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Ionic Equilibrium in Solutions

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Introduction

The equilibria involving ions are called ionic equilibrium. When common salt or sodium chloride is dissolved in water, it can conduct electricity! Conductance of electricity increases with increasing concentration of common salt. On the basis of conductance of their solutions substance were classified by Faraday as electrolytes and non-electrolytes.

An electrolyte is a substance or compound, which conducts electricity in molten aqueous state. On the contrary, the compound does not conduct electricity in molten or aqueous state are called non-electrolytes. Arrhenius gave the concept that an electrolyte conducts electricity due to presence of ions afterdissociation of the substances. The extents of dissociation of different electrolytes are different.

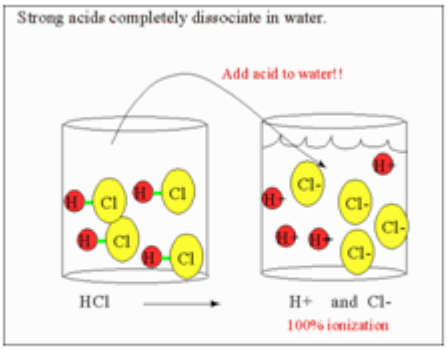
The fraction of total number of molecules that dissociate into ions is called its degree of dissociation or degree of ionisation and generally denoted by ?.

$$\alpha = \frac{\text{Number of moles dissociated or ionised}}{\text{Total number of moles taken}}$$

On the basis of degree of ionisation Faraday categorised the electrolytes as ‘strong electrolytes’ and ‘weak electrolytes’.

A strong electrolyte dissociates almost completely into its ions in aqueous solution and is a vey good conductor of electricity. The examples of strong electrolytes are NaOH, KOH, HCl, NaCl, etc.

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$



Dissociation of a Strong Acid

A weak electrolyte is a substance that dissociates to a small extent in aqueous solution and hence conducts electricity to a little extent. NH4Cl and CH3COOH are the examples of weak electrolyte.

$CH_3COOH \rightarrow CH_3COO^- + H_3O^+$

In general,ionisation of a weak electrolyte, AB is represented as follows

$AB(s) + aq \rightleftharpoons A^+(aq) + B^-(aq)$

This type of equilibrium is known as ionic equilibrium

Ionisation of Weak Acids and Bases

Ionisation of a weak acid HA can be represented as

$HA + H_2O \rightleftharpoons H_3O^+ + A^-$

If C is concentration of acid in mole per litre and ? is degree of dissociation

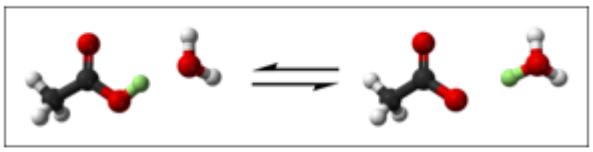
$$K_a = \frac{[H^+(aq)][A^-(aq)]}{[HA]} = \frac{C\alpha \times C\alpha}{C(1-\alpha)} = \frac{\alpha^2 C}{(1-\alpha)}$$

As the degree of dissociation of a weak acid is very small we can take 1- ??1

2

a

K = ? C, or $\alpha = \sqrt{\frac{K_a}{\alpha C}}$



Dissociation of acetic acid

Ionisation of a weak base BOH can be represented as

$BOH + H_2O \rightleftharpoons B^+(aq) + OH^-(aq)$

$$K_b = \frac{[B^+(aq)][OH^-(aq)]}{[BOH]} = \frac{C\alpha \times C\alpha}{C(1-\alpha)} = \frac{\alpha^2 C}{(1-\alpha)}$$

When a is small, 1-??1

Hence $K_b = ?^2C$

Protic Acids and its Types

Protic acids

Acids having ionisable hydrogen are known as protic acids.
Protic acids can be classified as monoprotic, and polyprotic acids

Examples:

Monoprotic acids: HCl, CH_3COOH, HNO_3. These acids contain only one ionisable hydrogen.

Polyprotic acids: H_2SO_4, $(COOH)_2$, H_2CO_3, H_3PO_4 H_3A SO_4, etc. Polyprotic acids produce more than one hydrogen ion on dissociation. They ionise in steps.

For example the dibasic acid H2X may ionise in two steps as follows:

$H_2X\ (aq)$? $H^+(aq) + HX^-(aq)$

$HX^-(aq)$? $H^+(aq) + X^-(aq)$

Their ionisation constants K_{a_1} and K_{a_2} called the first and second ionisation constant respectively and given by the equations

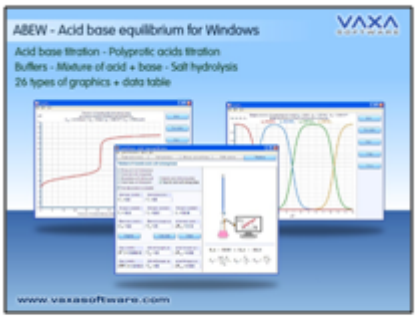
$$K_{a_1} = \frac{[H^+][HX^-]}{[H_2X]}, K_{a_2} = \frac{[H^+][X^{2-}]}{[HX^-]}$$

The overall equilibrium is obtained by adding the stepwise dissociation equilibria.
Thus for the above process the overall equilibrium will be

$H_2X\ (aq)$? $2H^+\ (aq) + X^{2-}\ (aq)$

$$K_a = \frac{[H^+]^2[X^{2-}]}{[H_2X]}$$

$$\text{And } K_a = K_{a_1} \times K_{a_2}$$



Polyprotic acids titration

How does dissociation affect ionic equilibrium in solution?

Try to answer. Still need help? Want to know more about it?Click here to schedule live help from a certified tutor!

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Reference Links:

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