pH scale

power of Hydrogen

pH

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Scale used to measure the concentration of hydrogen ions, H^+, in a solution.

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Scale generally runs from 0 - 14

pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

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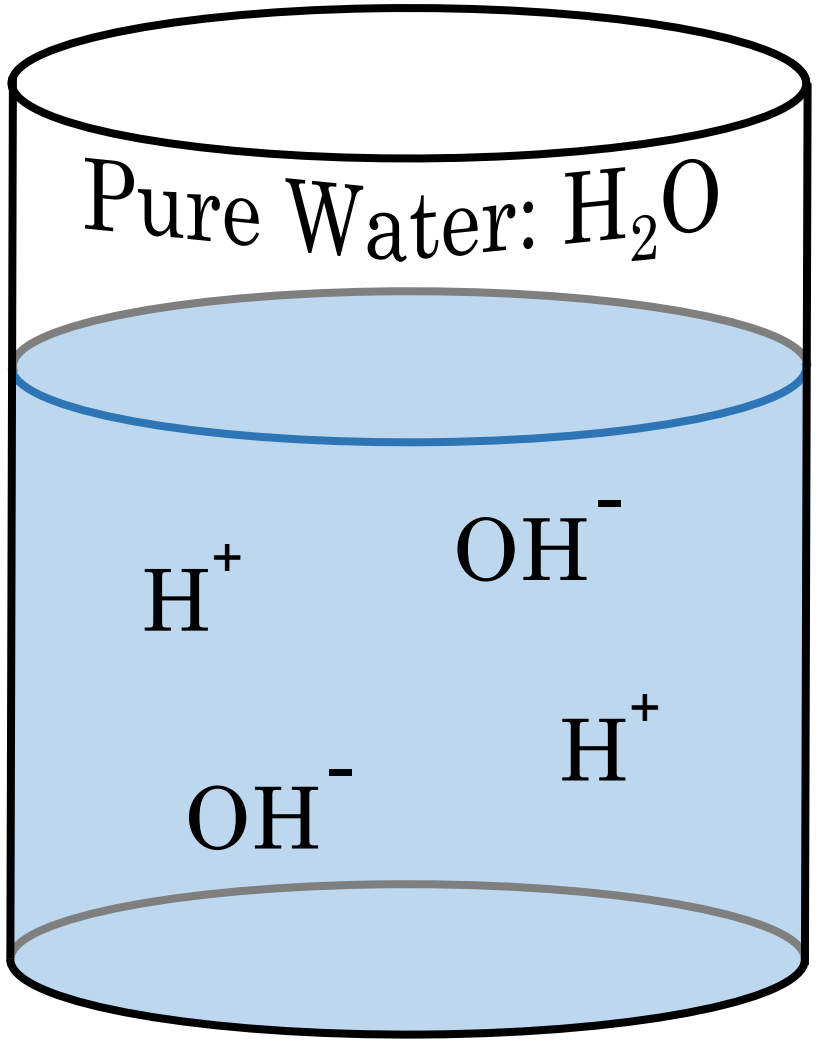
In pure water a few of the water, H_2O, molecules will split up into hydrogen, H^+, and hydroxide, OH^-, ions.

$$H_2O \rightarrow H^+ + OH^-$$



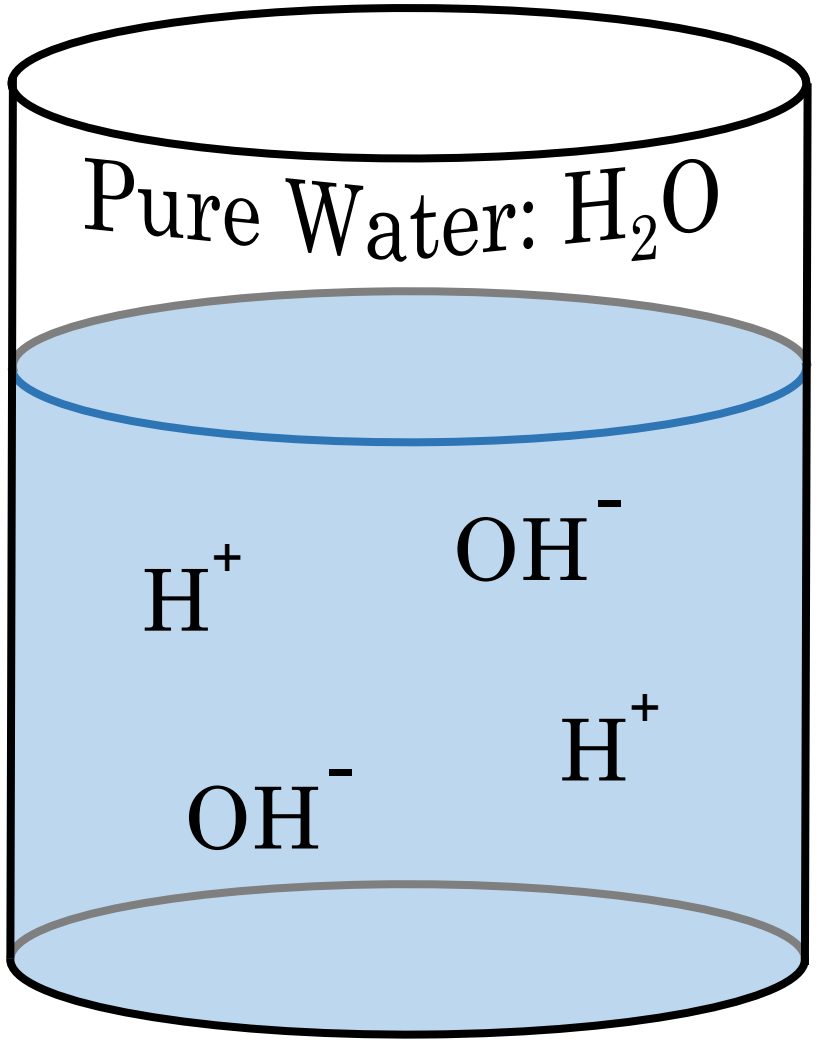
pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

In pure water the number of H^+ and OH^- ions are equal.

H^+ and OH^- are balanced.

This corresponds to a pH of 7.

pH 7 = Neutral



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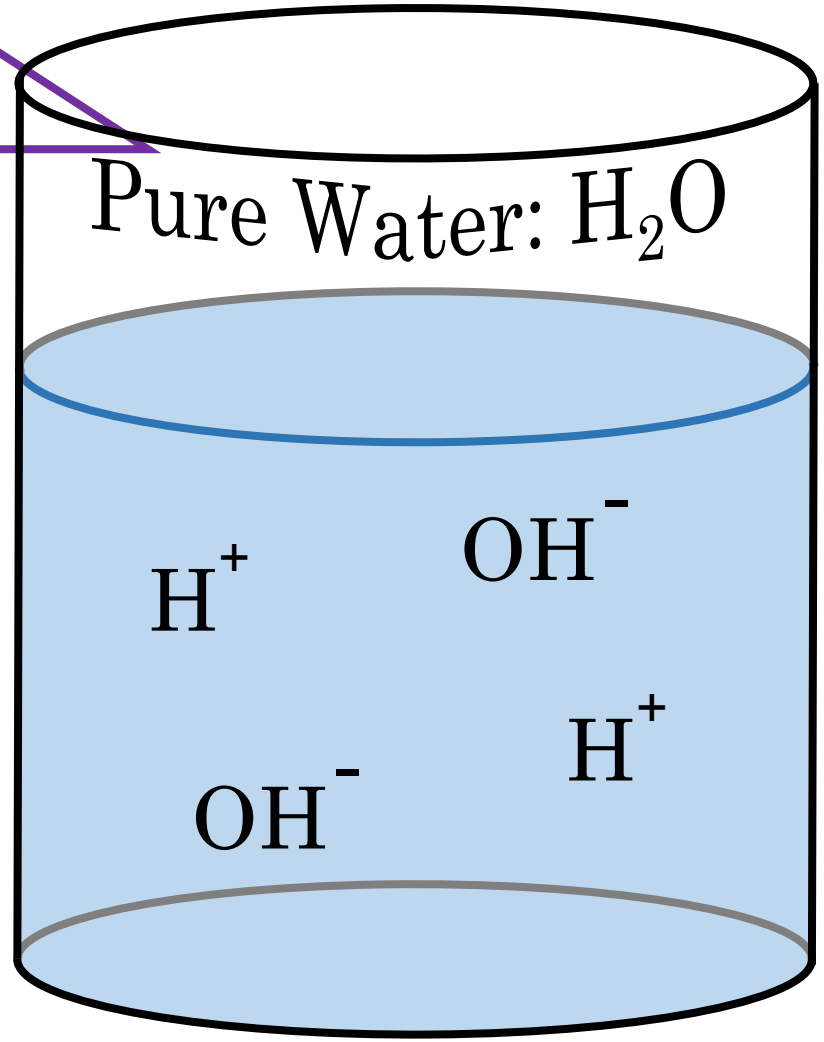


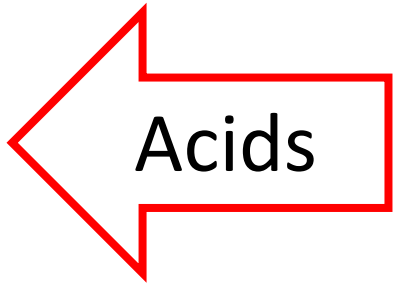
pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

If an acid is added to the water, the quantity of H^+ will increase.

Acids release H^+

more H^+
pH value drops



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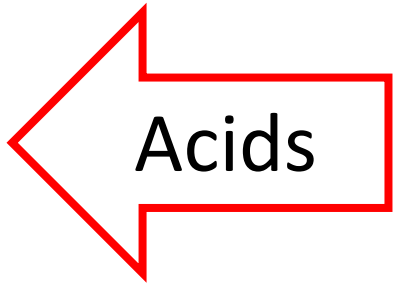


pH 0 1 2 3 4 5 6 **7** 8 9 10 11 12 13 14

- The stronger the acid, the lower the pH.
  - An acid with pH = 5 is 10X stronger than pH = 6
  - An acid with pH = 3 is 10X stronger than pH = 4
  - An acid with pH = 2 is 100X stronger than pH = 4

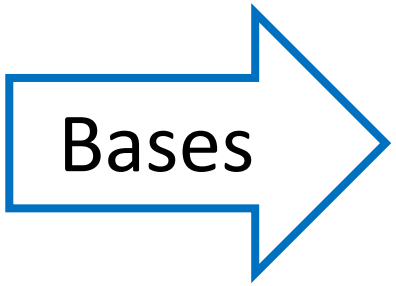
pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

If a base is added to the water, the quantity of OH^- will increase.

Bases release OH^-

less H^+

pH value rises



pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

If a base is added to the water, the quantity of OH^- will increase.

Bases release OH^-

less H^+

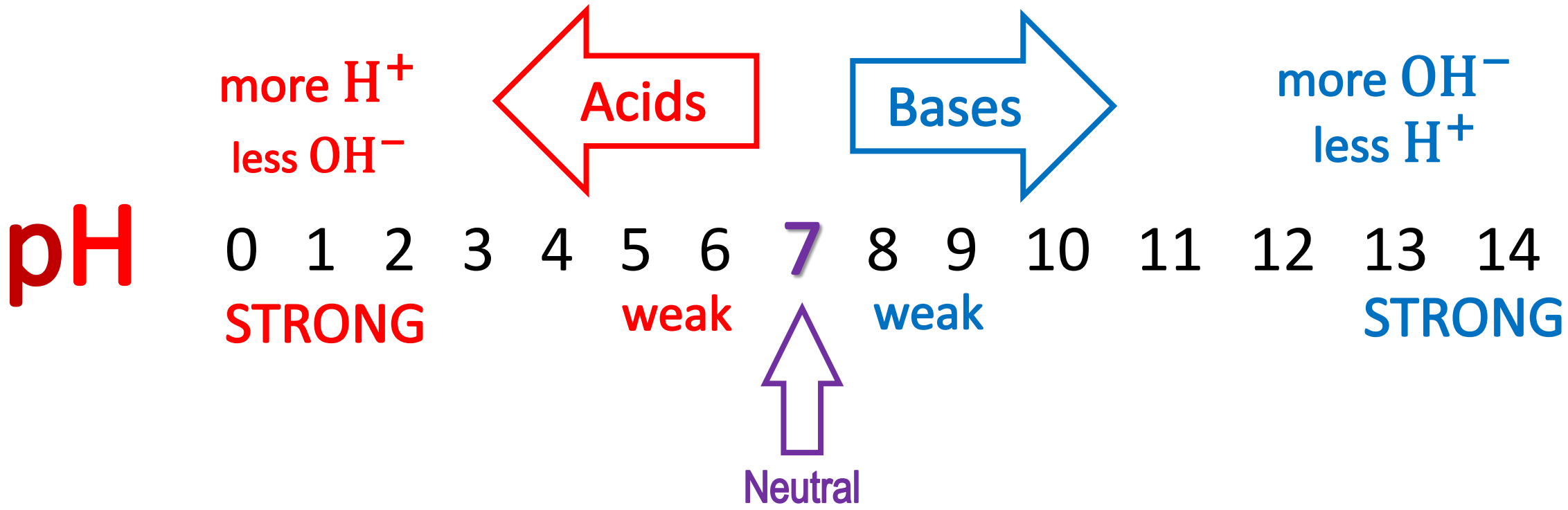
pH value rises

❖ The stronger the base, the higher the pH.

pH 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Dissolving a salt in the water *(normally)* does not affect the balance between $\mathbf{H}^+$ and $\mathbf{OH}^-$ ions.

Saline (salt) solutions are usually neutral: pH = 7


more H^+
less OH^-
Acids
Bases
more OH^-
less H^+
pH
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
STRONG
weak
weak
STRONG
Neutral

EST Course: Mathematics behind the pH scale

Exponents and Logarithms

$$10^{3} = 1000$$

$$10^{-3} = 0.001$$

$$10^{-5} = 0.00001$$

$$10^{2.5} \approx 316.2278$$

$$10^{?} = 1\,000\,000$$

$$? = \log(1\,000\,000)$$

$$? = 6$$

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Exponents and Logarithms

$$10^{3} = 1000$$

$$10^{-3} = 0.001$$

$$10^{-5} = 0.00001$$

$$10^{2.5} \approx 316.2278$$

$$10^{?} = 0.000\,000\,1$$

$$? = \log(0.000\,000\,1)$$

$$? = -7$$

EST Course: Mathematics behind the pH scale

Exponents and Logarithms

$$10^{3} = 1000$$

$$10^{-3} = 0.001$$

$$10^{-5} = 0.00001$$

$$10^{2.5} \approx 316.2278$$

$$10^{?} = 5000$$

$$? = \log(5000)$$

$$? \approx 3.699$$

EST Course: Mathematics behind the pH scale

	Concentration of hydrogen ions measured in moles per litre (mol/L) (a.k.a. molar concentration)	$\underline{\mathrm{pH} = -\log[H^+]}$
Pure water (Neutral):	$[H^+] = 1 \times 10^{-7}$ mol/L (0.0000001 mol/L)	$\mathrm{pH} = 7$
$10 \times$ more H^+:	$[H^+] = 1 \times 10^{-6}$ mol/L (0.000001 mol/L)	$\mathrm{pH} = 6$
A really small amount of H^+:	$[H^+] = 1 \times 10^{-13}$ mol/L (0.0000000000001 mol/L)	$\mathrm{pH} = 13$

pH of Common Substances