Summary

6.1 Ionic Bonding

The chemical properties of elements depend on an element's electron configuration. When the highest occupied energy level of an atom is filled with electrons, the atom is stable and not likely to react.

The chemical properties of an element depend on the number of valence electrons. An electron dot diagram is a model of an atom in which each dot represents a valence electron.

Elements that do not have complete sets of valence electrons tend to react. Some elements achieve stable electron configurations through the transfer of electrons between atoms. Each atom ends up with a more stable arrangement than it had before the transfer.

When an atom gains or loses an electron, the number of protons is no longer equal to the number of electrons. The atom is not neutral. An atom that has a net positive or negative electric charge is called an ion. An ion with a negative charge is an anion. An ion with a positive charge is a cation.

When an anion and a cation are close together, a chemical bond forms between them. A chemical bond is the force that holds atoms or ions together as a unit. An ionic bond is the force that holds cations and anions together. An ionic bond forms when electrons are transferred from one atom to another.

Cations form when electrons gain enough energy to escape from atoms. The amount of energy used to remove an electron is called ionization energy.

Compounds that contain ionic bonds are ionic compounds. Ionic compounds can be represented by chemical formulas. A chemical formula shows what elements a compound contains and the ratio of the atoms or ions of those elements in the compound.

Solids whose particles are arranged in a lattice structure are called crystals. The shape of an ionic crystal depends on the arrangement of ions in its rigid framework, or lattice. Crystals are classified into groups based on their shape. The properties of an ionic compound can be explained by the strong attractions among ions within a crystal lattice.

6.2 Covalent Bonding

A covalent bond is a chemical bond in which two atoms share a pair of valence electrons. When two atoms share one pair of electrons, the bond is called a single bond.

A molecule is a neutral group of atoms that are joined together by one or more covalent bonds. The attractions between the shared electrons and the protons in each nucleus hold the atoms together in covalent bonds. A chemical formula can be used to describe the molecules of an element as well as a compound.

When two atoms share two pairs of electrons, the bond is called a double bond. When two atoms share three pairs of electrons, the bond is called a triple bond.

In a molecule of an element, the atoms that form covalent bonds have the same ability to attract an electron. In a molecule of a compound, electrons are not always shared equally. A covalent bond in which electrons are not shared equally is called a polar covalent bond. When atoms form a polar covalent bond, the atom with the greater attraction for electrons has a partial negative charge. The other atom has a partial positive charge.

If a molecule that contains a polar covalent bond has only two atoms, it will be polar. When a molecule has more than two atoms, it may be polar or nonpolar. The type of atoms in a molecule and the molecule's shape are factors that determine whether a molecule is polar or nonpolar.

In a molecular compound, forces of attraction hold molecules together in a liquid or solid. Attractions between polar molecules are stronger than attractions between nonpolar molecules. Attractions among nonpolar molecules are weaker than attractions among polar molecules.

6.3 Naming Compounds and Writing Formulas

The name of an ionic compound must distinguish the compound from other ionic compounds containing the same elements. The formula of an ionic compound describes the ratio of the ions in the compound.

A compound made from only two elements is a binary compound. The names of binary compounds—such as sodium chloride—have a predictable pattern: the name of the cation followed by the name of the anion. The name for the cation is the name of the metal without any change: sodium atom and sodium ion. The name for the anion uses part of the name of the nonmetal with the suffix *–ide*: chlorine atom and chloride ion.

The alkali metals, alkaline earth metals, and aluminum form ions with positive charges equal to the group number. For example, the symbol for a calcium ion is Ca^{2+}, and the symbol for an aluminum ion is Al^{3+}.

Many transition metals form more than one type of ion. When a metal forms more than one ion, the name of the ion contains a Roman numeral to indicate the charge — for example, a copper(II) ion.

A covalently bonded group of atoms that has a positive or negative charge and acts as a unit is a polyatomic ion. Most simple polyatomic ions are anions. Sometimes there are parentheses in a formula that includes polyatomic ions. For example,the formula for iron(III) hydroxide is $Fe(OH)_3$.

If you know the name of an ionic compound, you can write its formula. Place the symbol of the cation first, and follow that with the symbol of the anion. Use subscripts to show the ratio of the ions in the compound.

Molecular compounds have names that identify specific compounds and formulas that match those names. The name and formula of a molecular compound describe the type and number of atoms in a molecule of the compound.

The general rule in naming molecular compounds is that the most metallic element appears first. The name of the second element is changed to end in the suffix *–ide*, as in carbon dioxide.

When writing molecular formulas, write the symbols for the elements in the order the elements appear in the name. The prefixes indicate the number of atoms of each element in the molecule. The prefixes appear as subscripts in the formula.

6.4 The Structure of Metals

In a metal, valence electrons are free to move among the atoms. In effect, the metal atoms become cations surrounded by a pool of shared electrons. A metallic bond is the attraction between a metal cation and the shared electrons that surround it. The cations in a metal form a lattice that is held in place by strong metallic bonds between the cations and the surrounding valence electrons.

The mobility of electrons within a metal lattice explains some of the properties of metals. The ability to conduct an electric current is an important property of metals. An electric current can be carried through a metal by the free flow of the shared electrons. Another important property of metals is malleability. The lattice in a metal is flexible compared to the rigid lattice in an ionic compound.

An alloy is a mixture of two or more elements, at least one of which is a metal. Alloys have the characteristic properties of metals.

The first important alloy was bronze. In its simplest form, bronze contains only copper and tin. Both are relatively soft metals. Mixed together in bronze, the metals are much harder and stronger than either metal alone. Scientists can design alloys with specific properties by varying the types and amounts of elements in an alloy.

Steel is an alloy of iron that contains small quantities of carbon and other elements. The carbon atoms form bonds with neighboring iron atoms. These bonds make the lattice harder and stronger than a lattice that contains only iron. The properties of any particular type of steel depend on which elements other than iron and carbon are used and how much of those elements are included.