van't Hoff factor *i*

The **van't Hoff factor** is really just a mathematical factor that scales the mixed or label concentration of a solute so that it matches the actual or total concentration of all species generated by that solute after dissolution.

Solutes generally come in three types that we are concerned with: non-electrolytes, weak electrolytes, and strong electrolytes. Each of these can be easily classified by the way in which they dissociate and the ions that they form or do not form as the case may be.

Non Electrolytes

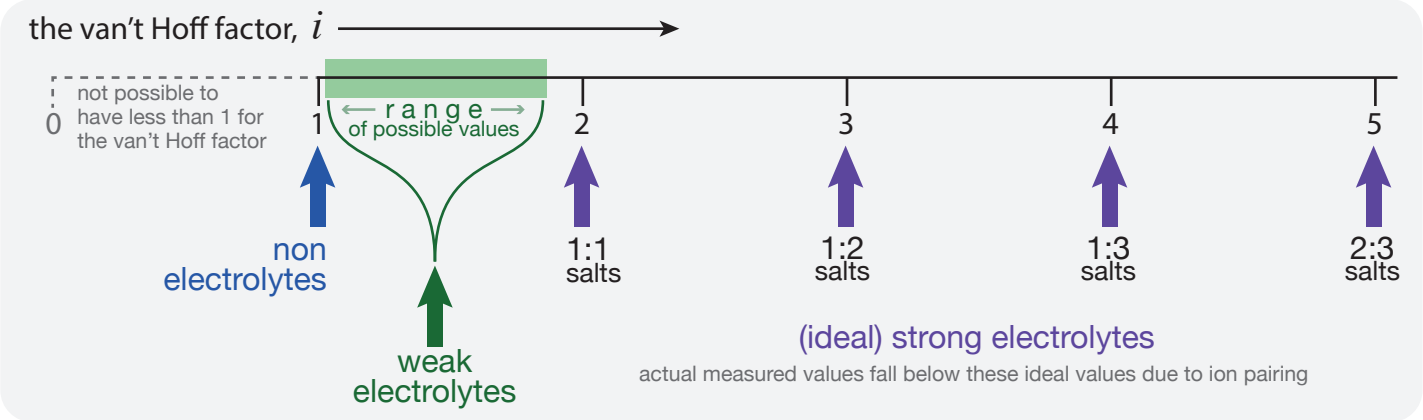
These solutes dissolve and do not split, ionize, or dissociate in any way. The actual concentration will match the mixed concentration and the van't Hoff factor will always be 1.0

Weak Electrolytes

These solutes dissolve and partially dissociate or ionize to yield a solution of the parent species plus the ions that are generated after ionization. They typically only ionize in small percentages such as 1 to 5%. However, any percent that is less than 100% is considered a "weak" electrolyte. The van't Hoff factor for these solutes can be any real number between 1 and 2.

Strong Electrolytes

These solutes tend to be soluble salts and completely dissociate 100% to yield a solution of cations and anions. The actual concentration of ions will be the the mixed concentration times the number of ions in the formula. That number is the van't Hoff factor. It is ideally equal to an integer number that is typically 2, 3, 4, or 5.



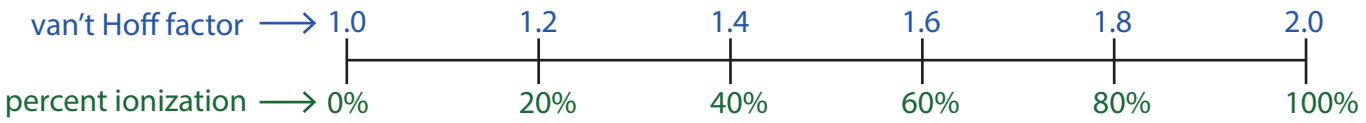
The TRUE van't Hoff Factor is a *measured* quantity

Although we commonly just assume that the van't Hoff factor is a nice integer number, the truth is that the van't Hoff factor is actually a measured quantity. The most straight forward way to measure it is to measure a colligative property of the solution such as freezing point depression, boiling point elevation, or osmotic pressure. Each of these colligative properties of a solution will reveal a true *total* concentration of all species. This measured concentration is often referred to as the effective concentration. The ratio between this effective concentration and the stated (label) concentration is the van't Hoff factor.

$$i = \frac{m_{\text{effective}}}{m_{\text{stated}}}$$

Although the formula to the left shows molalities which are used for freezing point depression and boiling point elevation, molarities like with osmotic pressure calculations can be used also.

It is also fairly straight forward in converting the value of *i* for a weak electrolyte into a percent ionization value.



$$\%\ \text{ionization} = (i - 1) \times 100\%$$