\ mm\,Hg}{4.912} \sim 4.835\ mm\,Hg$

8.6 $\frac{dP}{dT} = \frac{\Delta S}{\Delta V}$

$T \to 0$ then $\Delta S \to 0 \therefore \frac{dP}{dT} \to 0$

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8.7 $F = E - TS \quad E = 0 \quad F = -TS \quad S = -\frac{F}{T}$

$F = nkT \ln\left(\frac{eV}{n}\left(\frac{2\pi mkT}{h^2}\right)^{3/2}\right)$

$S = nk\left(\frac{eV}{n}\left(\frac{2\pi mkT}{h^2}\right)^{3/2}\right)$

eq 7.51 is of the form

$S_{tr} = Nk\left\{\ln\left(\frac{V}{N}\right) + \frac{3}{2}\ln T + \frac{5}{2} + \frac{3}{2}\ln\frac{2\pi mk}{h^2}\right\}$

$\Rightarrow S_{vap}\left[\frac{5}{2}\ln T - \ln P + \ln\frac{(2\pi m)^{3/2}(kc)^{5/2}}{h^3}\right] \quad T \gg \Theta_E$

$T \gg \Theta_3 \; S_{SO} = R\left\{3\ln T - 3\ln\Theta_E + 3\right\} \quad P = \frac{(2\pi m)^{3/2}k^{5/2}}{h^3 e^{5/2}}\Theta_E^3 \frac{1}{T}e^{-\Theta_E/T}$