

GENERAL CHEMISTRY

STANDARD 12.6

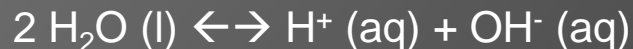
12.6: Calculate the pH of strong acid and strong base solutions

DEFINITIONS

- **Autoionization of Water:** The chemical equilibrium reaction between water and the hydrogen (H^+) and hydroxide (OH^-) ions.
- **Autoionization Constant for Water:** The equilibrium constant for the Autoionization of Water equilibrium reaction
 - Numerically equal to 1.0×10^{-14} at 25°C
- **pH:** The negative base-ten logarithm of the hydrogen ion concentration of a solution

AUTOIONIZATION OF WATER

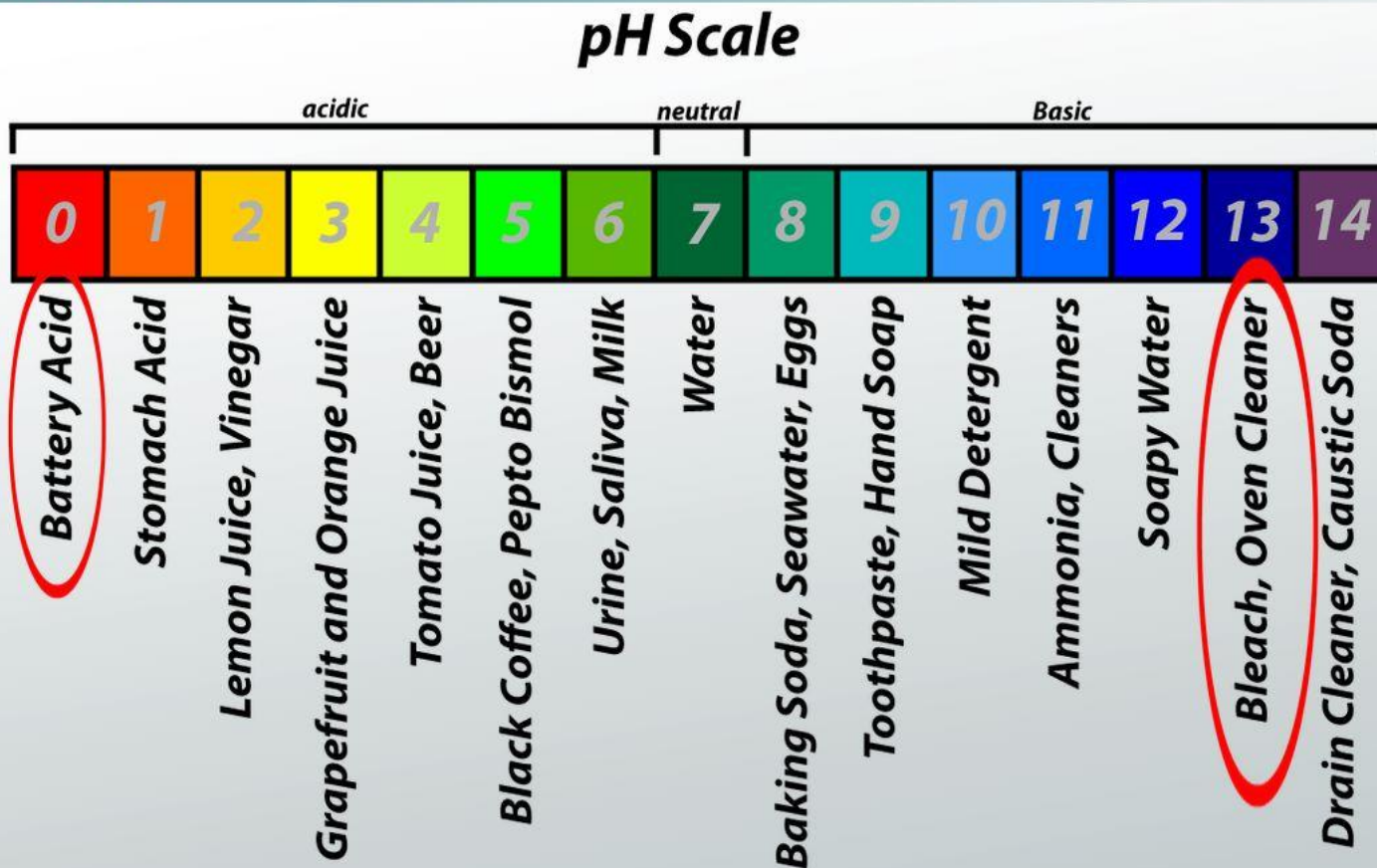
- Consider the chemical equation for the autoionization for water:



- K_{eq} for the above reaction is equal to 1.0×10^{-14} at 25°C
- This leads directly to the logarithmic nature of the pH scale
 - This means that a change of one unit of pH results in a change in 10 times the hydrogen ion concentration (10^1)
 - A change of 2 units of pH results in a change in 100 times the hydrogen ion concentration (10^2)
 - And so on...

PH SCALE

THE pH SCALE



12.6: Calculate the pH of strong acid and strong base solutions

EQUATION FOR CALCULATING PH

- Definition of pH and pOH

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pOH} = -\log[\text{OH}^-]$$

$$\text{p}K_w = 14.00 = \text{pH} + \text{pOH}$$

EXAMPLE

- Calculate the pH of a 0.25 M HCl acid solution
 - Use the five step problem solving method to solve this problem
 - When the solution is a strong acid or a strong base, assume 100% dissociation
 - Assume that the concentration of the acid/base is equal to the $[H^+]$ or $[OH^-]$, respectively

Step 1

$[H^+] = 0.25 \text{ M}$
 $\text{pH} = ?$

Step 2

$\text{pH} = -\log[H^+]$

Step 3

$\text{pH} = -\log[H^+]$

Step 4

$\text{pH} = -\log(0.25)$

Step 5

$\text{pH} = 0.60$

ANOTHER EXAMPLE

- Calculate the pH of a 0.25 M NaOH acid solution
 - Use the five step problem solving method to solve this problem
 - For a base, calculate the pOH of the base first and then subtract from 14 to find the pH, because $14 = \text{pH} + \text{pOH}$

Step 1

$[\text{OH}^-] = 0.25 \text{ M}$
 $\text{pH} = ?$

Step 2

$\text{pOH} = -\log[\text{OH}^-]$

Step 3

$\text{pOH} = -\log[\text{OH}^-]$

Step 4

$\text{pOH} = -\log(0.25)$

Step 5

$\text{pOH} = 0.60$
 $14 - 0.60 = 13.40$
 $\text{pH} = 13.40$

TRY IT YOURSELF

- Calculate the pH of the following strong acid or strong base solutions
 - 12.0 M NaOH solution
 - 1.25 M HCl solution
 - 3.5 M H₂SO₄ solution
 - 3.5 M LiOH Solution

TRY IT YOURSELF SOLUTIONS

- Calculate the pH of the following strong acid or strong base solutions
 - 12.0 M NaOH solution
pH = 15.1
 - 1.25 M HCl solution
pH = -0.0969
 - 3.5 M H₂SO₄ solution
pH = -0.54
 - 3.5 M LiOH Solution
pH = 15