

Calculating pH

How is pH related to the concentration of hydronium ions?

Why?

In biology and other science courses pH is introduced as a way to quantify the acidity or basicity of a solution. This property can be measured using a pH probe or with an indicator paper strip that changes color at different pH values. But, what is actually being measured? We know that a pH of 7 is neutral, below 7 is acid, and above 7 is base, but why? What in the solution is the paper strip or probe actually reacting with?

Model 1 – Ion Concentrations for Acids and Bases

Beaker	Solution	Acidic, Basic or Neutral?	$[H_3O^+]$	$[OH^-]$	$[H_3O^+] \times [OH^-]$
1	0.10 M HCl(aq)	Acidic	1.0×10^{-1} M	1.0×10^{-13} M	1×10^{-14}
2	0.0010 M HCl(aq)	Acidic	1.0×10^{-3} M	1.0×10^{-11} M	1×10^{-14}
3	0.000010 M HCl(aq)	Acidic	1.0×10^{-5} M	1.0×10^{-9} M	1×10^{-14}
4	0.0000010 M HCl(aq)	Acidic	1.0×10^{-6} M	1.0×10^{-8} M	1×10^{-14}
5	0.00000010 M HCl(aq)	Neutral	1.0×10^{-7} M	1.0×10^{-7} M	1×10^{-14}
6	0.00000010 M NaOH(aq)	Neutral	1.0×10^{-7} M	1.0×10^{-7} M	1×10^{-14}
7	0.0000010 M NaOH(aq)	Basic	1.0×10^{-8} M	1.0×10^{-6} M	1×10^{-14}
8	0.00010 M NaOH(aq)	Basic	1.0×10^{-10} M	1.0×10^{-4} M	1×10^{-14}
9	0.010 M NaOH(aq)	Basic	1.0×10^{-12} M	1.0×10^{-2} M	1×10^{-14}
10	0.10 M NaOH(aq)	Basic	1.0×10^{-13} M	1.0×10^{-1} M	1×10^{-14}

1. What does the symbol $[H_3O^+]$ in Model 1 indicate?

The molar concentration of hydronium ion.

2. In Beaker 2, which ion has a higher concentration, hydronium ion or hydroxide ion?

Hydronium ion.

3. Describe how the concentration of hydronium ion was calculated for Beaker 3 in Model 1 from the concentration of the acid.

Since HCl is a strong acid, all of the molecules ionize in water. Therefore, the H_3O^+ concentration is equal to the initial acid concentration in the solution.

4. Describe how the concentration of hydroxide ion was calculated for Beaker 8 in Model 1 from the concentration of the base.

Since NaOH is a strong base, it completely dissociates in water. Therefore, the OH^- concentration is equal to the initial base concentration in the solution.

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