Important Formulas of Colligative Properties PDF

Formulas
Examples
with Units

List of 22
Important Formulas of Colligative Properties

1) Boiling Point Elevation Formula

Evaluate Formula

Formula

$$\Delta T_b = K_b \cdot m$$

Example with Units

$$274.0629\,\text{K} = 0.51 \cdot 1.79\,\text{mol/kg}$$

2) Cryoscopic Constant given Depression in Freezing Point Formula

Evaluate Formula

Formula

$$k_f = \frac{\Delta T_f}{i \cdot m}$$

Example with Units

$$6.6507\,\text{K*kg/mol} = \frac{12\,\text{K}}{1.008 \cdot 1.79\,\text{mol/kg}}$$

3) Cryoscopic Constant given Latent Heat of Fusion Formula

Evaluate Formula

Formula

$$k_f = \frac{[R] \cdot T_f^{\,2}}{1000 \cdot L_{fusion}}$$

Example with Units

$$6.2234\,\text{K*kg/mol} = \frac{8.3145 \cdot 500\,\text{K}^2}{1000 \cdot 334\,\text{J/kg}}$$

4) Ebullioscopic Constant given Elevation in Boiling Point Formula

Evaluate Formula

Formula

$$k_b = \frac{\Delta T_b}{i \cdot m}$$

Example with Units

$$0.5487\,\text{K*kg/mol} = \frac{0.99\,\text{K}}{1.008 \cdot 1.79\,\text{mol/kg}}$$

5) Ebullioscopic Constant using Latent Heat of Vaporization Formula

Evaluate Formula

Formula

$$k_b = \frac{[R] \cdot T_{sbp}^{\,2}}{1000 \cdot L_{vaporization}}$$

Example with Units

$$0.5404\,\text{K*kg/mol} = \frac{8.3145 \cdot 12.12\text{E+}3\,\text{K}^2}{1000 \cdot 2260000\,\text{J/kg}}$$

6) Freezing Point Depression Formula

Evaluate Formula

Formula

$$\Delta T_f = k_f \cdot m$$

Example with Units

$$285.0535\,\text{K} = 6.65\,\text{K*kg/mol} \cdot 1.79\,\text{mol/kg}$$

7) Osmotic Pressure for Non Electrolyte Formula

Evaluate Formula

Formula

$$\pi = c \cdot [R] \cdot T$$

Example with Units

$$2.4777\,\text{Pa} = 0.001\,\text{mol/L} \cdot 8.3145 \cdot 298\,\text{K}$$

8) Osmotic Pressure given Concentration of Two Substances Formula

Evaluate Formula

Formula

$$\pi = \left(C_1 + C_2\right) \cdot [R] \cdot T$$

Example with Units

$$2.5\,\text{Pa} = \left(8.2\text{E-}7\,\text{mol/L} + 1.89\text{E-}7\,\text{mol/L}\right) \cdot 8.3145 \cdot 298\,\text{K}$$

9) Osmotic Pressure given Density of Solution Formula

Evaluate Formula

Formula

$$\pi = \rho_{sol} \cdot [g] \cdot h$$

Example with Units

$$2.4987\,\text{Pa} = 0.049\,\text{g/L} \cdot 9.8066\,\text{m/s}^2 \cdot 5.2\,\text{m}$$

10) Osmotic Pressure given Depression in Freezing Point Formula

Evaluate Formula

Formula

$$\pi = \frac{\Delta H_{fusion} \cdot \Delta T_f \cdot T}{V_m \cdot \left(T_{fp}^2\right)}$$

Example with Units

$$2.4995\,\text{Pa} = \frac{3.246\,\text{kJ/mol} \cdot 12\,\text{K} \cdot 298\,\text{K}}{51.6\,\text{m}^3\text{/mol} \cdot \left(300\,\text{K}^2\right)}$$

11) Osmotic Pressure given Relative Lowering of Vapour Pressure Formula

Evaluate Formula

Formula

$$\pi = \frac{\Delta p \cdot [R] \cdot T}{V_m}$$

Example with Units

$$2.4969\,\text{Pa} = \frac{0.052 \cdot 8.3145 \cdot 298\,\text{K}}{51.6\,\text{m}^3\text{/mol}}$$

12) Osmotic Pressure given Vapour Pressure Formula

Evaluate Formula

Formula

$$\pi = \frac{\left(p_o - p\right) \cdot [R] \cdot T}{V_m \cdot p_o}$$

Example with Units

$$2.5003\,\text{Pa} = \frac{\left(2000\,\text{Pa} - 1895.86\,\text{Pa}\right) \cdot 8.3145 \cdot 298\,\text{K}}{51.6\,\text{m}^3\text{/mol} \cdot 2000\,\text{Pa}}$$

13) Ostwald-Walker Dynamic Method for Relative Lowering of Vapour Pressure Formula

Evaluate Formula

Formula

$$\Delta p = \frac{w_B}{w_A + w_B}$$

Example with Units

$$0.052 = \frac{0.548\,\text{g}}{10\,\text{g} + 0.548\,\text{g}}$$

14) Relative Lowering of Vapour Pressure Formula

Evaluate Formula

Formula

$$\Delta p = \frac{p_o - p}{p_o}$$

Example with Units

$$0.0521 = \frac{2000\,\text{Pa} - 1895.86\,\text{Pa}}{2000\,\text{Pa}}$$

15) Relative Lowering of Vapour Pressure given Number of Moles for Concentrated Solution Formula

Evaluate Formula

Formula

$$\Delta p = \frac{n}{n + N}$$

Example with Units

$$0.0494 = \frac{0.52\,\text{mol}}{0.52\,\text{mol} + 10\,\text{mol}}$$

16) Relative Lowering of Vapour Pressure given Number of Moles for Dilute Solution Formula

Evaluate Formula

Formula

$$\Delta p = \frac{n}{N}$$

Example with Units

$$0.052 = \frac{0.52\,\text{mol}}{10\,\text{mol}}$$

17) Total Concentration of Particles using Osmotic Pressure Formula

Evaluate Formula

Formula

$$c = \frac{\pi}{[R] \cdot T}$$

Example with Units

$$0.001\,\text{mol/L} = \frac{2.5\,\text{Pa}}{8.3145 \cdot 298\,\text{K}}$$

18) Van't Hoff equation for Depression in Freezing Point of electrolyte Formula

Evaluate Formula

Formula

$$\Delta T_f = i \cdot k_f \cdot m$$

Example with Units

$$11.9987\,\text{K} = 1.008 \cdot 6.65\,\text{K*kg/mol} \cdot 1.79\,\text{mol/kg}$$

19) Van't Hoff Equation for Elevation in Boiling Point of Electrolyte Formula

Evaluate Formula

Formula

$$\Delta T_b = i \cdot k_b \cdot m$$

Example with Units

$$0.9238\,\text{K} = 1.008 \cdot 0.512\,\text{K*kg/mol} \cdot 1.79\,\text{mol/kg}$$

20) Van't Hoff Osmotic Pressure for Electrolyte Formula

Evaluate Formula

Formula

$$\pi = i \cdot c \cdot R \cdot T$$

Example with Units

$$2.4974\,\text{Pa} = 1.008 \cdot 0.001\,\text{mol/L} \cdot 8.314 \cdot 298\,\text{K}$$

21) Van't Hoff Osmotic Pressure for Mixture of Two Solutions Formula

Evaluate Formula

Formula

$$\pi = \left(\left(i_1 \cdot C_1 \right) + \left(i_2 \cdot C_2 \right) \right) \cdot [R] \cdot T$$

Example with Units

$$2.6564\,\text{Pa} = \left(\left(1.1 \cdot 8.2\text{E-}7\,\text{mol/L} \right) + \left(0.9 \cdot 1.89\text{E-}7\,\text{mol/L} \right) \right) \cdot 8.3145 \cdot 298\,\text{K}$$

22) Van't Hoff Relative Lowering of Vapour Pressure given Molecular Mass and Molality Formula

Evaluate Formula

Formula

$$\Delta p_{\text{Van't Hoff}} = \frac{i \cdot m \cdot M}{1000}$$

Example with Units

$$3.2\text{E-}5 = \frac{1.008 \cdot 1.79\,\text{mol/kg} \cdot 18\,\text{g}}{1000}$$

Variables used in list of Important Formulas of Colligative Properties above

- **c** Molar Concentration of Solute *(Mole per Liter)*
- C_1 Concentration of Particle 1 *(Mole per Liter)*
- C_2 Concentration of Particle 2 *(Mole per Liter)*
- **h** Equilibrium Height *(Meter)*
- **i** Van't Hoff Factor
- i_1 Van't Hoff Factor of Particle 1
- i_2 Van't Hoff Factor of Particle 2
- k_b Ebullioscopic Constant of Solvent *(Kelvin Kilogram per Mole)*
- K_b Molal Boiling Point Elevation Constant
- k_f Cryoscopic Constant *(Kelvin Kilogram per Mole)*
- L_{fusion} Latent Heat of Fusion *(Joule per Kilogram)*
- $L_{vaporization}$ Latent Heat of Vaporization *(Joule per Kilogram)*
- **m** Molality *(Mole per Kilogram)*
- **M** Molecular Mass Solvent *(Gram)*
- **n** Number of Moles of Solute *(Mole)*
- **N** Number of Moles of Solvent *(Mole)*
- **p** Vapour Pressure of Solvent in Solution *(Pascal)*
- p_o Vapour Pressure of Pure Solvent *(Pascal)*
- **R** Universal Gas Constant
- **T** Temperature *(Kelvin)*
- T_f Solvent Freezing Point for Cryoscopic Constant *(Kelvin)*
- T_{fp} Solvent Freezing Point *(Kelvin)*
- T_{sbp} Solvent BP given Latent Heat of Vaporization *(Kelvin)*
- V_m Molar Volume *(Cubic Meter per Mole)*
- w_A Loss of Mass in bulb set A *(Gram)*
- w_B Loss of Mass in Bulb Set B *(Gram)*

Constants, Functions, Measurements used in list of Important Formulas of Colligative Properties above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- constant(s): **[R]**, 8.31446261815324
  Universal gas constant
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Gram (g)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Amount of Substance** in Mole (mol)
  Amount of Substance Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Molar Concentration** in Mole per Liter (mol/L)
  Molar Concentration Unit Conversion
- Measurement: **Density** in Gram per Liter (g/L)
  Density Unit Conversion
- Measurement: **Latent Heat** in Joule per Kilogram (J/kg)
  Latent Heat Unit Conversion
- Measurement: **Molar Magnetic Susceptibility** in Cubic Meter per Mole (m^3/mol)
  Molar Magnetic Susceptibility Unit Conversion
- Measurement: **Molality** in Mole per Kilogram (mol/kg)
  Molality Unit Conversion
- Measurement: **Molar Enthalpy** in Kilojoule per Mole (kJ/mol)
  Molar Enthalpy Unit Conversion
- Measurement: **Cryoscopic Constant** in Kelvin Kilogram per Mole (K*kg/mol)
  Cryoscopic Constant Unit Conversion

- ΔH_{fusion} Molar Enthalpy of Fusion *(Kilojoule per Mole)*
- Δp Relative Lowering of Vapour Pressure
- $\Delta p_{Van't\ Hoff}$ Colligative Pressure given Van't Hoff factor
- ΔT_b Boiling Point Elevation *(Kelvin)*
- ΔT_f Depression in Freezing Point *(Kelvin)*
- ΔT_f Depression in Freezing Point *(Kelvin)*
- π Osmotic Pressure *(Pascal)*
- ρ_{sol} Density of Solution *(Gram per Liter)*

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