Exercise 14.3

pH & pOH

Name: ______________________

Date:________________ Per:________

The pH of a solution represents the concentration of hydrogen ions $[H^+]$ (or hydronium ions $[H_3O^+]$) present in solution. The greater the concentration of [H+], the lower the value of the pH. Solutions with a pH less than 7 are acidic. Solutions with a pH greater than 7 are basic. Solutions with a pH of exactly 7 are neutral because they contain equal concentrations of $[H^+]$ and $[OH^-]$.

$[H^+]$ and $[OH^-]$ exist in aqueous solution in equilibrium. As one increases, the other decreases. The product of the ion concentrations must always = 1.0×10^{-14} at 25ºC. This value is called the ion product of water (K_w). The pH scale typically runs from 0-14, but very strong acids may have negative pH's, and very strong bases may have pH's greater than 14.

A corollary concept to pH is pOH, which represents the concentration of hydroxide [OH-] ions present in solution. pOH works oppositely to pH. The higher the pOH value, the more acidic a solution is.

pH	$[H_3O^+]$	$[OH^-]$	pOH	
0	1.0×10^{0}	1.0×10^{-14}	14	Acidic
1	1.0×10^{-1}	1.0×10^{-13}	13	
3	1.0×10^{-3}	1.0×10^{-11}	11	
5	1.0×10^{-5}	1.0×10^{-9}	9	
7	1.0×10^{-7}	1.0×10^{-7}	7	Neutral
9	1.0×10^{-9}	1.0×10^{-5}	5	Basic
11	1.0×10^{-11}	1.0×10^{-3}	3	
13	1.0×10^{-13}	1.0×10^{-1}	1	
14	1.0×10^{-14}	1.0×10^{0}	0	

<u>Equations</u>

$pH = -\log [H^+]$	$[H^+] = 10^{-pH}$
$pOH = -\log [OH^-]$	$[OH^-] = 10^{-pOH}$
$pH + pOH = 14.0$	$[H^+][OH^-] = 1.0 \times 10^{-14}$

DIRECTIONS: Complete the following table.

	$[H^+]$	pH	$[OH^-]$	pOH	Acid/Base
1.	3.50×10^{-3} *M*				
2.		5.30			
3.			6.70×10^{-3} *M*		
4.				9.70	
5.	4.50×10^{-9} *M*				
6.		11.2			
7.			9.10×10^{-11} *M*		
8.				1.40	

DIRECTIONS: Calculate the following.

1. A solution has an $[H^+] = 4.3 \times 10^{-3}$ *M*. Find the $[OH^-]$, the pH and pOH.

2. A solution has an $[H_3O^+] = 8.41 \times 10^{-10}$ *M*. Find the $[OH^-]$, the pH and pOH.

3. A solution has an $[OH^-] = 5.5 \times 10^{-3}$ *M*. Find the $[H^+]$, the pH and pOH.

4. A solution has an $[OH^-] = 3.71 \times 10^{-6}$ *M*. Find the $[H^+]$, the pH and pOH.

5. Lemon juice has a pH of 2.0. Determine the $[H_3O^+]$ and $[OH^-]$ in lemon juice.

Revised: 2018-10-25

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Significant Figures and Logarithms

A logarithm has two parts:

the characteristic (the digits before the decimal, which indicate order of magnitude)

the mantissa (the digits after the decimal)

log (2.216 x 10^{10}) = 10.3456 (10 = characteristic, .3456 = mantissa)

$$\log(2.216 \times 10^{10}) = \log(2.216) + \log(10^{10}) = 0.3456 + (10) = 10.3456$$

When taking a log of a number, the mantissa should have the same number of digits as the number of significant digits in the original number.

Examples:

$\log(5.12 \times 10^{-5}) = -4.291$ (3 decimal places because the original number had 3 decimal places)

$\log(5 \times 10^{-5}) = -4.3$ (1 decimal place because the original number had 1 decimal place)

$\log(5.1 \times 10^{-5}) = -4.29$

When taking an antilog, count the digits in the mantissa – that's the number of significant figures your answer should have.

$10^{-4.3} = 5 \times 10^{-5}$ $10^{-4.291} = 5.12 \times 10^{-5}$

6. The [H+] concentration of milk is 2.51 x 10-7. Calculate the pH of milk. Is it an acid or base?

7. Human blood has an $[OH^-] = 2.51 \times 10^{-7}$ *M*. Find the pH of blood. Is it an acid or base?

8. HCl is a strong acid. Find the pOH of a 2.0 *M* HCl solution.

9. Calculate the pH of a 0.10 M HNO_3 solution.

10. Find the pH of a 0.500 *M* $Ba(OH)_2$ solution.

11. A solution has a hydroxide-ion concentration of 1.5×10^{-5} *M*.
    a. What is the concentration of hydronium ions in this solution? ______________________
    b. What is the pH of this solution? ______________________
    c. Is the solution acidic, basic, or neutral? ______________________

12. A solution has a pH of 5.60. Calculate the hydrogen-ion concentration. ______________________

13. Calculate $[H^+]$ for a solution with a pOH of 4.75. ______________________

14. Calculate the pOH and pH of a 0.02 M KOH solution. ______________________

15. Calculate the molarity of hydroxide ion in an aqueous solution that has a pOH of 5.00. ______________________