3. Solution

start with clausius-clapeyron equation

\[ Q = T \Delta V \frac{d \text{psat}}{dT} \]

Here \( \Delta V \) is latent heat of vaporization

note

\[ \Delta V = V^* - V^\ominus = V^\ominus (\rho^\ominus \rho^*) \]

\( \Delta V \) is volume change with vaporization

psat is saturated vapor pressure

Assume vapor is ideal gas and \( Q = f(T) \), then \( \Delta V = \frac{nRT}{psat} \)

\[ \Rightarrow Q = \frac{nRT}{psat} \frac{d \text{psat}}{dT} \]

\[ = nR \left( \frac{d \ln \text{psat}}{d(T/T^\ominus)} \right) \]

\[ = -nR \frac{d \ln \text{psat}}{d(1/T)} \]

So we get

\[ d \ln \text{psat} = -\frac{Q}{nR} d(1/T) \]

Integration:

\[ \ln \text{psat} = -\frac{Q}{nRT} + C \]

\[ \Rightarrow \text{psat} = e^{-\frac{Q}{nRT}} = C e^{-\frac{Q}{nRT}} \]

(note \( Q \) is molar quantity)

At constant pressure \( Q = \Delta H \)