TYPE 1 (weak ACID)

(only a weak ACID put in solution)

For a weak acid (HA) in water:

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

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

Our Equilibrium "Chart"

	[HA]	**[H⁺]**	**[A⁻]**
initial	C_{HA}	0	0
change	$-x$	$+x$	$+x$
final	$C_{HA} - x$	x	x

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

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

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

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

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:

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

So that Equation 1.1 shown above becomes

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

and solving:

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

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