# The pH Scale

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## The pH Scale

- The pH scale is a scale the indicates the concentration of a solution.
- pH is short for a French phrase that translates to "hydrogen power."
- The pH of a solution is defined as the negative of the common logarithm of the hydronium ion concentration [$H_3O^+$].

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

## Measuring Strength of Acids and Bases

- pH is a measurement which indicates acidic or basic strength, measuring the concentration of $H_3O^+$ ions.
- **More $H^+$ or $H_3O^+$ions = lower pH = acid.**

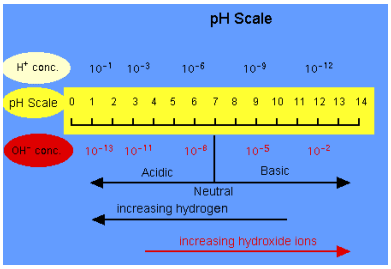
| 1: acid | 7: neutral | 14: base |
|---|---|---|

- An indicator changes color depending on pH of a solution.
- pH paper is treated with indicators to change color when dipped in a solution.

## The pH Scale

- Since the pH scale is logarithmic….
- Each whole pH value below 7 is ten times more acidic than the next higher value. For example, pH 4 is ten times more acidic than pH 5 and 100 times (10 times 10) more acidic than pH 6.
- The same holds true for pH values above 7, each of which is ten times more alkaline (another way to say basic) than the next lower whole value. For example, pH 10 is ten times more alkaline than pH 9 and 100 times (10 times 10) more alkaline than pH 8.

## The pH Scale




## pH & Acidity

- pH is related to the concept of concentration of hydronium ions found in water. [$H_3O^+$]
- Water and all its solutions contain hydronium ions and hydroxide ions.
- Acidic solutions: More $H^+$ or $H_3O^+$ ions.
- Basic solutions: Fewer $H_3O^+$ ions / more $OH^-$ ions.
  - If pH = 2:
    $H_3O^+$ ion concentration = 0.01 M
    $OH^-$ ion concentration = 0.000000000001 M
- If pH = 12:
  $H_3O^+$ ion concentration = 0.000000000001 M
  $OH^-$ ion concentration = 0.01 M

## pH Examples

- Example 1:
  - 0.001 mol $H_3O^+$ = 1 x $10^{-3}$ mol $H_3O^+$
  - Concentration is 0.001M
  - pH = −log $[H_3O^+]$ = −log (1x $10^{-3}$) = −(−3.0) = 3.0
  - pH is 3.0 – This is an acid.
- Example 2:
  - 0.000 000 01 mol $H_3O^+$ = 1 x $10^{-8}$ mol $H_3O^+$
  - Concentration is 0.000 000 01M
  - pH = −log $[H_3O^+]$ = −log (1x $10^{-8}$) = −(−8.0) = 8.0
  - pH is 8.0 – This is a base.

## pH Practice

- What is the pH of a HCl solution with a $[H_3O^+]$ concentration of 0.001 M (also 1 x $10^{-3}$M)
- What is the pH of a $HNO_3$ solution with a $[H_3O^+]$ concentration of 0.00001 M (also 1 x $10^{-5}$M)

## pH Practice – Backwards

- What is the $[H_3O^+]$ of an acid if the pH is 5.2?
- If pH = −log $[H_3O^+]$ ,
- then $[H_3O^+]$ = antilog (−pH)

## The End