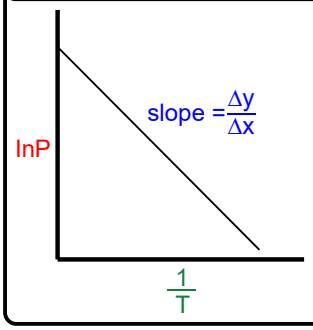
CONCEPT: CLAUSIUS-CLAPEYRON EQUATION

- **Clausius-Clapeyron Equation** establishes a relationship between _____ of liquids and _____.
  - □ Recall: *vapor pressure* represents an equilibrium between _____ and _____.
  - □ As temperature _____, vapor pressure _____.

Linear Form of Clausius-Clapeyron Equation

- We use this form of the equation when a plot of _____ vs _____ temperature is given.
  - □ Usually used to calculate the enthalpy of vaporization.
    - Recall a slope-intercept form of a straight line: y = mx + b

Clausius-Clapeyron Equation (Linear Form)



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

slope

- □ R = 8.314 _____
- □ P = Vapor Pressure in ____ or ____
- □ ΔH_{vap} = Enthalpy of vaporization in ____
- □ T = Temperature in K
- □ C = constant of a substance

EXAMPLE: The vapor pressure of a substance is measured over a range of temperatures. A plot of the natural log of the vapor pressure vs the inverse of the temperatures (in Kelvin) produces a straight line with a slope of -2.79×10^3 K. Find the enthalpy of vaporization of the substance.

PRACTICE: Vapor pressure measurements at various temperature values are given below. Determine the molar heat of vaporization for cyclohexane.

T(°C)	0.0	20.0	40.00	60.0
P (mmHg)	28	78	186	389

a) 11,520 J/mol b) 72,193 J/mol

c) 33,147 J/mol d) 52,968 J/mol

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Two-Point Form of Clausius-Clapeyron Equation

● We use this form of the equation when _____ temperatures and/or _____ pressures are mentioned.

□ When given *Normal boiling point*, Pressure = _____ torr or mmHg.

Clausius-Clapeyron Equation (Two-Point Form)

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

□ R = 8.314 _____

□ P = Vapor Pressure in ____ or ____

□ ΔH_{vap} = Enthalpy of vaporization in ____

□ T = Temperature in K

EXAMPLE: The enthalpy of vaporization of water is 40.3 kJ/mol at its normal boiling point at 100ºC. What is the vapor pressure (mmHg) of water at 60ºC?

a) 813.3 mmHg b) 790.1 mmHg c) 159.8 mmHg d) 305.7 mmHg

PRACTICE: Benzene has a heat of vaporization of 30.72 kJ/mol and a normal boiling point of 80.1°C. At what temperature does benzene boil when the external pressure is 405 torr?

a) 251.9 K b) 720.7 K c) 924.2 K d) 333.2 K