

Steps for solving weak acid equilibrium problems:

1. List the major species in the solution
2. Choose all the species that can produce H^+ , and write balanced equations for the reactions producing H^+
3. Using the values of the K_{eq} for the reactions you wrote, decide which equilibrium is dominating the production of H^+
4. Write the equilibrium constant expression for the dominant equilibrium
5. List the initial, change, and equilibrium concentrations for the species participating in the dominant equilibrium
6. Define the change needed to achieve equilibrium using x
7. Write the equilibrium concentrations in terms of x
8. Substitute the equilibrium concentrations into the equilibrium constant expression
9. Assume $[HA]_0 \approx [HA]$ (assuming that very little of the weak acid dissociates) and solve for x
10. After solving for x , make sure x is less than or equal to 5% of $[HA]_0$ (so that the approximation in step 9 was valid)
11. Calculate $[H^+]$, pH, or whatever else the question asks for.

Calculating the pH of a weak acid solution example:

ex> What is the pH of a 1.00 M solution of HF ($K_a = 7.2 \times 10^{-4}$)?

[1.6]

ex2> Calculate the pH of a 0.100 M aqueous solution of HClO ($K_a = 3.5 \times 10^{-8}$)

[4.2]

Example with a mixture of weak acids:

ex> (a) What is the pH of a solution containing 1.00 M HCN ($K_a = 6.2 \times 10^{-10}$) and 5.00 M HNO₂ ($K_a = 4.0 \times 10^{-4}$)?
[1.4]

(b) What is the concentration of CN⁻ in the solution?
[1.4 x 10⁻⁸]

Examples of percent dissociation (also called percent ionization):

ex> Calculate the percent dissociation of acetic acid ($K_a = 1.8 \times 10^{-5}$) in

(a) 1.00 M $\text{HC}_2\text{H}_3\text{O}_2$

[0.42%]

(b) 0.100 M $\text{HC}_2\text{H}_3\text{O}_2$

[1.3%]

ex2> In a 0.100 M aqueous solution of lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$), the lactic acid is 3.7% dissociated. Calculate K_a for lactic acid.

[1.4×10^{-4}]

5) A 0.020 M solution of niacin ($K_a = 1.5 \times 10^{-5}$), a B vitamin, has a pH of 3.26. Calculate the percent ionization of niacin. [2.7%]

6) Calculate the pH of a 0.20 M solution of HCN ($K_a = 4.9 \times 10^{-10}$). [5.00]

- 7) In a 0.250 M solution of HNO_2 ($K_a = 4.0 \times 10^{-4}$),
(a) what are the major species present in solution?
(b) what is the pH of the solution?

[2.00]

- 8) In a 0.250 M solution of acetic acid ($K_a = 1.8 \times 10^{-5}$)
(a) what are the major species present in solution?
(b) what is the pH of the solution?

[2.68]

- 9) A 0.0560 gram sample of acetic acid (CH_3COOH , $K_a = 1.8 \times 10^{-5}$) is added to enough water to make 50.00 mL of solution. Calculate the $[\text{H}^+]$, $[\text{CH}_3\text{COO}^-]$, $[\text{CH}_3\text{COOH}]$, and the pH at equilibrium.
[5.8×10^{-4} M, 5.8×10^{-4} M, 0.0181 M, 3.24]

- 10) Calculate the pH of each of the following:
- (a) a solution containing 0.10 M HCl and 0.10 M HClO ($K_a = 3.5 \times 10^{-8}$) [1.00]
 - (b) a solution containing 0.050 M HNO_3 and 0.50 M $\text{HC}_2\text{H}_3\text{O}_2$ [1.30]

- 11) (a) Calculate the pH of a solution that contains 1.0 M HF ($K_a = 7.2 \times 10^{-4}$) and 1.0 M HOC_6H_5 ($K_a = 1.6 \times 10^{-10}$).
- (b) Also calculate the OC_6H_5^- concentration at equilibrium.

- 12) Calculate the percent dissociation of the acid in each of the following solutions:

(a) 0.050 M acetic acid

[1.9%]

(b) 0.0050 M acetic acid

[5.8%]