1. Derive the exponential form of Clausius-Clapeyron to its logarithmic form

$$P_A = ke^{\frac{-\Delta H}{RT}}$$

$$lnP_A = \ln(ke^{\frac{-\Delta H}{RT}})$$

$$lnP_A = \ln k + lne^{\frac{-\Delta H}{RT}}$$

$$lnP_A = \ln k + \frac{-\Delta H}{RT}$$

2. The vapor pressure of ethanol at 34.9°C is 100.0 torr. Calculate the vapor pressure of ethanol at 56.2°C with given Enthalpy of vaporization (ΔH) is 41.7 kJ/mol and universal gas constant is 8.314 J/mol K

$$\frac{P_1}{P_2} = \frac{e^{\frac{-\Delta H}{RT_1}}}{e^{\frac{-\Delta H}{RT_2}}}$$

$$\frac{P_1}{P_2} = e^{\frac{-\Delta H}{RT_1} - \frac{-\Delta H}{RT_2}}$$

$$\frac{P_1}{P_2} = e^{\frac{\Delta H}{RT_2} - \frac{\Delta H}{RT_1}}$$

$$\frac{P_1}{P_2} = e^{\frac{\Delta H}{R}(\frac{1}{T_2} - \frac{1}{T_1})}$$

$$P_1 = P_2 e^{\frac{\Delta H}{R}(\frac{1}{T_2} - \frac{1}{T_1})}$$

$$P_1 = 100e^{\frac{41.7}{.008314}(\frac{1}{308} - \frac{1}{329.35})} = 287.4\ torr$$

3. This unknown compound has vapor pressure of 13.6 torr at 16.0°C and 26.7 torr at 27.0°C. With these given information, calculate the enthalpy of vaporization of this unknown compound.

$$P_1 = P_2 e^{\frac{\Delta H}{R}(\frac{1}{T_2} - \frac{1}{T_1})}$$

$$lnP_1 = \ln(P_2 e^{\frac{\Delta H}{R}(\frac{1}{T_2} - \frac{1}{T_1})})$$

$$lnP_1 = \ln P_2 + lne^{\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$lnP_1 = \ln P_2 + \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$lnP_1 = \ln P_2 + \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$lnP_1 - \ln P_2 = +\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \rightarrow \Delta H = R\frac{\ln\left(\frac{P_1}{P_2}\right)}{\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$\Delta H = R\frac{\ln\left(\frac{P_1}{P_2}\right)}{\left(\frac{1}{T_2} - \frac{1}{T_1}\right)} = 8.314\frac{\ln\left(\frac{13.6}{26.7}\right)}{\left(\frac{1}{300.15} - \frac{1}{289.15}\right)} = \frac{44250J}{mol} = 44.250kJ/mol$$

4. At 30.0°C, water has vapor pressure of 31.8 torr. Given enthalpy of vaporization (∆H) of water is 44.0kJ/mol. What is the vapor pressure at 28.0°C?

Same method as question 2

$$P_1 = P_2 e^{\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$P_1 = 31.8e^{\frac{44.0}{.008314}\left(\frac{1}{303.15} - \frac{1}{301.15}\right)} = 28.32\ torr$$

5. A compound has vapor pressure of 29.0 torr at 37.6°C and 15.0 torr at 29.9°C. Calculate the enthalpy of vaporization of this compound.

Same method as question 3

$$lnP_1 - \ln P_2 = +\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \rightarrow \Delta H = R\frac{\ln\left(\frac{P_1}{P_2}\right)}{\left(\frac{1}{T_2} - \frac{1}{T_1}\right)}$$

$$\Delta H = R\frac{\ln\left(\frac{P_1}{P_2}\right)}{\left(\frac{1}{T_2} - \frac{1}{T_1}\right)} = 8.314\frac{\ln\left(\frac{29.0}{15.0}\right)}{\left(\frac{1}{303.05} - \frac{1}{310.75}\right)} = \frac{67033J}{mol} = 67.033kJ/mol$$

6. At 30.0°C, water has vapor pressure of 31.8 torr. Given enthalpy of vaporization (ΔH) of water is 44.0kJ/mol. What is the temperature when vapor pressure is 28.3 torr?

$$lnP_1 = \ln P_2 + \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$lnP_1 = \ln P_2 + \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$lnP_1 - \ln P_2 = \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

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

$$\ln\left(\frac{31.8}{28.3}\right)\frac{.008314}{44.0} = \left(\frac{1}{T_2} - \frac{1}{303.15}\right)$$

$$.000022033 = \left(\frac{1}{T_2} - \frac{1}{303.15}\right)$$

$$\frac{1}{T_2} = .000022033 + \frac{1}{303.15}$$

$$T_2 = \frac{1}{.000022033 + \frac{1}{303.15}} = 301.14°K = 27.99℃$$