6.5 – pH and pOH Scale Assignment

1. Calculate the pH of a solution of nitric acid that: $HNO_3 \rightarrow H^+ + NO_3^-$

   a. has a concentrations of 1.0×10^{-4} M (strong ∴ complete)

$pH = -\log[H^+]$

$pH = -\log(1.0 \times 10^{-4} M)$

$pH = 4$

   b. consists of 6.3 g of solute dissolved in 1.00 L of solution?

$M = \frac{wt}{mm \cdot V} = \frac{6.3g}{\left(63.02\frac{g}{mol}\right)(1L)} = 0.09996M$

$pH = -\log[H^+]$

$= -\log(0.09996M)$

$pH = 1.00$

2. Calculate the pH of a solution that consists of 5.0 g of HCl in 250 mL of solution.

$M = \frac{wt}{mm \cdot V} = \frac{5.0g}{\left(36.46\frac{g}{mol}\right)(0.25L)} = 0.50M$

$pH = -\log[H^+]$

$= -\log[0.50]$

$pH = 0.30$

3. What is the $[H^+]$ of a solution with a pH of 10.0 at 25°C? What is the pOH?

$pH = -\log[H^+]$

$10.0 = -\log[H^+]$

$[H^+] = \text{antilog}(-10)$

$\boxed{[H^+] = 1.0 \times 10^{-10}}$

$pH + pOH = 14$

$\boxed{pOH = 14 - 10 = 4}$

4. What is the pH of an aqueous solution containing 0.00200 M barium hydroxide, $Ba(OH)_2$, a strong base?

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

0.00200 M → 0.004 M

$pOH = -\log[OH^-] = -\log(0.004M) = 2.40$

$pOH + pH = 14$

$pH = 14 - pOH = 14 - 2.40 = \boxed{11.6}$

5. Determine the K_b for the benzoate ion, $C_6H_5COO^-$.

$K_a = 6.6 \times 10^{-5}$

$K_a \times K_b = 1.0 \times 10^{-14}$

$6.6 \times 10^{-5} \times K_b = 1.0 \times 10^{-14}$

$\therefore K_b = 1.5 \times 10^{-10}$

6. Calculate the pOH of a 0.100 M solution of acetic acid.

$K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$

$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

$1.8 \times 10^{-5} = \dfrac{x^2}{0.10M}$

$\therefore x^2 = 1.8 \times 10^{-6} M$

$X = 1.34 \times 10^{-3} M$

$pH = -\log[H^+]$

$= -\log(1.34 \times 10^{-3} M)$

$pH = 2.87$

$pOH = 14 - pH$

$= 14 - 2.87 = 11.1$

7. A 2.67 g sample of hydrogen fluoride gas (HF) is dissolved in sufficient water to make 1.05 L of solution at 25°C to form an acidic solution. Hydrogen fluoride is a weak acid with $K_a = 6.6 \times 10^{-4}$.

$HF_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + F^-_{(aq)}$

Calculate the pOH of this solution.

$M = \dfrac{wt}{mm \cdot V} = \dfrac{2.67g}{(20.01g/mol)(1.05L)} = 0.127M = [HF]$

$K_a = \dfrac{[H_3O^+][F^-]}{[HF]}$

$6.6 \times 10^{-4} = \dfrac{x^2}{0.127M}$

$\therefore x^2 = 8.38 \times 10^{-5} M$

$x = 9.15 \times 10^{-3} M$

$pH = -\log[H^+]$

$= -\log(9.15 \times 10^{-3} M)$

$pH = 2.04$

$pOH = 14 - pH$

$= 14 - 2.04$

$pOH = 11.96 = 12$

8. A 0.20M solution.
what is K_a?

$AH \rightleftharpoons A^- + H^+$

$pH = -\log [H^+]$

$1.67 = -\log [H^+]$

$[H^+] = \text{antilog}(-1.67)$

$[H^+] = 0.021379\ M$

$$K_a = \frac{[A^-][H^+]}{AH} = \frac{(2.13\times10^{-2})^2}{(0.20M)} = \boxed{0.2\times10^{-3}}$$