

CHAPTER 4:

Some Types of Chemical Reactions

Chapter Four Goals

- **The Periodic Table**
- **Aqueous Solutions**
- **Oxidation Numbers**
- **Naming Some Inorganic Compounds**
- **Chemical Reactions**

The Periodic Table: Metals, Nonmetals, and Metalloids

Mendeleev & Meyer

The periodic law

**The properties of the elements are
periodic functions of their atomic numbers.**

The Periodic Table: Metals, Nonmetals, and Metalloids

- **Groups or Families**
 - Vertical group of elements on periodic table
 - Similar chemical and physical properties
- **Periods**
 - Horizontal group of elements on periodic table
 - Transition from metals to nonmetals

The Periodic Table: Metals, Nonmetals, and Metalloids

Representative Elements

Metals

Metalloids

Non-Metals

1A	2A	3A	4A	5A	6A	7A	8A
H		B	C	N	O	F	He
Li	Be	Al	Si	P	S	Cl	Ar
Na	Mg	Ga	Ge	As	Se	Br	Kr
K	Ca	In	Sn	Sb	Te	I	Xe
Rb	Sr	Tl	Pb	Bi	Po	At	Rn
Cs	Ba						
Fr	Ra						

The Periodic Table: Metals, Nonmetals, and Metalloids

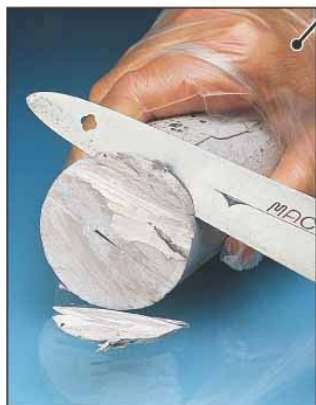
Some chemical properties of metals

- Outer shells contain few electrons
- Form cations by losing electrons
- Form ionic compounds with nonmetals
- Solid state characterized by metallic bonding

The Periodic Table: Metals, Nonmetals, and Metalloids

- **Group IA metals**
alkali metals
Li, Na, K, Rb, Cs, Fr
- **Group IIA metals**
alkaline earth metals
Be, Mg, Ca, Sr, Ba, Ra

Alkali and alkaline earth metals



1A (1)	2A (2)
3 Li Lithium	4 Be Beryllium
11 Na Sodium	12 Mg Magnesium
19 K Potassium	20 Ca Calcium
37 Rb Rubidium	38 Sr Strontium
55 Cs Cesium	56 Ba Barium
87 Fr Francium	88 Ra Radium

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	—	—	—	—	—	—	—	—	—



The Periodic Table: Metals, Nonmetals, and Metalloids

Some chemical properties of nonmetals

- Outer shells contain four or more electrons
- Form anions by gaining electrons
- Form ionic compounds with metals and covalent compounds with other nonmetals
- Form covalently bonded molecules; noble gases are monatomic

The Periodic Table: Metals, Nonmetals, and Metalloids

- Group VIA nonmetals
 - O, S, Se
- Group VIIA nonmetals
 - halogens
 - F, Cl, Br, I, At
- Group 0 nonmetals
 - noble, inert or rare gases
 - He, Ne, Ar, Kr, Xe, Rn

TABLE 4-3 *Some Physical Properties of Metals and Nonmetals*

Metals	Nonmetals
<ol style="list-style-type: none">1. High electrical conductivity that decreases with increasing temperature2. High thermal conductivity3. Metallic gray or silver luster*4. Almost all are solids[†]5. Malleable (can be hammered into sheets)6. Ductile (can be drawn into wires)	<ol style="list-style-type: none">1. Poor electrical conductivity (except carbon in the form of graphite)2. Good heat insulators (except carbon in the form of diamond)3. No metallic luster4. Solids, liquids, or gases5. Brittle in solid state6. Nonductile

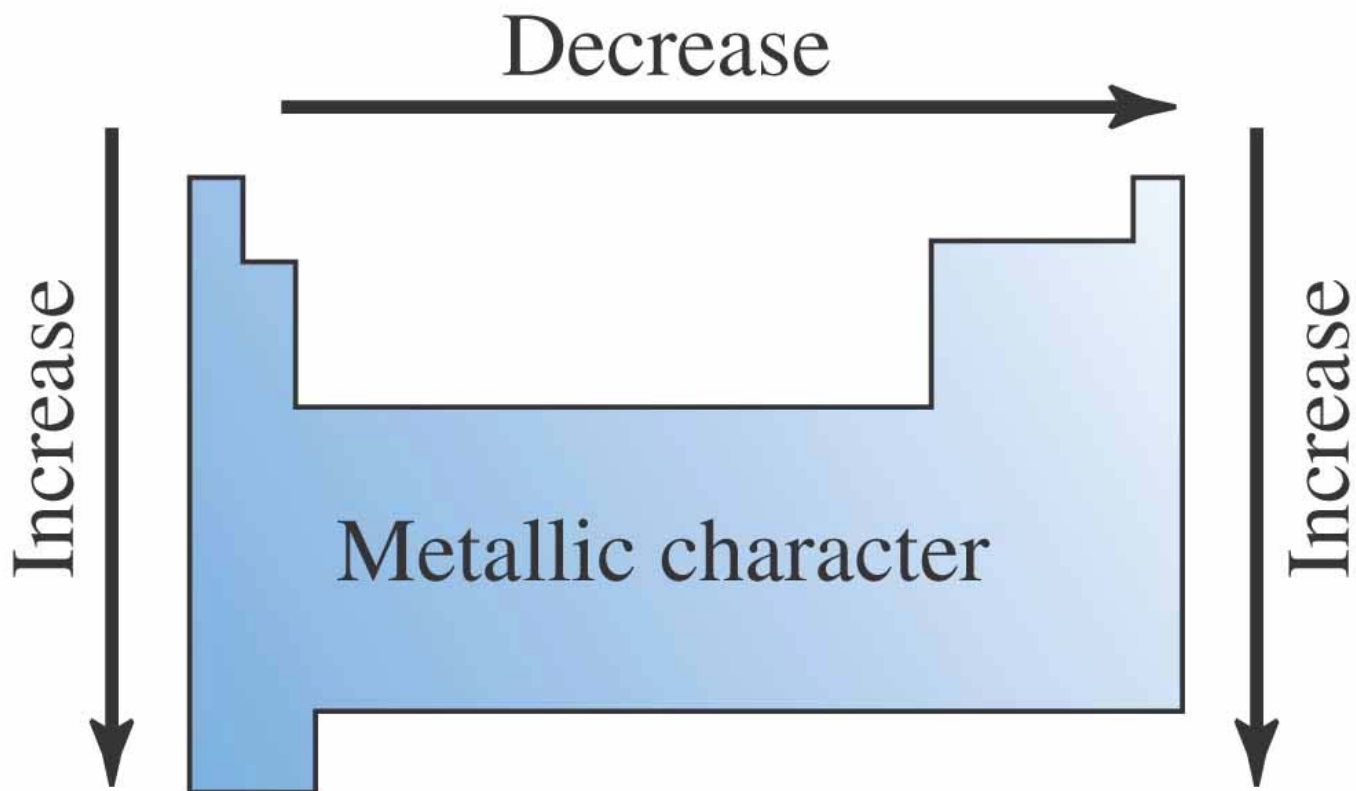
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TABLE 4-4 *Some Chemical Properties of Metals and Nonmetals*

Metals	Nonmetals
<ol style="list-style-type: none">1. Outer shells contain few electrons—usually three or fewer2. Form cations (positive ions) by losing electrons3. Form ionic compounds with nonmetals4. Solid state characterized by metallic bonding	<ol style="list-style-type: none">1. Outer shells contain four or more electrons*2. Form anions (negative ions) by gaining electrons[†]3. Form ionic compounds with metals[†] and molecular (covalent) other compounds with nonmetals4. Covalently bonded molecules; noble gases are monatomic

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Periodic trends in metallic character



Aqueous Solutions: An Introduction

Electrolytes

- Classification of solutes:
 - Nonelectrolytes – do not conduct electricity in water. The reason nonelectrolytes do not conduct electricity is because they do not form ions in solution. C_2H_5OH .
 - Strong electrolytes - conduct electricity extremely well in dilute aqueous solutions. HCl , HNO_3 , $NaOH$, KOH , $NaCl$, KBr etc.
 - Weak electrolytes - conduct electricity poorly in dilute aqueous solutions. CH_3COOH .

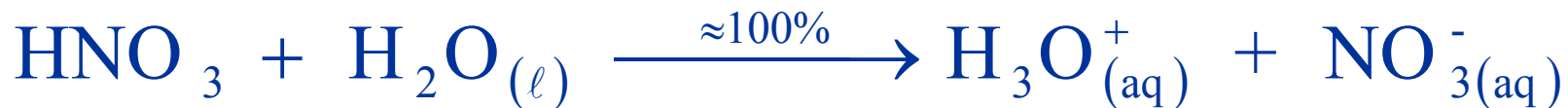
(a) (b) (c)

H_2O molecule Sugar molecule Hydrogen ion, H^+ Acetic acid molecule, CH_3COOH Acetate ion, CH_3COO^- Potassium ion, K^+ Chromate ion, CrO_4^{2-}

Aqueous Solutions: An Introduction

1. Strong Acids

- Acids are substances that generate H^+ in aqueous solutions. HCl , HBr , HI , HNO_3 , H_2SO_4 .
- Strong acids ionize 100% in water.



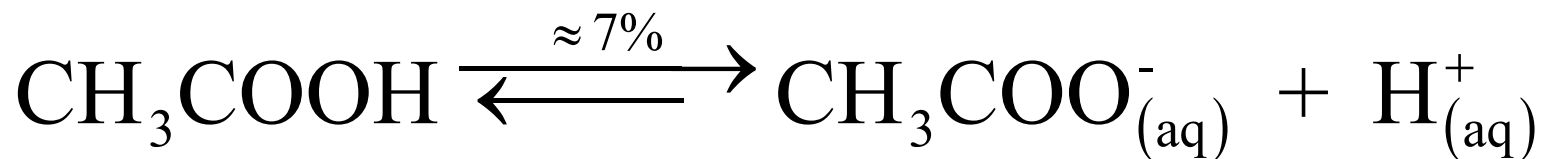
or



Aqueous Solutions: An Introduction

2. Weak acids

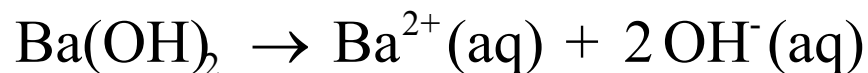
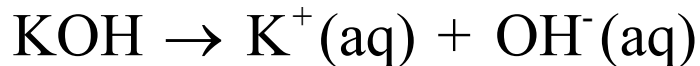
- ionize significantly less than 100% in water.
- HF, CH₃COOH, HCN, H₂CO₃, H₂SO₃, H₃PO₄.
 - Typically ionize 10% or less!



Aqueous Solutions: An Introduction

3. Strong Bases

- Characteristic of common inorganic bases is that they produce OH⁻ ions in solution. LiOH, NaOH, KOH, RbOH, CsOH, Ca(OH)₂, Sr(OH)₂, Ba(OH)₂



Aqueous Solutions: An Introduction

4. Insoluble or sparingly soluble bases

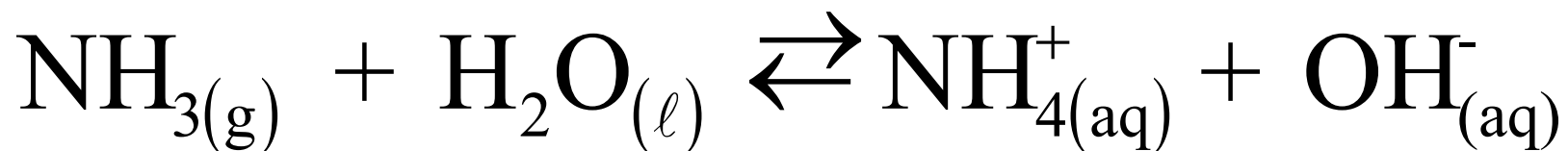
- Ionic compounds that are insoluble in water, consequently, not very basic.



Aqueous Solutions: An Introduction

5. Weak bases

- are covalent compounds that ionize slightly in water.
- Ammonia is most common weak base
 - NH_3



Chemistry is fun!