Pearson

Chapter Summary and Review

Key Learning Outcomes

CHAPTER OBJECTIVES	ASSESSMENT
Write Molecular and Empirical Formulas (4.3)	• Example 4.1 For Practice 4.1 Exercises 31, 32, 33, 34, 35, 36
Use Lewis Symbols to Predict the Chemical Formula of an Ionic Compound (4.5)	• Example 4.2 For Practice 4.2 Exercises 43, 44
Write Formulas for Ionic Compounds (4.6)	• Examples 4.3, 4.4 For Practice 4.3, 4.4 Exercises 47, 48, 49, 50
Name Ionic Compounds (4.6)	• Examples 4.5, 4.6 For Practice 4.5, 4.6 For More Practice 4.5, 4.6 Exercises 51, 52, 53, 54
Name Ionic Compounds Containing Polyatomic Ions (4.6)	• Example 4.7 For Practice 4.7 For More Practice 4.7 Exercises 55, 56
Name Molecular Compounds (4.8)	• Example 4.8 For Practice 4.8 For More Practice 4.8 Exercises 63, 64, 65, 66
Calculate Formula Mass (4.9)	• Example 4.9 For Practice 4.9 Exercises 71, 72
Use Formula Mass to Count Molecules by Weighing (4.9)	• Example 4.10 For Practice 4.10 For More Practice 4.10 Exercises 77, 78, 79, 80
Calculate Mass Percent Composition (4.10)	• Example 4.11 For Practice 4.11 For More Practice 4.11 Exercises 83, 84, 85, 86
Use Mass Percent Composition as a Conversion Factor (4.10)	• Example 4.12 For Practice 4.12 For More Practice 4.12 Exercises 87, 88, 89, 90
Use Chemical Formulas as Conversion Factors (4.10)	• Example 4.13 For Practice 4.13 For More Practice 4.13 Exercises 93, 94, 95, 96
Obtain an Empirical Formula from Experimental Data (4.11)	• Examples 4.14, 4.15 For Practice 4.14, 4.15 Exercises 97, 98, 99, 100, 101, 102, 103, 104

Calculate a Molecular Formula from an Empirical Formula and Molar Mass (4.11)	• Example 4.16 For Practice 4.16 For More Practice 4.16 Exercises 105, 106
Determine an Empirical Formula from Combustion Analysis (4.11)	• Examples 4.17, 4.18 For Practice 4.17, 4.18 Exercises 107, 108, 109, 110

Key Terms

Section 4.2

chemical bond
ionic bond
ionic compound
covalent bond
molecular compound

Section 4.3

chemical formula
empirical formula
molecular formula
structural formula
ball-and-stick molecular model
space-filling molecular model

Section 4.4

Lewis model
Lewis electron-dot structure (Lewis structure)
Lewis symbol
octet
duet
octet rule

Section 4.5

formula unit
lattice energy

Section 4.6

common name
systematic name
binary compound
polyatomic ion
oxyanion
hydrate

Section 4.7

bonding pair
lone pair (nonbonding electrons)
double bond
triple bond

Section 4.9

formula mass

Section 4.10

mass percent composition (mass percent)

Section 4.11

empirical formula molar mass
combustion analysis

Section 4.12

organic compound
hydrocarbon

Key Concepts

Types of Chemical Bonds (4.2)

- Chemical bonds, the forces that hold atoms together in compounds, arise from the interactions between nuclei and electrons in atoms.
- In an ionic bond, one or more electrons are *transferred* from one atom to another, forming a cation (positively charged) and an anion (negatively charged). The two ions are drawn together by the attraction between the opposite charges.
- In a covalent bond, one or more electrons are *shared* between two atoms. The atoms are held together by the attraction between their nuclei and the shared electrons.

Representing Molecules and Compounds (4.3)

- A compound is represented with a chemical formula, which indicates the elements present and the number of atoms of each.
- An empirical formula gives only the *relative* number of atoms, while a molecular formula gives the *actual* number of atoms present in the molecule.
- Structural formulas show how the atoms are bonded together, while molecular models portray the geometry of the molecule.

The Lewis Model (4.4)

- In the Lewis model, chemical bonds form when atoms transfer (ionic bonding) or share (covalent bonding) valence electrons to attain noble gas electron configurations.
- The Lewis model represents valence electrons as dots surrounding the symbol for an element. When two or more elements bond together, the dots are transferred or shared so that every atom gets eight dots, an octet (or two dots, a duet, in the case of hydrogen).

Ionic Bonding (4.5)

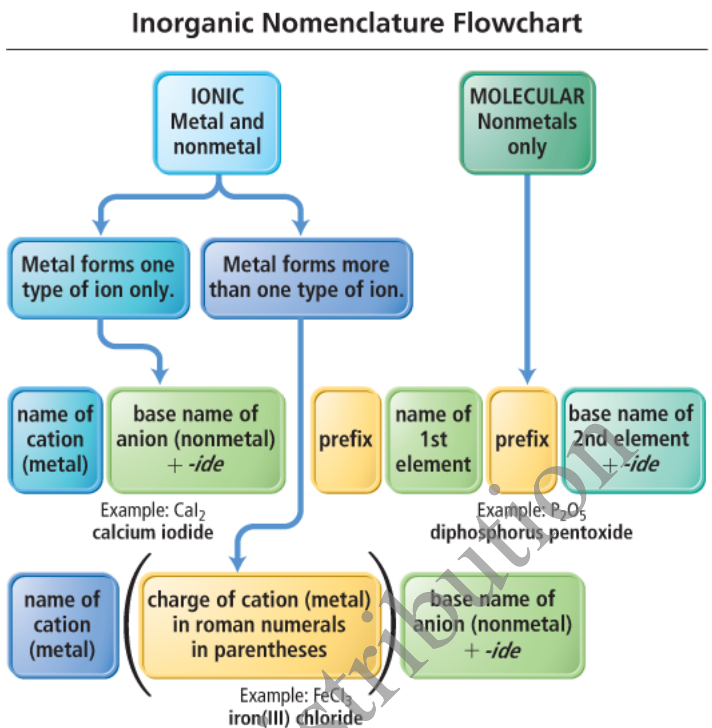
- In an ionic Lewis structure involving main-group metals, the metal transfers its valence electrons (dots) to the nonmetal.
- The formation of most ionic compounds is exothermic because of lattice energy, which is the energy released when metal cations and nonmetal anions coalesce to form a solid.

Covalent Bonding (4.7)

- In a covalent Lewis structure, neighboring atoms share valence electrons to attain octets (or duets).
- A single shared electron pair constitutes a single bond, while two or three shared pairs constitute double or triple bonds, respectively.

Naming Inorganic Ionic and Molecular Compounds (4.6, 4.8)

- A flowchart for naming simple inorganic compounds follows.



Formula Mass and Mole Concept for Compounds (4.9)

- The formula mass of a compound is the sum of the atomic masses of all the atoms in the chemical formula. Like the atomic masses of elements, the formula mass characterizes the average mass of a molecule (or a formula unit).
- The mass of one mole of a compound is its molar mass and equals its formula mass (in grams).

Chemical Composition (4.10, 4.11)

- The mass percent composition of a compound indicates each element's percentage of the total compound's mass. We can determine the mass percent composition from the compound's chemical formula and the molar masses of its elements.
- The chemical formula of a compound provides the relative number of atoms (or moles) of each element in a compound, and therefore we can use it to determine numerical relationships between moles of the compound and moles of its constituent elements.
- If we know the mass percent composition and molar mass of a compound, we can determine the compound's empirical and molecular formulas.

Organic Compounds (4.12)

- Organic compounds are composed of carbon, hydrogen, and a few other elements such as nitrogen, oxygen, and sulfur.
- The simplest organic compounds are hydrocarbons, compounds composed of only carbon and hydrogen.

Key Equations and Relationships

Formula Mass (4.9)

$$\left(\frac{\text{\# atoms of 1st element}}{\text{in chemical formula}} \times \frac{\text{atomic mass}}{\text{of 1st element}}\right) + \left(\frac{\text{\# atoms of 2nd element}}{\text{in chemical formula}} \times \frac{\text{atomic mass}}{\text{of 2nd element}}\right) + \ldots$$

Mass Percent Composition (4.10)

$$\text{mass \% of element X} = \frac{\text{mass of X in 1 mol compound}}{\text{mass of 1 mol compound}} \times 100\%$$

Empirical Formula Molar Mass (4.11)

$$\text{molecular formula} = n \times (\text{empirical formula})$$

$$n = \frac{\text{molar mass}}{\text{empirical formula molar mass}}$$