

pH and Indicators

pH:

$[H_3O^+]$	$[OH^-]$	pH

$$pH + pOH = 14$$

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

Each jump in pH is a 10X difference in concentration

1---2---3---4---5---6--7---8--9--10--11--12--13-- 14

High Acid

neutral

High Base

Table M
Common Acid-Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.1-4.4	red to yellow
bromthymol blue	6.0-7.6	yellow to blue
phenolphthalein	8-9	colorless to pink
litmus	4.5-8.3	red to blue
bromcresol green	3.8-5.4	yellow to blue
thymol blue	8.0-9.6	yellow to blue

Source: *The Merck Index*, 14th ed., 2006, Merck Publishing Group

Color Chart for changes Methyl orange is red from 1-3.1,
orange from 3.1 - 4.4
yellow from 4.4-14

Name _____ Date _____ Class _____

pH and pOH

The pH of a solution indicates how acidic or basic that solution is.

pH range 0 to-7 acidic

7 neutral

7-14 basic

Since $[H^+][OH^-] = 10^{-14}$ at 25 °C, if $[H^+]$ is known, the $[OH^-]$ can be calculated and vice versa.

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

$pOH = -\log [OH^-]$

So if $[H^+] = 10^{-6} M$, $pH = 6$.

So if $[OH^-] = 10^{-8} M$, $pOH = 8$.

Together, $pH + pOH = 14$.

Complete the following chart.

	[H ⁺]	pH	[OH ⁻]	pOH	Acidic or Basic
1.	10 ⁻⁵ M	5	10 ⁻⁹ M	9	Acidic
2.		7			
3.			10 ⁻⁴ M		
4.	10 ⁻² M				
5.				11	
6.		12			
7.			10 ⁻⁵ M		
8.	10 ⁻¹¹ M				
9.				13	
10.		6			

pH and Indicators

There are several ways to test for pH from complex instruments called pH meters to dyes that change color as the pH changes. These dyes are called indicator dyes (or just indicators) and change color depending on the pH. Most indicators have two forms, each with its own color.

For example, litmus is a pH indicator as is bromthymol blue (BTB).

From Table M in the Reference Tables, fill in the blanks below. The first row for Methyl Orange has been completed as an example.

Indicator	Color and (pH range)		
	before	During	After
Methyl orange	Red (< 3.2)	orange (3.2-4.4)	Yellow (> 4.4)
Bromthymol blue			
Phenolphthalein			
Litmus			
Bromcresol green			
Thymol blue			

1. At pH 5, what will be the color of:
 - a. Methyl orange _____
 - b. BTB _____
 - c. Phenolphthalein _____

2. At H^+ concentration of 0.000 000 01 what will be the color of:
 - a. Methyl orange _____
 - b. Litmus _____
 - c. Bromcresol green _____

3. Pure water is neutral and has a pH of _____. At this pH what will be the color of:
 - a. Methyl orange _____
 - b. BTB _____
 - c. Thymol blue _____

4. What is the pH of 0.001 M HCl _____
5. What is the pH of 0.01 M HCl. _____
6. What is the pH of 0.1 M HCl. _____
7. As the H^+ concentration increases from 0.001 to 0.1 M, the pH _____
8. When the pH decreases from 6 to 3, the hydrogen ion, H^+ , increases by _____ times.
9. When the pH changes from 8 to 10, explain how the hydrogen ion, H^+ concentration changes.
10. A truck carrying concentrated nitric acid overturns and spills its contents. The acid drains into a nearby pond. The pH of the pond water was 8.0 before the spill. After the spill, the pond water is 1,000 times more acidic.
- a. Name an ion in the pond water that has increased in concentration due to this spill. _____
- b. What is the new pH of the pond water after the spill? _____
- c. What color would bromthymol blue be at this new pH? _____