Acids and Bases

Chapter 10

Properties of acids:

- Taste sour
- Change the color of litmus paper from blue to red
- React with
  - Some metals to produce $H_2(g)$ and a salt
  - Hydroxides to produce water and a salt
  - Carbonates to produce $CO_2(g)$, water, and a salt

Properties of bases:

Taste bitter (caustic)
Feel slippery
Change the color of litmus paper from red to blue
React with acids

The Arrhenius definition:

Acids produce H^+ in water.

$$HCl_{(aq)} \xrightarrow{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$$

Bases produce OH^- in water.

$$NaOH_{(aq)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$$

The Brønsted-Lowry definition:

Acids donate protons (H^+).

$$HCl_{(aq)} + H_2O \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Bases accept protons (H^+).

Conjugate acid – base pairs.

Conjugate acid-base pair

$$HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Conjugate acid-base pair

The hydronium ion.

$$H_3O^+_{(aq)} = H^+_{(aq)}$$

The strong acids are strong electrolytes.

The strong acids are (MEMORIZE!):

HCl

HBR

HI

$HClO_4$

HNO_3

H_2SO_4

The strong bases are also strong electrolytes.

The strong bases are (MEMORIZE!):

LiOH

NaOH

KOH

$Sr(OH)_2$

$Ca(OH)_2$

$Ba(OH)_2$

The equilibrium constant for a weak acid is called K_a.

$$HC_2H_3O_2(aq) + H_2O(l) \rightleftarrows C_2H_3O_2^-(aq) + H_3O^+(aq)$$

$$K_a = \frac{[C_2H_3O_2^-][H_3O^+]}{[HC_2H_3O_2]} = 1.8 \times 10^{-5}$$

In the reaction between a strong acid and a strong base the net ionic equation is always:

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

The autoionization of water:

$$H_2O(l) + H_2O(l) \rightleftarrows OH^-(aq) + H_3O^+(aq)$$

$$K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14}$$

In pure water, $[H_3O^+] = [OH^-] = 1 \times 10^{-7}$ M

Here is how to calculate pH and pOH (given $[H_3O^+]$ or $[OH^-]$).

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

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

Here is how to calculate $[H_3O^+]$ or $[OH^-]$ (given pH or pOH).

$$\left[H_3O^+\right] = 10^{-pH}$$

$$\left[OH^-\right] = 10^{-pOH}$$

RELATIONSHIPS BETWEEN pH, pOH, $[H_3O^+]$, AND $[OH^-]$

$$pH + pOH = 14$$

$$[H_3O^+][OH^-] = 1 \times 10^{-14}$$

The more acidic a solution is:

The higher the $[H^+]$

The lower the pH

The lower the $[OH^-]$

The higher the pOH

THE MORE BASIC A SOLUTION IS:

The lower the $[H^+]$

The higher the pH

The higher the $[OH^-]$

The lower the pOH

What is the pH of a solution that is prepared by dissolving 12.75 g of hydroiodic acid in enough water to make 250.0 mL of solution?

0.3993

What is the $[OH^-]$ in a solution whose pH = 9.335?

2.16×10^{-5} ***M***

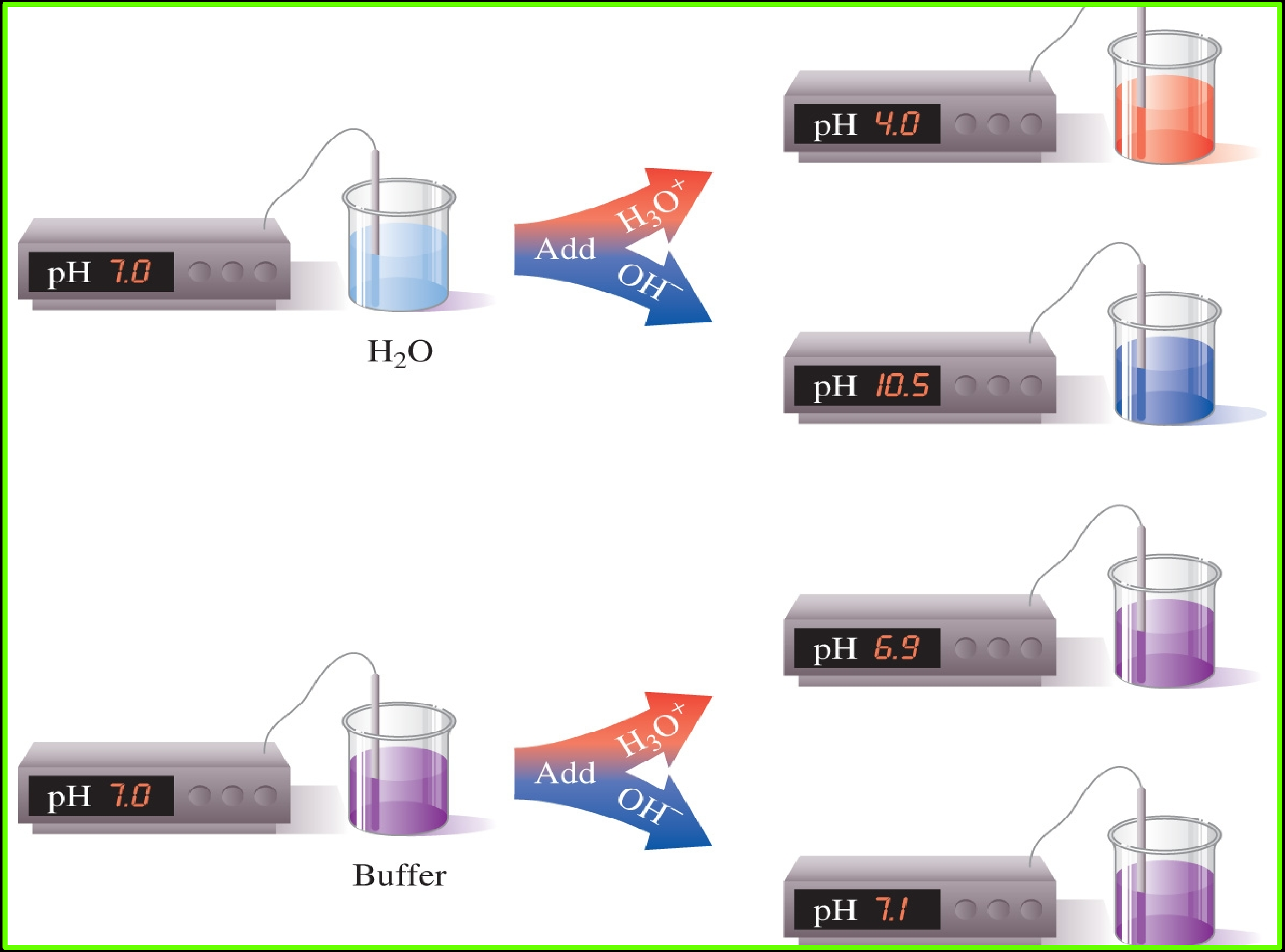
What is the pH in a solution that is made by dissolving 0.001014 g of $Ca(OH)_2$ in enough water to make 500.0 mL of solution?

9.738

A buffer solution is made from a weak base and a salt of its conjugate base.

For example: $HC_2H_3O_2$ and $NaC_2H_3O_2$

A buffer solution keeps the pH from changing too much when an acid or base is added.



The weak acid reacts with bases and the salt of the weak acid reacts with acids