Ionic Equilibriums in Water

#3

Which volume (mL) of HCOOH 2.00 mol/L shall be added to 30.215 g of HCOONa to prepare a buffer solution with pH 4.00?

Solution

HCOONa is a salt, completely dissociated: $HCOONa(aq) \rightarrow Na^+(aq) + HCOO^-(aq)$

Na^+ = weak acid, weaker than water

$HCOO^-$ = weak base B

HCOOH = conjugate weak acid A

HCOONa: $\frac{30.215\ g}{68.0\ \frac{g}{mol}} = 0.444\ mol$

$$pH_{buffer} = pK_{a_{HCOOH}} + \log\frac{[B]}{[A]} = pK_{a_{HCOOH}} + \log\frac{\frac{n_B}{V}}{\frac{n_A}{V}} = pK_{a_{HCOOH}} + \log\frac{n_B}{n_A}$$

$$4.00 = 3.75 + \log\frac{0.444\ mol}{n_A}$$

$$\log\frac{0.444\ mol}{n_A} = 0.25$$

$$\frac{0.444\ mol}{n_A} = 1.78$$

$$n_A = 0.249\ mol$$

So we need to add 0.249 moles of HCOOH. This amount is present in

$$\frac{0.249\ mol}{2.00\ \frac{mol}{L}} = 0.125\ L$$

So we add 125 mL of HCOOH 2.00 mol/L.