Chem 321

Module 14: Calculation of the Buffer pH Using Activities

Buffer solution: mix 4.0 mL of 1.0 M $NaC_2H_3O_2$
6.5 mL of 3.0 M $HC_2H_3O_2$
89.5 mL de-ionized water

Solution

The concentration of each diluted solute is first determined.

$[NaC_2H_3O_2] = 1.0\ M\ (0.0040\ L)/(0.100\ L) = 0.040_0\ M$

$[HC_2H_3O_2] = 3.0\ M\ (0.0065\ L)/(0.100\ L) = 0.19_5\ M$

Since the only important source of ions is the $NaC_2H_3O_2$ this is a +1/-1 electrolyte, the ionic strength $\mu = 0.040$ M.

for $\mu = 0.40$ M,

$$\gamma_{C_2H_3O_2^-} = 0.902 - \frac{0.040 - 0.010}{0.040}(0.902 - 0.82) = 0.84_0$$

$$\gamma_{HC_2H_3O_2} \approx 1 \text{ (since } HC_2H_3O_2 \text{ is uncharged)}$$

	$HC_2H_3O_2$	+ H_2O	⇆ H_3O^+	+ $C_2H_3O_2^-$
init	0.19_5 M		$\sim 10^{-7}$ M	0.040 M
equil	$\sim 0.19_5$		x	~ 0.040

$$K_a = 1.75 \times 10^{-5} = \frac{a_{H_3O^+} a_{C_2H_3O_2^-}}{a_{HC_2H_3O_2}} = \frac{a_{H_3O^+}[C_2H_3O_2^-]\gamma_{C_2H_3O_2^-}}{[HC_2H_3O_2^-]\gamma_{HC_2H_3O_2^-}} = \frac{a_{H_3O^+}(0.040_0)(0.84_0)}{(0.19_5)(1.0)}$$

$$a_{H3O+} = 1.0_2 \times 10^{-4} \quad \Rightarrow \quad pH = -\log(a_{H3O+}) = \mathbf{3.99}$$