CELL PHYSIOLOGY Special Lecture - Calculations for pH

I. Simple pH problems:

If a 1.0 mL solution of 0.01 M HCl is diluted to 100 mL at 25 °C, what is the pH of the resulting solution?

SOLUTION: CALCULATE $[H^+]$ AND TAKE THE NEGATIVE LOG OF THAT VALUE

$$[H^+] = \frac{(0.01\,mol/L)(1mL)(\frac{1L}{1000mL})}{(100mL)(\frac{1L}{1000mL})} = \frac{1\times10^{-5}\,mol}{1\times10^{-1}\,L}$$

$$= 1\times10^{-4}\,mol/L \;;\; -\log[1\times10^{-4}] = \underline{\underline{4.00}}$$

If a 1.0 mL solution of 1.0 M NaOH is diluted to 100 L at 25 °C, what is the resulting pH of the solution?

SOLUTION: CALCULATE $[OH^-]$ AND THEN DETERMINE pOH
SUBTRACT pOH FROM 14 TO GET pH

$$[OH^-] = \frac{(1.0\,mol/L)(1mL)(\frac{1L}{1000mL})}{100L} = \frac{1\times10^{-3}\,mol}{1\times10^{2}\,L}$$

$$= 1\times10^{-5}\,mol/L \;;\; -\log[1\times10^{-5}] = 5.00\;;$$

$$14.0 - 5.00 = \underline{\underline{9.00}}$$

II. Derivation of the Henderson-Hasselbach equation

$$HA \rightleftharpoons H^+ + A^- \qquad K_{eq} = \frac{[H^+][A^-]}{[HA]} \qquad pH = -\log[H^+]$$

① REARRANGE $[H^+] = \frac{K_{eq}[HA]}{[A^-]}$

② MULTIPLY $\times(-1)$ AND APPLY log of both sides

$$-\log[H^+] = -\log K_{eq} - \log\frac{[HA]}{[A^-]}$$

③ $pH = -\log K_{eq} + \log\frac{[A^-]}{[HA]}$ ASSUME FOR ACID, $K_{eq} = K_A$

④ $pH = pK_{eq} + \log\frac{[A^-]}{[HA]}$ $\quad pH = pK_a + \log\frac{[A^-]}{[HA]}$