Answer on the question #62973, Chemistry / Physical Chemistry

Question:

The equilibrium vapour pressure over a solid at 300K is known to be 20 Torr, and the enthalpy of sublimation is 8.0 kcal mol-1. Determine the equilibrium vapour pressure over the solid at 350K, assuming that deltaH sublimation is a constant

Solution:

To solve this, we use Clausius-Clapeyron equation.

This equation relates the vapour pressure, enthalpy of sublimation and temperature:

$$\ln(P) = const - \frac{\Delta H_{subl}}{RT}$$

Then, vapour pressure change for different temperatures is:

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{subl}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Then, $T_1 = 300K$ and $T_2 = 350\ K$.
In its turn, $P_1 = 20\ Torr$, and P_2 is the value we need to compute (vapour pressure at 350K).
R is the gas constant, $R = 1.987\frac{cal}{K\cdot mol}$.
If we assume, that the change in heat capacity for this temperature interval is zero ($\Delta c_p = 0$), sublimation enthalpy ΔH_{subl} is equal at both temperatures. Now, we should rearrange the equation to get $\ln(P_2)$, knowing that $\ln\left(\frac{P_2}{P_1}\right) = \ln(P_2) - \ln(P_1)$:

$$\ln(P_2) = \ln(P_1) + \frac{\Delta H_{subl}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln(P_2) = \ln(20\ Torr) + \frac{8\cdot 10^3\frac{cal}{mol}}{1.987\frac{cal}{K\cdot mol}}\left(\frac{1}{300K} - \frac{1}{350K}\right)$$

$$P_2 = 136\ Torr$$

Answer: 136 Torr