This chapter introduced some of the fundamental concepts of chemistry, with particular attention to the basic properties of atoms and elements. These entities are the building blocks of all substances we encounter, yet most common substances do not consist of only pure elements or individual atoms. Instead, nearly all substances are chemical compounds or mixtures of chemical compounds. Although there are only about 115 elements (of which about 86 occur naturally), millions of chemical compounds are known, with a tremendous range of physical and chemical properties. Consequently, a major emphasis of modern chemistry focuses on understanding the relationship between the structures and properties of chemical compounds.

### 2.1: The Atomic Theory of Matter

- **Dalton’s atomic theory of matter:**
  1. Each element is composed of extremely small particles called atoms
  2. All atoms of a given element are identical; the atoms of different elements are different and have different properties
  3. Atoms of an element are not changed into different types of atoms by chemical reactions
  4. Compounds are formed when atoms of more than one element combine
- explains the law of constant composition, law of conservation of mass

### 2.2: The Discovery of Atomic Structure

- subatomic particles – what atoms are composed of
- Like charges repel each other; unlike charges attract

**Cathode Rays and Electrons**

- cathode rays – radiation resulting from a high voltage
- cause certain materials to give off light (fluoresce)
- mass of an electron $9.10939 \times 10^{-28} g$
- 2000 times smaller than hydrogen

**1.2.2 Radioactivity**

- radioactivity – spontaneous emission of radiation
- three types of radiation: alpha ($\alpha$), beta ($\beta$), gamma ($\gamma$)
- alpha and beta radiation are affected by an electric field
- beta particles have a charge of 1-
- alpha particles have a charge of 2+
- gamma radiation has no particles and no charge

**1.2.3 The Nuclear Atom**
• Rutherford determined that there was a nucleus in every atom
• Protons discovered by Rutherford in 1919
• Neutrons discovered by James Chadwich in 1932

2.3: The Modern View of Atomic Structure

• charge of an electron is $-1.602 \times 10^{-19}$
• charge of a proton is $+1.602 \times 10^{-19}$
• $1.602 \times 10^{-19}$ is called to electronic charge

<table>
<thead>
<tr>
<th>Particle</th>
<th>Charge</th>
<th>Mass (amu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>Positive</td>
<td>1.0073</td>
</tr>
<tr>
<td>Neutron</td>
<td>None</td>
<td>1.0087</td>
</tr>
<tr>
<td>Electron</td>
<td>Negative</td>
<td>5.486 $\times 10^{-4}$</td>
</tr>
</tbody>
</table>

• atomic mass unit (amu) – equals $1.66054 \times 10^{-24}$ grams
• angstrom (Å) – unit of length to measure atomic dimensions
  • 1 angstrom $= 10^{-10}$ m
• atoms have diameters of 1-5 Å
• nucleus – diameter of $10^{-4}$ Å

2.4: Atomic Mass

• all atoms of an element have the same number of protons in the nucleus
• isotopes - atoms of the same element that have a different number of neutrons
• atomic number – the number of protons in an atom
• mass number – number of protons + number of neutrons
• nuclide – atom of a specific isotope

2.5: The Periodic Table

• periodic table – the arrangement of all the elements by atomic number and similarities into a table
• columns = groups
• metallic elements – all elements on the left side and in the middle of the periodic table
• nonmetallic elements – elements on the periodic table that are divided by a diagonal steplike line from boron to astatine
• metalloids – properties of metals and nonmetals

2.6: Molecules and Molecular Compounds

• molecule – two or more atoms bonded together

1. Molecules and Chemical Formulas

• ◦ chemical formula – way of representing molecules
  ◦ diatomic molecule – any molecule made up of two atoms
  ◦ molecular compounds – contains more than one type of atom

1. Molecular and Empirical Formulas

• ◦ molecular formulas – chemical formulas that indication the actual number of atoms
  ◦ empirical formula – chemical formulas that only give the relative number of atoms

1. 1. 1. Picturing Molecules

• ◦ structural formulas – shows which atoms are attached to other atoms
  ◦ perspective drawing – gives an idea of the three-dimensional shape of a molecule
  ◦ ball-and-stick models – shows atoms as balls bonded by sticks
2.7: Ions and Ionic Compounds

- ion – charged particle formed by the removal or addition of an electron
- cation – ion with a positive charge
- anion – ion with a negative charge
- metal atoms tend to lose electrons
- nonmetal atoms tend to gain electrons
- polyatomic ions – joined atoms that have a net positive or negative charge

1. Predicting Ionic Charges

- alkalie metals form 1+ ions
  - alkaline earth from 2+ ions
  - halogens form 1- ions
  - group 6A from 2- ions

1. Ionic Compounds

- ionic compound – a compound that contains positively and negatively charged ions
- ionic compounds are generally combinations of metals and nonmetals
- molecular compounds are generally nonmetals only

2.8: Naming Inorganic Compounds

- chemical nomenclature – the naming of substances
- over 10 million known chemical substances
- organic compounds – contain carbon
- inorganic compounds – everything else

- positive ions
  a. cations formed from atoms have the same name as the metal
  b. if a metal can form cations of differing charges, the positive charge is given by a roman numeral in parentheses following the name of the metal
     c. cations formed from nonmetal atoms have names that end in –ium
Negative Ions

- monatomic anions have names formed by dropping the ending of the name of the element and adding the ending –ide
- polyatomic anions containing oxygen have names ending in –ate or –ite
  ▶ called oxyanions

a. anions derived by adding $\text{H}^+$ to an oxyanion are named by adding as a prefix the word hydrogen or dihydrogen, as appropriate

1. Ionic compounds

a. names of ionic compounds are the cation name followed by the anion name

1. 1. Names and formulas of Acids

1. 1. acids based on anions whose names end in –ide have associated acids that have the hydro- prefix and an –ic ending
   2. acids based on anions whose names end in –ate or -ite

<table>
<thead>
<tr>
<th>Anion</th>
<th>Acid</th>
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<tbody>
<tr>
<td>_____ide</td>
<td>Hydro_____ic acid</td>
</tr>
<tr>
<td>_____ate</td>
<td>_____ic acid</td>
</tr>
<tr>
<td>_____ite</td>
<td>_____ous acid</td>
</tr>
</tbody>
</table>

1. Names and Formulas of Binary Molecular Compounds

- the name of the element farthest to the left in the periodic table is usually written first
- if elements in same group lower one written first
- name of second element is given an –ide ending
- greek prefixes used to indicate number of atoms of each element
- if prefix ends in a or o and the name of the anion begins with a vowel, the a or o is dropped

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>Mono-</td>
<td>1</td>
</tr>
<tr>
<td>Di-</td>
<td>2</td>
</tr>
<tr>
<td>Tri-</td>
<td>3</td>
</tr>
<tr>
<td>Tetra-</td>
<td>4</td>
</tr>
<tr>
<td>Penta-</td>
<td>5</td>
</tr>
<tr>
<td>Prefix</td>
<td>Meaning</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
</tr>
<tr>
<td>Hexa-</td>
<td>6</td>
</tr>
<tr>
<td>Hepta-</td>
<td>7</td>
</tr>
<tr>
<td>Octa-</td>
<td>8</td>
</tr>
<tr>
<td>Nona-</td>
<td>9</td>
</tr>
<tr>
<td>Deca-</td>
<td>10</td>
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</tbody>
</table>