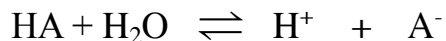


TYPE 1 (weak ACID)

(only a weak ACID put in solution)

For a weak acid (HA) in water:



$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$
 and let C_{HA} be the analytical concentration (label) of the weak acid

Our Equilibrium "ICE" Table

	[HA]	[H ⁺]	[A ⁻]
initial	C_{HA}	0	0
change	$-x$	$+x$	$+x$
equilibrium	$C_{\text{HA}} - x$	x	x

$$K_a = \frac{x^2}{(C_{\text{HA}} - x)} \quad \text{Equation 1.1}$$

$$K_a C_{\text{HA}} - K_a(x) = x^2$$

$$0 = x^2 + K_a(x) - K_a C_{\text{HA}}$$

$$[\text{H}^+] = [\text{A}^-] = x = \frac{-K_a + \sqrt{K_a^2 + 4K_a C_{\text{HA}}}}{2}$$

This equation is the exact solution for calculating the [H⁺] for any solution made by mixing a concentration of ONLY a weak acid in water. (What I have designated a "Type 1" problem)

If we are using a REASONABLE concentration for HA (somewhere between 1.0 M and 0.05 M) AND K_a is small enough (say less than 10^{-4}) we can make the following assumption:

$$C_{\text{HA}} - x \cong C_{\text{HA}} \quad \text{all this is saying is that } x \text{ is so small compared to } C_{\text{HA}}, \text{ it doesn't change it}$$

So that Equation 1.1 shown above becomes

$$K_a = \frac{x^2}{C_{\text{HA}}}$$

and solving:

$$[\text{H}^+] = [\text{A}^-] = x = \sqrt{K_a C_{\text{HA}}} \quad \text{Equation 1.2}$$

This equation is the approximate solution for calculating the [H⁺] for any weak acid with $K_a < 10^{-4}$ when put in water.