Full form of the Clausius-Clapeyron equation:

$$\ln P = \frac{-\Delta H_{vap}}{R}\left(\frac{1}{T}\right) + C$$

Two-point version of the equation:

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

Utility of the Clausius-Clapeyron Equation

It provides a means to determine experimentally the heat of vaporization, which is the energy required to vaporize 1 mole of molecules in the liquid state.

or

If ΔH_{vap} is known, and vapor pressure at one T is known, then vapor pressure at a new T can be calculated.

SAMPLE PROBLEM 12.1 **Using the Clausius-Clapeyron equation**

PROBLEM: The vapor pressure of ethanol is 115 torr at 34.9 °C. If DH_{vap} of ethanol is 40.5 kJ/mol, calculate the temperature (in °C) when the vapor pressure is 760 torr.

PLAN: We are given four of the five variables in the Clausius-Clapeyron equation. Substitute and solve for T_2.

SOLUTION:

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

$T_1 = 34.9\ ^{o}C = 308.0\ K$

$$\ln \frac{760\ torr}{115\ torr} = \frac{-40.5 \times 10^{3}\ J/mol}{8.314\ J/mol \cdot K}\left(\frac{1}{T_2} - \frac{1}{308\ K}\right)$$

$T_2 = 350\ K = 77\ ^{o}C$

Vapor Pressure and Boiling Point

If we assume an open container, then the boiling point (BP) is the temperature at which the vapor pressure equals the external pressure (usually atmospheric pressure, 760 mmHg).

Thus, the BP depends on the applied pressure

Water boils at 100 ºC at sea level, but at 72 ºC on the peak of Mt. Everest!

Viscosity: a liquid's resistance to flow

- Affected by temperature (viscosity decreases at higher T)
- Affected by molecular shape (longer molecules exhibit higher viscosity)

Table 12.4 Viscosity of Water at Several Temperatures

temperature (^oC)	viscosity ($N \cdot s/m^2$)*
20	1.00×10^{-3}
40	0.65×10^{-3}
60	0.47×10^{-3}
80	0.35×10^{-3}

*The units of viscosity are newton-seconds per square meter.