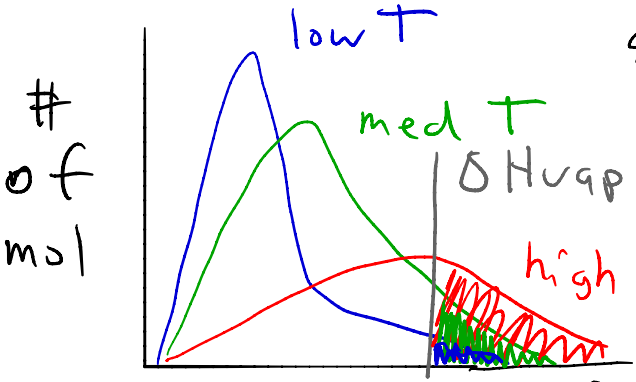
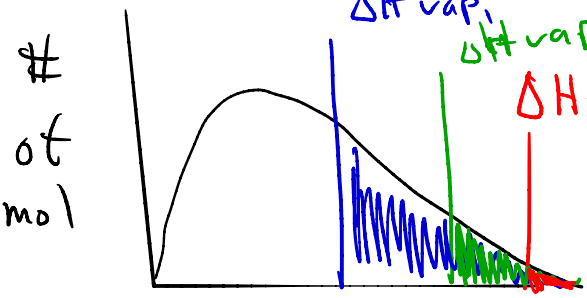
# Enthalpy of vaporization of ethanol

Vapor pressure - The equilibrium pressure of a gas automatically generated by a liquid due to the fact that a fraction of molecules have sufficient energy to evaporate



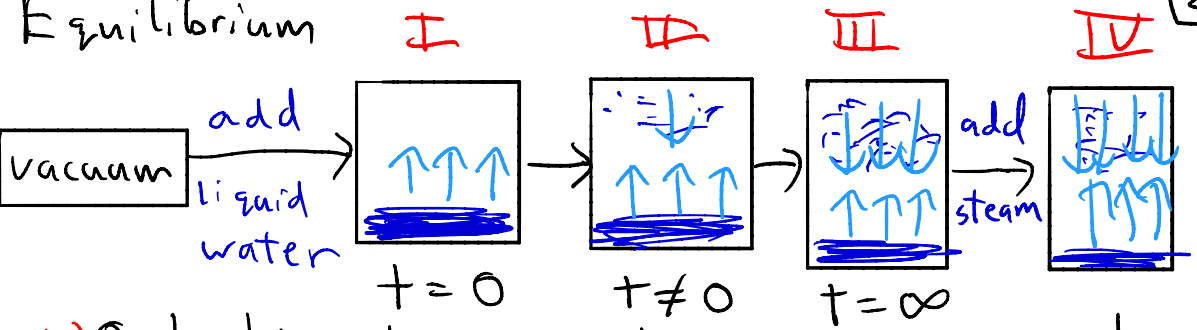

- At any temperature, some fraction of molecules will have the energy to evaporate.
- As temperature increases, the fraction of molecules with enough energy to evaporate also increases.

$\Delta H_{vap_1} < \Delta H_{vap_2} < \Delta H_{vap_3}$




At any specific temperature, the higher of heat of vaporization, the fewer the # of molecules with the energy to evaporate.

# Equilibrium

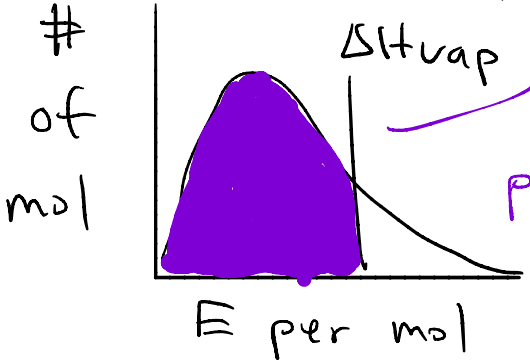



I) Only liquid water is present, so only evaporation can occur.

II) As soon as any evaporation occurs, condensation will also begin to occur.

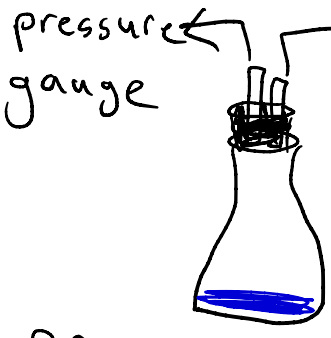
III) Eventually, enough vapor forms that the rate of condensation will equal the rate of evaporation → Equilibrium

IV) If steam is added to the container after equilibrium is reached, the rate of condensation will exceed evaporation. Liquid will therefore condense until the rates of evaporation and condensation equal each other again.




This area represents the fraction of gas particles that do not have the energy to remain in the gas phase.

In a closed container at a fixed temperature, evaporation of a liquid will stop once vapor pressure is reached.




In this experiment, a liquid sample is added to a sealed container and allowed to reach equilibrium. The pressure and temperature of the container is measured before and after the liquid is added. The difference in pressured measured is the vapor pressure of that liquid (assuming temperature stays the same).

The liquid is added by syringe to maintain a closed container. A volume of air, equal to the volume of liquid added, is removed to maintain the initial pressure of the container.

$n = e^{-E_x/RT}$ This equation gives the number of particles ($n$) that have at least a particular energy ($E_x$) at a given temperature ($T$).

Clausius-Clapeyron equation

$$P = Ce^{-\Delta H_{vap}/RT}$$

$P$: vapor pressure; $\Delta H_{vap}$: heat of vaporization; $R$: thermodynamic constant; $C$: constant

$$\ln(P) = \ln(Ce^{-\Delta H_{vap}/RT})$$

$$\ln P = \ln(e^{-\Delta H_{vap}/RT}) + \ln C$$

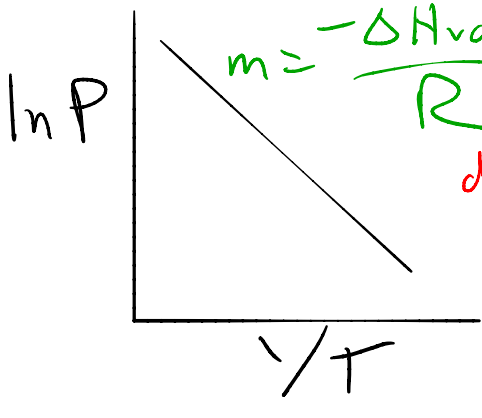
$\ln a \cdot b = \ln a + \ln b$

$$\ln P = -\frac{\Delta H_{vap}}{RT} + \ln C$$

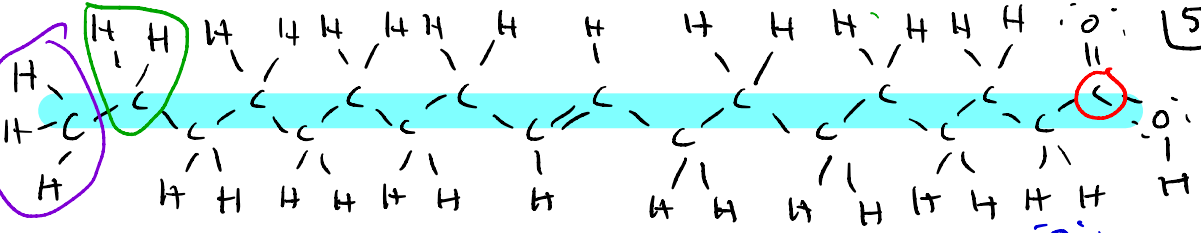
substitution of variables

$$\underbrace{\ln P}_{y} = \underbrace{-\frac{\Delta H_{vap}}{R}}_{m}\underbrace{\left(\frac{1}{T}\right)}_{x} + \underbrace{\ln C}_{b}$$

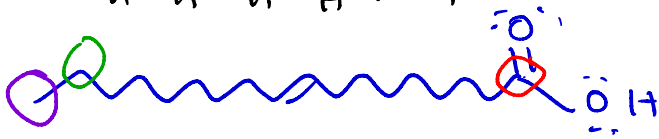
$y = mx + b$



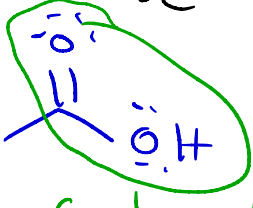

$m = \frac{-\Delta H_{vap}}{R}$ By measuring the vapor pressure at different temperatures, the heat of vaporization can be determined from the slope of this graph.



## Line structure

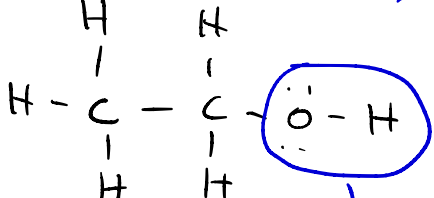


- Line structures are based on the assumption that carbon is tetravalent. has 4 bonds and/or lone pairs
- In a line structure, any "missing" connections are presumed to be hydrogens



carboxylic acids

Ethanol



alcohol

Functional group - A pattern of atoms that has predictable behavior regardless of the molecule it is located on.

Denatured ethanol - Ethanol that contains additives so it cannot be consumed.