Part 1: Introduction to Acids and Bases

Properties of Acids and Bases

- Acids taste sour. Bases taste bitter and feel slippery.
- Acids and bases are conductors of electricity.
- Acids and bases can be identified by their reactions with some metals and metal carbonates.
- Acids turn blue litmus red.
- Bases turn red litmus blue.

•All water solutions contain hydrogen ions (H^+) and hydroxide ions ($OH^−$).

- An acidic solution contains more hydrogen ions than hydroxide ions.

• A basic solution contains more hydroxide ions than hydrogen ions.

•The usual solvent for acids and bases is water—water produces equal numbers of hydrogen and hydroxide ions in a process called self-ionization. $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^−(aq)$

• The **Arrhenius model** states that an acid is a substance that contains hydrogen and ionizes to produce hydrogen ions in an aqueous solution, and a base is a substance that contains a hydroxide group and dissociates to produce a hydroxide ion in solution.

•Arrhenius acids and bases:

HCl ionizes to produce H^+ ions. $HCl(g) \rightarrow H^+(aq) + Cl^−(aq)$

NaOH dissociates to produce $OH^−$ ions. $NaOH(s) \rightarrow Na+(aq) + OH^−(aq)$

• **The Brønsted-Lowry Model** of acids and bases states that an acid is a hydrogen ion donor, and a base is a hydrogen ion acceptor. Brønsted-Lowry Model is a more inclusive model of acids and bases.

• A conjugate acid is the species produced when a base accepts a hydrogen ion.

• A conjugate base is the species produced when an acid donates a hydrogen ion.

• A conjugate acid-base pair consists of two substances related to each other by donating and accepting a single hydrogen ion.

- $HF(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + F^−(aq)$ HF = acid, H_2O = base, H_3O^+ = conjugate acid, $F^−$ = conjugate base
- $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^−(aq)$ NH_3 = base, $H_2O(l)$ = acid, NH_4^+ = conjugate acid, $OH^−$ = conjugate base

•Water and other substances that can act as acids or bases are called amphoteric.

The Lewis Model

•According to the Lewis model, a Lewis acid is an electron-pair acceptor and a Lewis base is an electron-pair donor.

• The Lewis model includes all the substances classified as Brønsted-Lowry acids and bases and many more.

Three Models For Acids and Bases

Model	Acid Definition	Base Definition
Arrhenius	H^+ producer	$OH^−$ producer
Brønsted-Lowry	H^+ donor	H^+ acceptor
Lewis	electron-pair acceptor	electron-pair donor

1 Tastes bitter… (CH 13)

A Acidic solution **B** Basic solution
C Neutral solution **D** Amphoteric solutions

Bases taste bitter →B

2 Acidic solutions … (CH 13)

A Tastes bitter
B Has slippery texture
C Doesn't conduct electricity
D Conducts electricity

Acids and bases are conductors of electricity. →D

3 Acidic solutions turn the color of litmus paper from… (CH 13)

A Blue to red **B** Blue to green
C Blue to yellow **D** Red to blue

Acids turn blue litmus red →A

4 Basic solutions turn the color of litmus paper from… (CH 13)

A Blue to red **B** Red to yellow
C Red to green **D** Red to blue

Bases turn red litmus blue. →D

5 A substance that turns red litmus paper to blue (CH 13)

A NaCl **B** HCOOH
C HF **D** KOH

KOH, Bases turn red litmus blue. →D

6 A neutral solution contains two equal concentrations of hydronium ions and … (CH 13)

A Cl^- **B** O^{2-}
C NH_4^+ **D** OH^-

A neutral solution contains equal concentrations of H_3O^+ ions and OH^-. →D

7 In an acidic solution: concentration of hydrogen ions are ……… hydroxide. (CH 13)

A Not related to **B** Equals to
C Less than **D** Greater than

An acidic solution contains more hydrogen ions than hydroxide ions. →D

8 Ionization of pure water results in a number of OH^- and H^+ ions in which… (CH 13)

A Their amounts are equal
B Number of OH^- ions is more
C Number of H^+ ions is more
D Number of H^+ ions is too little

Ionization of pure water results in a number of OH- and H+ ions in which their amounts are equal →A

9 Arrhenius Acid is a substance that produce and contains….. ions. (CH 13)

A Nitrogen **B** Hydrogen
C Oxygen **D** Fluorine

Arrhenius Acid is a substance that produce and contains hydrogen ions. →B

CHAPTER 13: Acids and Bases

10 Arrhenius Base is a substance that produce and contains….. ions.

CH 13

A Sodium **B** Hydrogen

C Hydroxide **D** Bromine

Arrhenius base is a substance that produce and contains hydroxide ions. →C

11 Which of the following compounds does not follow Arrhenius model in the definition of bases?

CH13

A NaOH **B** KOH

C NH_3 **D** $Mg(OH)_2$

Arrhenius model didn't give explanations about the basic behavior for some bases like NH_3, N_2H_4, CH_3NH_2. →C

12 Which of the following substance that is a hydrogen ion donor according to Bronsted-Lowry model

CH 13

A Base **B** Neutral substance

C Acid **D** Table salt

Brønsted-Lowry Model of acids and bases states that an acid is a hydrogen ion donor →C

13 Which of the following substance that is a hydrogen ion acceptor according to Bronsted-Lowry model

CH 13

A Base **B** Neutral substance

C Acid **D** Tale salt

Brønsted-Lowry Model of acids and bases states that a base is a hydrogen ion acceptor →A

14 In an acidic solution…

CH 13

A $[H_3O^+] = 10^{-9}$ **B** $[H_3O^+] = 10^{-14}$

C $[OH^-] < [H_3O^+]$ **D** $[OH^-] > [H_3O^+]$

In an acidic solution $[OH^-] < [H^+]$ →C

15 If $[H_3O^+] < [OH^-]$ then the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In a basic solution $[H_3O^+] < [OH^-]$ →C

15 If $[H_3O^+] = [OH^-]$ then the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In neutral solution $[H^+] = [OH^-]$ →B

16 If $[H_3O^+] > 1x10^{-7}$ M, the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In an acidic solution $[H_3O^+] > 1x10^{-7}$M →A

17 If $[H_3O^+] < 1x10^{-7}$ M, the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In a basic solution $[H_3O^+] < 1x10^{-7}$M →C

18 If $[OH^-] < 1x10^{-7}$ M, the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In an acidic solution $[OH^-] < 1x10^{-7}$M →A

19 If $[OH^-] > 1x10^{-7}$ M, the solution is

CH 13

A Acidic **B** Neutral

C Basic **D** Amphoteric

In a basic solution $[OH^-] > 1x10^{-7}$M →C

20 The conjugate base of HCl is

CH 13

A H_3O^+ **B** OH- **C** Cl^- **D** H_2Cl^+

Conjugate base = Acid – H^+

$HCl - H^+ = Cl^-$ →C

21 The conjugate acid of NH_3 is

CH 13

A H_3O^+ **B** OH^- **C** NH_2^- **D** NH_4^+

Conjugate acid = Base + H^+

$NH_3 + H^+ = NH_4^+$ →D

22 The conjugate acid of HSO_4^- is

CH 13

A H_3O^+ **B** H_2SO_4 **C** H_2SO_3 **D** SO_4^{--}

Conjugate acid = Base + H^+

$HSO_4^- + H^+ = H_2SO_4$ →B

23 Which of the following is amphoteric

CH 13

A H_3O^+ **B** H_2SO_4 **C** H_2SO_3 **D** HSO_4^-

Amphoteric can accept H^+ or donate H^+ at the same time →D

24 Which of the following is monoprotic acid

CH 13

A H_2CO_3 **B** H_2SO_4 **C** H_2SO_3 **D** HNO_3

Monoprotic acid is an acid that can donate 1 Hydrogen ion only →D

25 Which type of acid accepts an electron pair?

CH 13

A Arrhenius **B** Brønsted-Lowry

C Lewis **D** Dalton

A Lewis acid is an electron-pair acceptor. →C

26 Which of the following represents a Lewis acid?

CH 13

A F^- **B** NH_3

C BH_3 **D** OH^-

BH_3, Because Boron B have an empty p orbital in the outer most shell of its electron configuration and can accept a pair of electrons. →C

27 What is the concentration of $[OH^-]$, if the concentration of $[H_3O^+]$ is $1x10^{-3}$M. ($K_w=1x10^{-14}$ at 25⁰C)

CH 13

A $1x10^{-3}$M **B** $1x10^{3}$M

C $1x10^{-11}$M **D** $1x10^{11}$M

$K_w = [H_3O^+] x [OH^-]$

$1x10^{-14} = [H_3O^+] x [OH^-]$

$[OH^-] = 1x10^{-14} \div 1x10^{-3}$

$[OH^-] = 1x10^{-11}$M →C

28 What is the concentration of $[H_3O^+]$, if the concentration of $[OH^-]$ is $1x10^{-5}$M. ($Kw=1x10^{-14}$ at 25⁰C)

CH 13

A $1x10^{-3}$M **B** $1x10^{3}$M

C $1x10^{-9}$M **D** $1x10^{9}$M

$K_w = [H_3O^+] x [OH^-]$

$1x10^{-14} = [H_3O^+] x [OH^-]$

$[H_3O^+] = 1x10^{-14} \div 1x10^{-5}$

$[H_3O^+] = 1x10^{-9}$M →C

29 Which of the following is not amphoteric?

CH 13

A HCO_3^- **B** HI **C** HSO_4^- **D** $H_2PO_4^-$

HSO_4^- , Because it can donate and accept H^+ at the same time →B

CHAPTER 13: Acids and Bases

Part 2: Strengths of Acids and Bases, pH, and Neutralization

Acids that ionize completely are **strong acids**, because they produce the maximum number of hydrogen ions, strong acids are good conductors of electricity. Acids that ionize only partially in dilute aqueous solutions are called **weak acids**

Strong Acids		Weak Acids	
Name	Ionization Equation	Name	Ionization Equations
Hydrochloric	$HCl \rightarrow H^+ + Cl^-$	Hydrofluoric	$HF \rightleftharpoons H^+ + F^-$
Hydroiodic	$HI \rightarrow H^+ + I^-$	Hydrosulfuric	$H_2S \rightleftharpoons H^+ + HS^-$
Nitric	$HNO_3 \rightarrow H^+ + NO_3^-$	Carbonic	$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$
Sulfuric	$H_2SO_4 \rightarrow H^+ + HSO_4^-$	Hypochlorous	$HClO \rightleftharpoons H^+ + ClO^-$

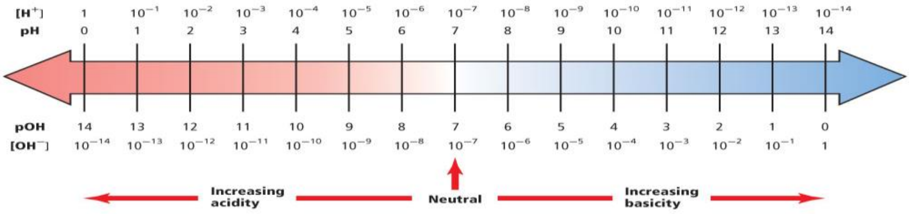
With a strong acid, the conjugate base is a weak base. The acid ionization constant is the value of the equilibrium constant expression for the ionization of a weak acid, K_a. Weaker acids have a smaller K_a

A base that dissociates completely into metal ions and hydroxide ions is known as **a strong base. A weak base** ionizes only partially in dilute aqueous solution. The base ionization constant, K_b, is the value of the equilibrium constant expression for the ionization of a base. Weaker base have a smaller K_b

pH is the negative logarithm of the hydrogen ion concentration of a solution. **pH** $= -\log [H_3O^+]$

pOH of a solution is the negative logarithm of the hydroxide ion concentration. **pOH** $= -\log [OH^-]$

The sum of pH and pOH equals 14



A **neutralization reaction** is a reaction in which an acid and a base in an aqueous solution react to produce a salt and water. Neutralization is a double-replacement reaction.

A **salt** is an ionic compound made up of a cation from a base and an anion from an acid.

Titration is a method for determining the concentration of a solution by reacting a known volume of that solution with a solution of known concentration.

Equivalence point, which is the point at which moles of H_3O^+ion from the acid equals moles of OH^- ion from the base.

An **end point** is the point at which an indicator used in a titration changes color.

An indicator will change color at the equivalence point.

Buffers are solutions that resist changes in pH when limited amounts of acid or base are added. A buffer is a solution made up of a weak species and its conjugate.

30 CH 13 **Where is the equilibrium point in the ionization equation for a strong acid?**

A Far right **B** Far left

C Slightly right **D** Slightly left

The equilibrium point in the ionization equation for a strong acid is far right. →A

31 CH 13 **A solution with a small K_a is a ____.**

A Weak acid **B** Weak base

C Strong acid **D** Strong base

A solution with a small K_a is a weak acid →A

32 CH 13 **A solution with a small K_b is a ____.**

A Weak acid **B** Weak base

C Strong acid **D** Strong base

The base ionization constant is the value of the equilibrium constant expression for the ionization of a weak base, K_b. →B

33 CH 13 **What is the conjugate of a weak acid?**

A Strong acid **B** Strong base

C Weak acid **D** Weak base

A weak acid, the conjugate base is a strong base →B

34 CH 13 **The strength of a weak acid is measured by __**

A Ion product constant

B Base ionization constant

C pOH

D Acid ionization constant

The base ionization constant is the value of the equilibrium constant expression for the ionization of a weak acid, K_a. →D

35 CH 13 **In a solution with a pH of 4.0, which of the following is true?**

A $[H_3O^+] > [OH^-]$ **B** $[H_3O^+] < [OH^-]$

C $[H_3O^+] = [OH^-]$ **D** None of the above

pH = 4, acidic solution so $[H_3O^+] > [OH^-]$ →A

36 CH 13 **In a solution with a pH of 10.0, which of the following is true?**

A $[H_3O^+] > [OH^-]$ **B** $[H_3O^+] < [OH^-]$

C $[H_3O^+] = [OH^-]$ **D** None of the above

pH = 10, basic solution so $[H_3O^+] < [OH^-]$ →B

37 CH 13 **In a solution with a pH of 7.0, which of the following is true?**

A $[H_3O^+] > [OH^-]$ **B** $[H_3O^+] < [OH^-]$

C $[H_3O^+] = [OH^-]$ **D** None of the above

pH = 7, neutral solution so $[H_3O^+] = [OH^-]$ →C

38 If $[H_3O^+]$ of a solution with 0.001M, pH is

CH 13

A -3 **B** 3 **C** -11 **D** 11

pH = –log $[H_3O^+]$
pH = –log $1x10^{-3}$
pH = 3 →B

39 If pH=5 of a solution, $[H_3O^+]$ is

CH 13

A $1x10^5$M **B** $1x10^{-5}$M **C** $1x10^{-9}$M **D** $1x10^9$M

$[H_3O^+] = 10^{-pH}$
$[H_3O^+] = 10^{-5}$M →B

40 If $[OH^-]$ of a solution with 0.001M, pOH is

CH 13

A -3 **B** 3 **C** -11 **D** 11

pOH = –log $[OH^-]$
pOH = –log $1x10^{-3}$
pOH = 3 →B

41 If $[OH^-]$ of a solution with 0.0001M, pH is

CH 13

A -4 **B** 4 **C** -10 **D** 10

pOH = –log $[OH^-]$
pOH = –log $1x10^{-4}$
pOH = 4
pH = 14 – pOH
= 14 - 4 = 10 →D

42 If pOH=4 of a solution, $[OH^-]$ is

CH 13

A $1x10^4$M **B** $1x10^{-4}$M **C** $1x10^{-10}$M **D** $1x10^{10}$M

$[OH^-] = 10^{-pOH}$
$[OH^-] = 10^{-4}$M →B

43 If pOH=6 of a solution, pH is

CH 13

A 6 **B** -6 **C** 8 **D** -8

pH = 14 – pOH
= 14 - 6 = 8 →C

44 If pH=3 of a solution, pOH is

CH 13

A 3 **B** -3 **C** 11 **D** -11

pOH = 14 – pH
= 14 - 3 = 11 →C

45 What is the pH of 0.01M HCl, a strong acid?

CH 13

A -2 **B** 2 **C** 10 **D** -10

$[H_3O^+]$ =[HCl] = 10^{-2}M
pH = –log $[H_3O^+]$
pH = –log $1x10^{-2}$
pH = 2 →B

46 What is the pH of 0.05M H_2SO_4, a strong acid?

CH 13

A -1 **B** 1 **C** 5 **D** -5

$[H_3O^+]$ =2x$[H_2SO_4]$ = 0.1M
pH = –log $[H_3O^+]$
pH = –log $1x10^{-1}$
pH = 1 →B

47 What is the pOH of 0.001M NaOH, a strong base?

CH 13

A -3 **B** 3 **C** -11 **D** 11

[NaOH] = $[OH^-]$ = $1x10^{-3}$M
pOH = –log $[OH^-]$
pOH = –log $1x10^{-3}$
pOH = 3 →B

48 What is the pOH of 0.005M $Ca(OH)_2$, a strong base?

CH 13

A -2 **B** 2 **C** -5 **D** 5

$[OH^-]$ = 2 x $[Ca(OH)_2]$ = $1x10^{-2}$M
pOH = –log $[OH^-]$
pOH = –log $1x10^{-2}$
pOH = 2 →B

49 What is the pH of 0.0005M $Ca(OH)_2$, a strong base?

CH 13

A -11 **B** 11 **C** -3 **D** 3

$[OH^-]$ = 2 x $[Ca(OH)_2]$ = $1x10^{-3}$M
pOH = –log $[OH^-]$
pOH = –log $1x10^{-2}$
pOH = 3
pH = 14 – pOH
= 14 - 3 = 11 →B

50 A reaction in which an acid and a base in an aqueous solution react to produce a salt and water.

CH 13

A Combustion **B** Fertilization
C Neutralization **D** Decomposition

A neutralization reaction is a reaction in which an acid and a base in an aqueous solution react to produce a salt and water. →C

51 A neutralization reaction is

CH 13

A Combustion **B** Single-replacement
C Double-replacement **D** Decomposition

Neutralization reaction is a double-replacement reaction. →C

52 A method for determining the concentration of a solution by reacting a known volume of that solution with a solution of known concentration.

CH 13

A Combustion **B** Neutralization
C Titration **D** Decomposition

Titration is a method for determining the concentration of a solution by reacting a known volume of that solution with a solution of known concentration. →C

53 The point at which moles of H_3O^+ion from the acid equals moles of OH^- ion from the base.

CH 13

A Stating point **B** Reference point
C Equivalence point **D** Negative point

Equivalence point, which is the point at which moles of H_3O^+ion from the acid equals moles of OH^- ion from the base. →C

54 The point at which an indicator used in a titration changes color.

CH13

A Stating point **B** Reference point
C Equivalence point **D** End point

End point is the point at which an indicator used in a titration changes color. →D

55 Solutions that resist changes in pH when limited amounts of acid or base are added.

CH 13

A Receptors **B** Donors
C Quakers **D** Buffers

Buffers are solutions that resist changes in pH when limited amounts of acid or base are added. →D