# pH & Acid-Base Balance

Lec. Haider Abdulkareem AlMashhadani

*Lecture 6*

# 4A. Reaction of Acids with Hydroxide Bases

- The reaction of a Brønsted–Lowry acid (HA) with the metal salt of a hydroxide base (MOH) is an example of a neutralization reaction—an acid–base reaction that produces a salt and water as products.

$$HA_{(aq)} + MOH_{(aq)} \longrightarrow H{-}OH_{(l)} + MA_{(aq)}$$

acid base water salt

The acid HA donates a proton ($H^+$) to the $^-OH$ base to form $H_2O$.
The anion $A^-$ from the acid combines with the cation $M^+$ from the base to form the salt MA.

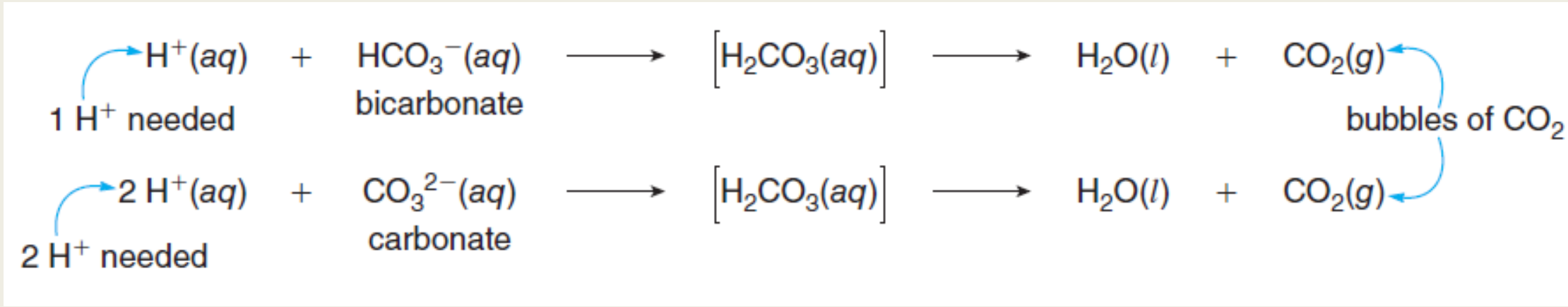
- For example, hydrochloric acid, HCl, reacts with sodium hydroxide, NaOH, to form water and sodium chloride, NaCl.

$$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow H{-}OH_{(l)} + NaCl_{(aq)}$$

acid base water salt

# 4B. Reaction of Acids with Bicarbonate and Carbonate

- Acids react with the bases bicarbonate ($HCO_3^-$) and carbonate ($CO_3^{2-}$). A bicarbonate base reacts with one proton to form carbonic acid, $H_2CO_3$. A carbonate base reacts with two protons. The carbonic acid formed in these reactions is unstable and decomposes to form $CO_2$ and $H_2O$. Thus, when an acid reacts with either base, bubbles of $CO_2$ gas are given off.



# PROBLEM

1. Write a balanced equation for each acid–base reaction.

   a. $HNO_{3(aq)} + NaOH_{(aq)} \longrightarrow$

   b. $H_2SO_{4(aq)} + KOH_{(aq)} \longrightarrow$

2. Write a balanced equation for the reaction of $H_2SO_4$ with $NaHCO_3$.

# 5. The pH Scale

- Knowing the hydronium ion concentration is necessary in many different instances.
- The blood must have an $H_3O^+$ concentration in a very narrow range for an individual's good health.
- Plants thrive in soil that is not too acidic or too basic.
- The $H_3O^+$ concentration in a swimming pool must be measured and adjusted to keep the water clean and free from bacteria and algae.
- The pH of a solution is a number generally between 0 and 14, defined in terms of the logarithm (log) of the $H_3O^+$ concentration.

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

**A logarithm is an exponent of a power of ten.**

The log is the exponent.

$\log(10^{5}) = 5$ $\log(10^{-10}) = -10$ $\log(0.001) = \log(10^{-3}) = -3$

The log is the exponent. Convert to scientific notation.

$$pH = -\log [H_3O^+] = -\log(10^{-4})$$
$$= -(-4) = 4$$

pH of apple juice

- **Acidic solution: pH < 7 $[H_3O^+] > 1 \times 10^{-7}$**
- **Neutral solution: pH = 7 $[H_3O^+] = 1 \times 10^{-7}$**
- **Basic solution: pH > 7 $[H_3O^+] < 1 \times 10^{-7}$**

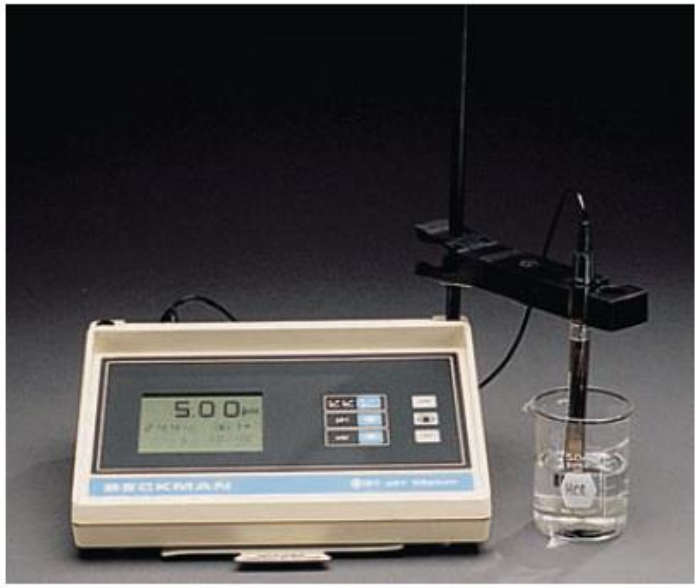
Note the relationship between $[H_3O^+]$ and pH.

- **The *lower* the pH, the *higher* the concentration of $H_3O^+$.**

The pH of a solution can be measured using a pH meter as shown in Figure 8.6. Approximate pH values are determined using pH paper or indicators that turn different colors depending on the pH of the solution. The pH of various substances is shown in Figure 8.7.

Figure 8.6 Measuring pH

a.




b.

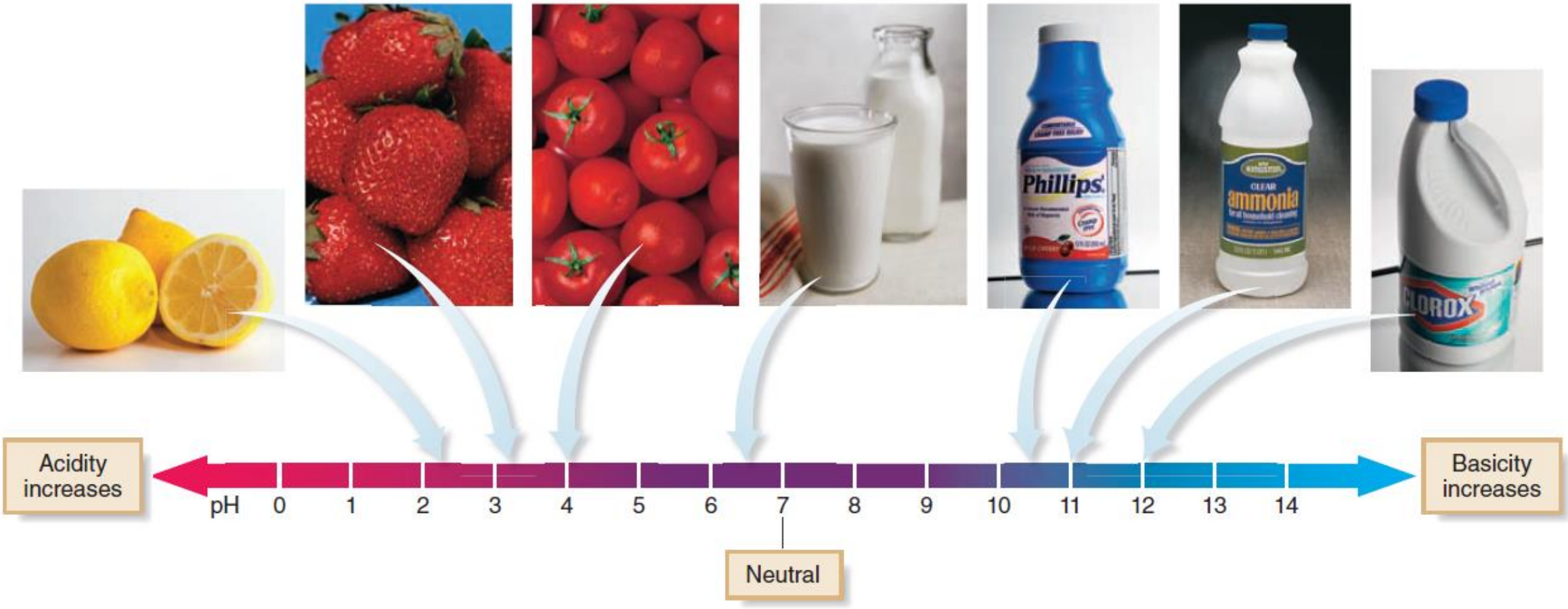

c.

a. A pH meter is a small electronic device that measures pH when an electrode is dipped into a solution.

b. Paper strips called pH paper change color corresponding to a particular pH, when a drop of an aqueous solution is applied to them.

c. An acid–base indicator can be used to give an approximate pH. The indicator is a dye that changes color depending on the pH of the solution.

## Figure 8.7 The pH of Some Common Substances




The pH of many fruits is less than 7, making them acidic. Many cleaning agents, such as household ammonia and bleach, are basic (pH > 7).

# PROBLEM

1. What is the pH of a urine sample that has an $H_3O^+$ concentration of $1 \times 10^{-5}$ M? Classify the solution as acidic, basic, or neutral.

2. What is the $H_3O^+$ concentration in lemon juice that has a pH of about 2? Classify the solution as acidic, basic, or neutral.

*End*