Answer on Question #50110 – Chemistry – Physical Chemistry

30 cm^3 0.05 M $Ca(OH)_2$ and 100 cm^3 0.1 M CH_3COOH are mixed. What is the pH of this buffer solution? K_a of CH_3COOH is 1.8×10^{-5}.

Solution:

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

$Ca(OH)_2 + 2CH_3COOH \rightarrow Ca(CH_3COO)_2 + 2H_2O$

$Ca(CH_3COO)_2 \rightarrow Ca^{2+} + 2CH_3COO^-$

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

Lets $[H^+]=x$, then $[CH_3COOH]=c_0-x$

$[CH_3COO^-]=x+y$, y is part of anions from salt.

$$= \frac{x \times (x+y)}{c_0 - x}$$

$$x^2 + (K \ \ + y) \times x - \quad \times c_0 = 0$$

$$n(Ca(OH)_2) = c \times V = 0.05 \times 0.03 = 0.0015\ mol$$

$$n(CH_3COOH) = c \times V = 0.1 \times 0.1 = 0.01\ mol$$

Acid reacts with base, 2×0.0015 moles spends:

$$c_0 = \frac{0.01 - 2 \times 0.0015}{0.1 + 0.03} = \frac{0.007}{0.13} = 0.053846\ M$$

$$y = \frac{2 \times 0.0015}{0.1 + 0.03} = \frac{0.003}{0.13} = 0.023077\ M$$

So,

$$x^2 + (0.000018 + 0.023077) \times x - 0.000018 \times 0.053846 = 0$$

$$x^2 + 0.023095 \times x - 0.000000969228 = 0$$

$$D = 0.023095^2 - 4 \times 1 \times 0.000000969228 = 0.000537255937$$

$$x = \frac{-0.023095 + \sqrt{0.000537255937}}{2 \times 1} = 0.00004189$$

$[H^+]=0.00004189$ M

$$pH = -\log_{10}[H^+] = -\log_{10} 0.00004189 = 4.38$$

Answer:

pH=4.38