

Worksheet 19 – Weak Acids and Bases

Calculating the pH of a strong acid (base) is straightforward because all of the initial acid (base) dissociates completely. For a monoprotic acid, $[\text{H}_3\text{O}^+] = [\text{Acid}]_{\text{initial}}$. For a monobasic base, $[\text{OH}^-] = [\text{Base}]_{\text{initial}}$.

When weak acids (bases) are added to water, an equilibrium occurs. We can use ICE tables and the K_a (K_b) values of the acids (bases) to determine the extent of the reaction.

As an approximation, $[\text{HA}]_{\text{initial}} = [\text{HA}]_{\text{eq}}$ for acids with very small K_a values. This approximation will not affect the calculated pH of a solution if the % ionization of the acid is less than 5%. We call this the 5% rule. In situations where the 5% rule does not apply, you'll need to use the quadratic formula to solve for x in the ICE table:

$$\text{For equations of the form } ax^2 + bx + c = 0, \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

You'll get two values of x (2 roots to the equation), but one of them will not make physical sense. Think about both values carefully and select the one that is appropriate.

1. Start with 100.00 mL of a 0.10 M solution of acetic acid, CH_3COOH . It has a pH = 2.87 at 25°C. Calculate the K_a of acetic acid at 25°C.

- a) Write the acid dissociation reaction.



- b) Write an expression for K_a in terms of the reactants and products of this reaction.

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$$

- c) Write an ICE table for these experimental conditions.

	$[\text{CH}_3\text{COOH}]$	$[\text{CH}_3\text{COO}^-]$	$[\text{H}_3\text{O}^+]$
Initial	0.10	0	0
Change	$-x$	$+x$	$+x$
Equil.	$0.10 - x$	x	x

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