Consider a 0.100M solution of nitrous acid, a WEAK ACID (HNO_2)

$$HNO_2 + H_2O \rightleftharpoons H_3O^+ + NO_2^-$$

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]} = 4.5 \times 10^{-4}$$

Values for Ka, like other equilibrium constants, are determined experimentally

What is the pH of the solution?

See pages A-13 and A-14 in your textbook for values for Ka (or use the internet)

To find the pH, we must determine the hydronium ion concentration: $[H_3O^+]$

... so we need to solve the equilibrium expression. As is usually the case, we don't know all the concentrations AT EQUILIBRIUM. We need to relate them to one another.

We assume that the amount of hydronium from the water is small enough to ignore

Species	[Initial]	Δ	[Equilibrium]
H_3O^+	0	$+x$	x
NO_2^-	0	$+x$	x
HNO_2	0.100	$-x$	$0.100 - x$

So far, this is very similar to problems from the equilibrium chapter (Chapter 14)

$$4.5\times10^{-4} = \frac{x^2}{0.100 - x}$$

Quadratic:

$$ax^2+bx+c=0$$

$$x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

If 'x' is much smaller than 0.100, then 0.100-x = approximately 0.100

$0.100 - x \approx 0.100$

How do we know this assumption actually works?

$$4.5\times10^{-4} = \frac{x^2}{0.100}$$

$$4.5\times10^{-5} = x^2$$

$$0.0067082039 = x = [H_3O^+]$$

So, $pH = 2.17$

* For situations where the amount of dissociated acid or base is much smaller than the original amount, it's safe to assume that the concentration of undissociated aciad or base remains essentially constant at the nominal concentration.

* But how do we know THAT'S true? A useful rule of thumb. If the Ka or Kb is at least 1000 times smaller than the nominal concentration, the assumption we made is safe.

Solving the quadratic gives us a pH of 2.19, which is only a small difference in the last significant figure.

Compare:

- Weak acid HNO_2 : pH of 0.10 M solution = 2.17

Let's compare the pH of the weak nitrous acid with the pH of a stopn acid like nitric acid:

0.10 m HNO_3, what is pH?

$HNO_3 + H_2O \longrightarrow H_3O^+ + NO_3^-$

0.10 m HNO_3, $[H_3O^+] = 0.10$

pH = 1.00

The stronger the acid:

- the lower the pH of a solution of given concentration will be
- the higher the concentration of hydronium ion (when compared to the nominal acid concentration)