Vapor Pressure

- Vapor pressure is the pressure exerted by a vapor in equilibrium with its liquid or solid phase.
- The vapor pressure of a substance is determined by its temperature and the nature of the substance.
- The vapor pressure of a substance increases with increasing temperature.
- The vapor pressure of a substance decreases with increasing molecular weight.
- The vapor pressure of a substance is independent of the amount of substance present.

Raoult's Law

Raoult's law states that the vapor pressure of a solution is equal to the sum of the vapor pressures of the pure components of the solution, each multiplied by its mole fraction in the solution.

Mathematically, Raoult's law can be expressed as follows:

$p_{total} = p_1x_1 + p_2x_2 + ... + p_nx_n$

where:

- p_{total} is the vapor pressure of the solution
- p_1, p_2, ..., p_n are the vapor pressures of the pure components of the solution
- x_1, x_2, ..., x_n are the mole fractions of the pure components of the solution

Henry's Law

Henry's law states that the partial pressure of a gas in a solution is proportional to the concentration of the gas in the solution.

Mathematically, Henry's law can be expressed as follows:

$p = k_Hc$

where:

- p is the partial pressure of the gas in the solution
- k_H is the Henry's law constant
- c is the concentration of the gas in the solution

Ideal and Non-Ideal Solutions

An ideal solution is a solution that obeys Raoult's law over the entire range of concentrations.

A non-ideal solution is a solution that does not obey Raoult's law over the entire range of concentrations.

Colligative Properties

Colligative properties are properties of solutions that depend on the number of solute particles present in the solution, and not on the nature of the solute particles.

The four colligative properties are:

- Vapor pressure lowering
- Boiling point elevation
- Freezing point depression
- Osmotic pressure

Vapor Pressure Lowering

The vapor pressure of a solution is lower than the vapor pressure of the pure solvent.

The vapor pressure lowering is proportional to the mole fraction of the solute in the solution.

The vapor pressure lowering can be calculated using the following equation:

$p_{solvent} = p_{solvent}^0 - x_{solute}p_{solvent}^0$

where:

- $p_{solvent}$ is the vapor pressure of the solution
- $p_{solvent}^0$ is the vapor pressure of the pure solvent
- x_{solute} is the mole fraction of the solute in the solution

Boiling Point Elevation

The boiling point of a solution is higher than the boiling point of the pure solvent.

The boiling point elevation is proportional to the molality of the solute in the solution.

The boiling point elevation can be calculated using the following equation:

$T_b = T_b^0 + K_bm$

where:

- T_b is the boiling point of the solution
- T_b^0 is the boiling point of the pure solvent
- K_b is the boiling point elevation constant
- m is the molality of the solute in the solution

Freezing Point Depression

The freezing point of a solution is lower than the freezing point of the pure solvent.

The freezing point depression is proportional to the molality of the solute in the solution.

The freezing point depression can be calculated using the following equation:

$T_f = T_f^0 - K_f m$

where:

- T_f is the freezing point of the solution
- T_f^0 is the freezing point of the pure solvent
- K_f is the freezing point depression constant
- m is the molality of the solute in the solution

Osmotic Pressure

Osmotic pressure is the pressure that must be applied to a solution to prevent the passage of solvent molecules from the pure solvent into the solution.

The osmotic pressure is proportional to the concentration of the solute in the solution.

The osmotic pressure can be calculated using the following equation:

$\pi = MRT$

where:

- π is the osmotic pressure
- M is the molarity of the solute in the solution
- R is the gas constant
- T is the temperature in Kelvin