

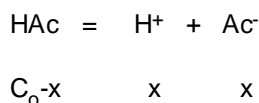
1.) Calculate the pH of a 0.0550 M solution of Acetic Acid

$$\begin{array}{l} \text{Initial Concentration} \\ \text{Equilibrium Constant} \end{array} \quad \begin{array}{l} C_0 := 0.0550 \cdot \text{M} \\ K_a := 1.80 \cdot 10^{-5} \cdot \text{M} \end{array} \quad M := \frac{\text{mol}}{\text{L}}$$

State the problem.

Give constants necessary to the solving of the problem. Include units.

Now, I set up the equilibrium expression for HAc. If x is the degree of dissociation, then at equilibrium, we have



Annotation...

Set up the physical application of the problem.

Substituting values into the equilibrium expression yields...

Annotation...

$$K_a = \frac{(\text{H}) \cdot (\text{Ac})}{(\text{HAc})} = \frac{(x) \cdot (x)}{C_0 - x} \quad \text{I will first assume that } x \ll C_0 \text{ because } K_a \text{ is relatively small.}$$

Show substitutions into applicable expressions.

$$K_a = \frac{x^2}{C_0} \quad \text{solving for } x \text{ gives...} \quad x = \sqrt{K_a \cdot C_0}$$

Solve equations explicitly with complete units, significant digits and annotations

$$x := \sqrt{(1.80 \cdot 10^{-5} \cdot \text{M}) \cdot (0.055 \cdot \text{M})} \quad x = 9.94987 \times 10^{-4} \text{ M}$$

$$\frac{x^2}{C_0 - x} = 1.83316 \times 10^{-5} \text{ M} \quad \text{checking assumption..}$$

check assumptions or shortcuts.

The calculated Ka is off, so the assumption is poor. I'll solve for x using the quadratic formula. Rearranging equation into the proper form gives

$$K_a \cdot (C_0 - x) = x^2 \quad \text{or} \quad x^2 + K_a \cdot x - K_a \cdot C_0 = 0$$

The quadratic solutions are

$$x = \frac{-b + \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a} \quad \text{or} \quad x = \frac{-b - \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$$

Substituting for proper values gives

$$x := \frac{-K_a + \sqrt{K_a^2 - (4) \cdot (1) \cdot (-K_a \cdot C_0)}}{2 \cdot (1)} \quad x = 9.86028 \times 10^{-4} \text{ M}$$

Since Ka and C₀ are defined, this is a suitable expression to evaluate

Now, calculating pH. By assignments given above, H⁺ = x, thus

$$\text{pH} = -\log(x) \quad \text{pH} := -\log(5.107 \cdot 10^{-4}) \quad \text{pH} = 3.29183$$

Highlight answer by box, or underline or some other delineation.