Chemistry 20 - Unit 2 - pH and pOH Notes

Name: ___________________________________

[H_3O^+] and [OH^-]

In water both H_3O^+ and OH^- exist $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$

These concentrations exist in a balanced relationship $[H_3O^+][OH^-] = 1.00 \times 10^{-14}$

This relationship is inversely related $\uparrow [H_3O^+] = \downarrow [OH^-]$

Example 1:

What is the hydroxide ion concentration in a solution with a hydronium ion concentration of 2.59×10^{-4} M?

$$[H_3O^+][OH^-] = 1.00 \times 10^{-14}$$

$$[OH^-] = \frac{1.00\times10^{-14}}{[H_3O^+]}$$

$$[OH^-] = \frac{1.00\times10^{-14}}{2.59\times10^{-4}} = 3.86 \times 10^{-11}$$

Example 2:

If 2.50 g of NaOH was dissolved in water to produce 500mL of solution, what would be the concentration of hydronium and hydroxide ions in solution?

$$NaOH \longrightarrow Na^+ + OH^-$$

$$[OH^-]\ \frac{mol}{L} = 2.50\ g \times \frac{1\ mol}{40\ g} \times \frac{1}{0.500\ L} = 0.125\ M$$

$$[H_3O^+][OH^-] = 1.00 \times 10^{-14}$$

$$[H_3O^+] = \frac{1.00\times10^{-14}}{[OH^-]} = \frac{1.00\times10^{-14}}{1.25} = 8.0 \times 10^{-14} M$$

pH Review

$$pH = -log[H_3O^+]$$

$$[H_3O^+] = 10^{-pH}$$

Example 3: What is the pH of a solution of 0.159 M HCl?

$$HCl \longrightarrow H^+ + Cl^-$$

$$pH = -log[H_3O^+]$$

$$pH = -log[0.159\ M]$$

$$pH = 0.799$$

Example 4: What is the hydronium and hydroxide ion concentration of a solution with a pH of 2.42?

$$[H_3O^+] = 10^{-pH} = 10^{-2.42} = 0.0038\ M$$

$$[H_3O^+][OH^-] = 1.00 \times 10^{-14}$$

$$[OH^-] = \frac{1.00\times10^{-14}}{[H_3O^+]} = \frac{1.00\times10^{-14}}{0.0038\ M} = 2.63 \times 10^{-12} M$$

pOH - Power of OH

$pOH = -log[OH^-]$ $[OH^-] = 10^{-pOH}$	Since: $[H_3O^+][OH^-] = 1.00 \times 10^{-14}$ Can take the "log" of both sides… $-log([H_3O^+][OH^-]) = -log(1.00 \times 10^{-14})$ And $-log([H_3O^+][OH^-]) = -log[H_3O^+] + -log[OH^-]$ Therefore… **pH + pOH = 14**

Example 5: A solution has a pH of 5.750. What are the hydronium and hydroxide ion concentration?

$$[H_3O^+] = 10^{-pH} = 10^{-5.750} = 1.78 \times 10^{-6}\ M$$

$$pH + pOH = 14$$

$$pOH = 14 - pH = 14 - 5.750 = 8.250$$

$$[OH^-] = 10^{-pOH} = 10^{-8.250} = 5.62 \times 10^{-9}\ M$$

Example 6: A solution has a hydronium ion concentration of 1.95×10^{-4} M. What are the pH, pOH and [OH-] values?

$$pH = -log[H_3O^+] = -log(1.95 \times 10^{-4}\ M) = 3.710$$

(SAVE THIS ANSWER IN FULL!)

$$pOH = 14 - pH = 14 - 3.710 = 10.290$$

$$[OH^-] = 10^{-pOH} = 10^{-10.290} = 5.13 \times 10^{-11}\ M$$

Example 7: A solution of calcium hydroxide was created using 5.673 g of solid in 250.00 mL of solution. What is the pH, pOH, [OH-] and [H3O+] values?

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

$$[Ca(OH)_2]\ \frac{mol}{L} = 5.673\ g \times \frac{1\ mol}{74.10\ g} \times \frac{1}{0.25000\ L} = 0.3062\ M$$

$$[OH^-] = [Ca(OH)_2] \times \frac{2[OH^-]}{[Ca(OH)_2]} = 0.3062\ M \times 2 = 0.6125\ M$$

$$pOH = -log[OH^-] = -log(0.6125) = 0.2129$$

$$pH = 14 - pOH = 14 - 0.2129 = 13.7871$$

$$[H_3O^+] = 10^{-pH} = 10^{-13.7871} = 1.633 \times 10^{-14}\ M$$

Chemistry 20 - Unit C - pH and pOH Practice

Name: ______________________________________

1) Calculate the pH of each of the following solutions.
   a) A solution of acetic acid has a hydronium ion concentration of 0.016 M.

   b) A bottle of household bleach has a hydronium ion concentration of 1.0×10^{-13} M.

2) Calculate the pOH of each of the following solutions.
   a) A solution of sodium hydroxide has a hydroxide ion concentration of 0.105 M.

   b) A solution of calcium hydroxide has a hydroxide ion concentration of 0.454 mmol/L.

3) Calculate the hydronium ion concentration for each of the following pH readings.
   a) 12.86

   b) 5.432

4) Calculate the hydroxide ion concentration for each of the following pOH readings.
   a) 13.92

b) 8.796

5) A soft drink was put on the market [H+] = 1.4×10^{-5} M. What is its pH?

6) A certain brand of beer had a hydrogen ion concentration equal to 1.9×10^{-5} mol/L.
   i) What is the pH of this beer?

7) A solution was made by dissolving 0.837g $Ba(OH)_2$ in 100 ml final volume. If $Ba(OH)_2$ is fully broken up into its ions, what is the pOH and the pH of this solution?

8) A sodium hydroxide solution is prepared by dissolving 6.0 g NaOH in 1.00 L of solution. Assuming that 100% dissociation occurs, what is the pOH and the pH of this solution?

9) Calculate the [H_3O^+], [OH^-], pH and pOH of these solutions;
   a) 1.5×10^{-4} M KOH

   b) A solution prepared by dissolving 0.040 g NaOH in 2.0 L of solution

c) A solution prepared by diluting 1.0 mL of 0.20 M HCl to a total volume of 5.0 L