Name _____ Section _____ Date _____

19A Acids and Bases
Extra Practice Problems

Calculating pH

Common logarithms have the property that the log of ten raised to some power is equal to the exponent. For example, the logarithm of 10^2 is two; $\log 10^2 = 2$. The logarithm of 10^{-5} is minus five; $\log 10^{-5} = -5$. The pH scale is based upon logarithms, and it is a convenient way to express the hydrogen ion concentration of a solution. It is defined as follows: $pH = -\log [H^+]$. The ion-product constant for water, K_w, relates the concentrations of hydrogen ion and hydroxide ion in water or in an aqueous solution.

$$K_w = [H^+] \times [OH^-] = 1.0 \times 10^{-14} \text{ (mol/L)}^2$$

Taking the negative logarithm of each term in the expression for K_w gives the following.

$$\log[H^+] + -\log[OH^-] = -\log(1.0 \times 10^{14})$$
$$pH + pOH = 14.00$$

A solution is neutral when $pH = pOH = 7.0$. An acidic solution has a $pH < 7.0$ and a $pOH > 7.0$. A solution that is basic has a $pH > 7.0$ and a $pOH < 7.0$.

Example A

A solution has a hydrogen ion concentration of $1 \times 10^{-6} M$. What is its pH? *19.*

Solution

$pH = -\log[H^+]$
$pH = -\log(1 \times 10^{-6})$ {reminder: the log (a × b) = log a + log b}
$pH = -(0.0 + (-6))$ {reminder: the log 1 = 0.0}
$pH = +6.0$

You Try It

1. What is the pH of a solution with $[H^+] = 1 \times 10^{-3} M$?

Your Solution *19.4*

Example B

What is the pH of a solution if the $[H^+] = 7.2 \times 10^{-9} M$?

Solution *19.5*

$pH = -\log[H^+]$
$= -\log(7.2 \times 10^{-9})$
$= -(0.86) - (-9.00)$ {Use log tables or your calculator to find the log of 7.2.}
$= 9.00 - 0.86$
$= 8.14$

You Try It *19.5*

2. What is the pOH of a solution if the $[OH^-] = 3.5 \times 10^{-2} M$?

Your Solution

Example C *19.5*

What is the pOH of a solution that has a pH of 3.4?

Solution

$$\begin{aligned} pH + pOH &= 14.0 \\ pOH &= 14.0 - pH \\ &= 14.0 - 3.4 \\ pOH &= 11.6 \end{aligned}$$

You Try It *19.5*

3. A solution has a pOH of 12.4. What is the pH of this solution?

Your Solution

Problems For You To Try *19.4, 19.5*

4. Classify each solution as acidic, basic, or neutral
   a. $[H^+] = 2.5 \times 10^{-9} M$
   b. pOH = 12.0
   c. $[OH^-] = 9.8 \times 10^{-11} M$
   d. $[H^+] = 1 \times 10^{-7} M$
   e. pH = 0.8

19.4, 19.5

5. Calculate the pH of each solution.
   a. $[H^+] = 1 \times 10^{-5} M$
   b. $[H^+] = 4.4 \times 10^{-11} M$
   c. $[OH^-] = 2.2 \times 10^{-7} M$
   d. pOH = 1.4

19.4

6. Classify the solutions in Problem 5 as acidic or basic.

19.4, 19.5

7. Why is there a minus sign in the definition of pH?