Answer on Question #44006 - Chemistry - Inorganic Chemistry

Question:

What is the concentration of acetic acid and the pH in a solution that is 0.25% ionized?

Answer:

The acetic acid dissociates according to the equation:

$CH_3COOH \rightarrow CH_3COO^- + H^+$

The constant of the dissociation:

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

For the weak acid, such as acetic, Ostwald's law of dilution can be written in the next form:

$\alpha = \sqrt{\frac{K_a}{c_0}}$, where c_o is for the initial concentration of acetic acid in the solution and α is for degree of dissociation. In this case the degree of dissociation is the same as degree of ionization, α = 0.25%.

K_a for acetic acid is 1.76×10^{-5}. In this case, c_0:

$$c_0 = \frac{K_a}{\alpha^2} = \frac{1.76\times10^{-5}}{(0.0025)^2} = \frac{1.76\times10^{-5}}{6.25\times10^{-6}} = 0.282\times10 = 2.82(mol/L)$$

pH is the negative logarithm of the concentration of H^+:

$pH = -\log([H^+])$;

Concentration of H^+:

$$[H^+] = \sqrt{K_a \times c_0} = \sqrt{1.76\times10^{-5}\times2.82} = 7.04\times10^{-3}$$

And pH equals:

$$pH = -\log([H^+]) = -\log(7.04\times10^{-3}) = 2.15$$