

9-1

Unit 9. Acid-Base Chemistry

Most fundamental thing to remember about this chapter: Acids and Bases are opposites.

9-2

Acids

- Ways you have dealt with/heard about acid before
 - health “acid indigestion”
 - gardening “pine trees like acid soil”
 - transportation “battery acid”
 - environment “acid rain”

9-3

Properties of Acids

Sour taste
No distinctive feel (until it eats through skin)
React with metals to yield $H_2(g)$
React with base (both are neutralized)
Blue litmus turns to pink

9-4

Properties of Bases

Bitter taste
Slippery to the touch
React with acid (both are neutralized)
Pink litmus turns to blue

9-5

Definitions of Acids

Arrhenius acid- substance that *ionizes* or *dissociates* in water to yield hydrogen ions (protons)

Bronsted-Lowry acid- a proton donor

Lewis acid- electron pair acceptor

9-6

Definitions of Bases

Arrhenius base- substance that ionizes in water to yield hydroxide ions

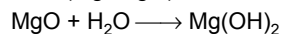
Bronsted-Lowry base- a hydrogen ion acceptor

Lewis base- electron pair donor

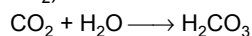
9-7

Acidic and Basic Oxides

metal oxides are basic oxides - react with water to produce bases (e.g. MgO)



nonmetal oxides are acidic oxides - acids form in water (e.g. CO₂)



9-8

Conjugate Acid/Conjugate Base

Acid + Base \longrightarrow Conjugate Acid + Conjugate Base

Conjugate Acid- the acid that is formed when a base accepts a proton.

Conjugate Base- the base that is formed when an acid donates a proton.

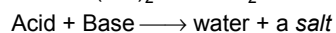
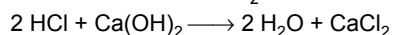
If acid is strong, conjugate base is weak

If base is strong, conjugate acid is weak

conjugate acid-base pairs differ only by one H⁺

9-9

All Neutralization Reactions are Similar



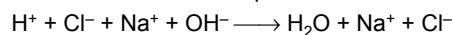
Salt- ionic compound formed from cation of base and anion of acid

9-10

Acids and Bases *Dissociate* in Solution

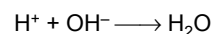
Dissociate- break apart into ions when dissolved in water.

Total Ionic Equation



Spectator ions- ions that are the same on both sides of the equation.

Net Reaction



9-11

Examples

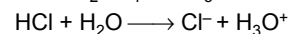
- React 1 mol HF with 1 mol LiOH
 - what is the balanced reaction?
 - what is the total ionic reaction?
 - name the spectator ions.
 - what is the net reaction?
- React sulfuric acid with potassium hydroxide
 - what is the balanced reaction?
 - what is the total ionic reaction?
 - name the spectator ions.
 - what is the net ionic equation?

9-12

Strong Acids/Weak Acids

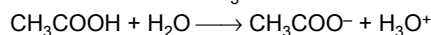
How strong an acid is depends on how much it dissociates.

Strong acid- HCl, H₂SO₄, HNO₃



K_{eq} = infinity (big)

Weak acid- acetic acid CH₃COOH



K_{eq} = 1.82 × 10⁻⁵ (small)

The K_{eq} is a constant which you would be given

9-13

Example

- React HNO_3 with NaOH
 - what is the balanced reaction?
 - identify the acid, base and conjugate acid and base.
 - what is the total ionic reaction?
 - name the spectator ions.
 - what is the net reaction?
 - are the acid, base, conjugate acid and base strong or weak?

9-14

Molarity

mole

 6.02×10^{23} molecules
molar mass in grams

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

9-15

Sample Test Questions

- What is the molarity of a solution composed of 1.0 mol HCl in 0.5 L water?
- What is the molarity of a solution composed of 1.0 mol HCl in 750 mL water?
- What is the molarity of a solution composed of 0.357 mol HCl in 750 mL water?
- What is the molarity of a solution composed of 100 g HCl in 250 mL water?

9-16

Normality

In water, $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$ But in water, $\text{H}_2\text{SO}_4 \rightarrow 2 \text{H}^+ + \text{SO}_4^{2-}$ Refer to H_2SO_4 as having 2 *equivalents* H^+

$$\text{Normality} = \frac{\text{equivalents of solute}}{\text{liters of solution}}$$

 $N = Mx$ monoprotic acids, $1M = 1N$ diprotic acids, $1M = 2N$ triprotic acids, $1M = 3N$

9-17

Sample Test Questions

- If you have 3.2 M HCl , what is the normality?
- If you have 3.2 M H_2SO_4 , what is the normality?
- If you have 3.2 M H_3PO_4 , what is the normality?

9-18

Sample Test Questions

- How many moles of citric acid ($\text{H}_3\text{C}_6\text{H}_5\text{O}_7$) would you use to make 1.0 L of 3.25 M citric acid?
- How many grams of citric acid would you use to make 1.0 L of 3.25 M citric acid?
- How many grams of citric acid would you use to make 0.75 L of 4.2 M citric acid?

9-19

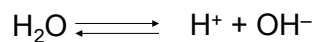
Molarity and Dilution

$$(V_i)(C_i) = (V_f)(C_f)$$

- How would you prepare 2.5 L of 2 M HCl from concentrated HCl (11.6 M)?
- Concentrated H₂SO₄ comes as a 18.0 M solution. How would you make a 2.0 N sol'n?

9-20

Water Dissociates Slightly



- [H⁺] is 1 × 10⁻⁷ M (measured experimentally)
- therefore, [OH⁻] is 1 × 10⁻⁷ M
 - Water is a weak acid
 - Water is also a weak base
- product is 1 × 10⁻¹⁴
- this is the basis of the *pH scale*

9-21

The pH Scale

scale of 0-14

low pH (pH 0 - pH 6) is acidic

pH 7 is neutral

high pH (pH 8 - pH 14) is basic

9-22

pH Math

$$\text{pH} = -\log[\text{H}_3\text{O}^+] \text{ or } \text{pH} = -\log [\text{H}^+]$$

$$[\text{H}_3\text{O}^+] [\text{OH}^-] = 1.0 \times 10^{-14}$$

$$\text{pH} + \text{pOH} = 14$$

Because log scale, a difference of 1 pH unit means there are 10× as many protons.

9-23

Sample Test Questions

- Is tomato juice (pH 4.0) acidic or basic?
- How many more/less protons are present in 2 than in 3?

9-24

Amphiprotic Compounds

sodium dihydrogen phosphate: NaH₂PO₄

Amphiprotic- can accept or donate a proton depending on the environment.

Important in *buffers*

Buffers

1. Why it is important to regulate pH.
2. Our blood is *buffered*.

Buffer- a molecule that prevents the pH from changing even when (small amounts) acid or base is added.

- a. Proteins buffer our blood.
- b. Amphiprotic compounds buffer our blood.

NaH₂PO₄ (minor),

NaHCO₃ (major).