Chapter 18 Oxidation–Reduction Reactions and Electrochemistry

18.1 Electron Transfer Reactions

Key Terms

oxidation–reduction (redox) reactions
reduction
oxidation
oxidation states

Summary

Oxidation–reduction, or *redox, reactions* involve the transfer of one or more electrons. *Oxidation* is a loss of electrons, and *reduction* is a gain of electrons. Whenever a metal reacts with a nonmetal to form an ionic compound, electrons are transferred from the metal to the nonmetal. Many redox reactions, such as combustion reactions, involve only nonmetals.

Oxidation states are the charges of ions or atoms. Rules for assigning oxidation states are as follows:

1. The oxidation state of an atom in an uncombined element is 0.
2. The oxidation state of a monatomic ion is the same as its charge.
3. Oxygen is assigned an oxidation state of –2 in most of its covalent compounds.
4. In its covalent compounds with nonmetals, hydrogen is assigned an oxidation state of +1.
5. In binary compounds, the element with the greater electronegativity is assigned a negative oxidation state equal to its charge as an anion in its ionic compounds.
6. For an electrically neutral compound, the sum of the oxidation states must be 0.
7. For an ionic species, the sum of the oxidation states must equal the overall charge.

18.2 Balancing Oxidation–Reduction Reactions

Key Terms

oxidizing agent (electron acceptor)
reducing agent (electron donor)
half-reactions

Summary

Oxidation can be defined as an increase in oxidation state (a loss of electrons), and reduction can be defined as a decrease in oxidation state (a gain of electrons). The *electron acceptor* is the *oxidizing agent,* and the *electron donor* is the *reducing agent.*

Oxidation–reduction reactions that occur in aqueous solution are very complicated. As a result, they are difficult to balance using trial and error. Instead, we can balance them by separating them into two *half-reactions,* which are equations that have electrons as reactants or products. The half-reactions are balanced separately. First, the number of electrons gained and lost is equalized. Then the half-reactions are added together, and electrons are canceled to give the overall balanced equation. The key principle here is that the number of electrons lost (from the reactant that is oxidized) must equal the number of electrons gained (from the reactant that is reduced).

18.3 Electrochemistry and Its Applications

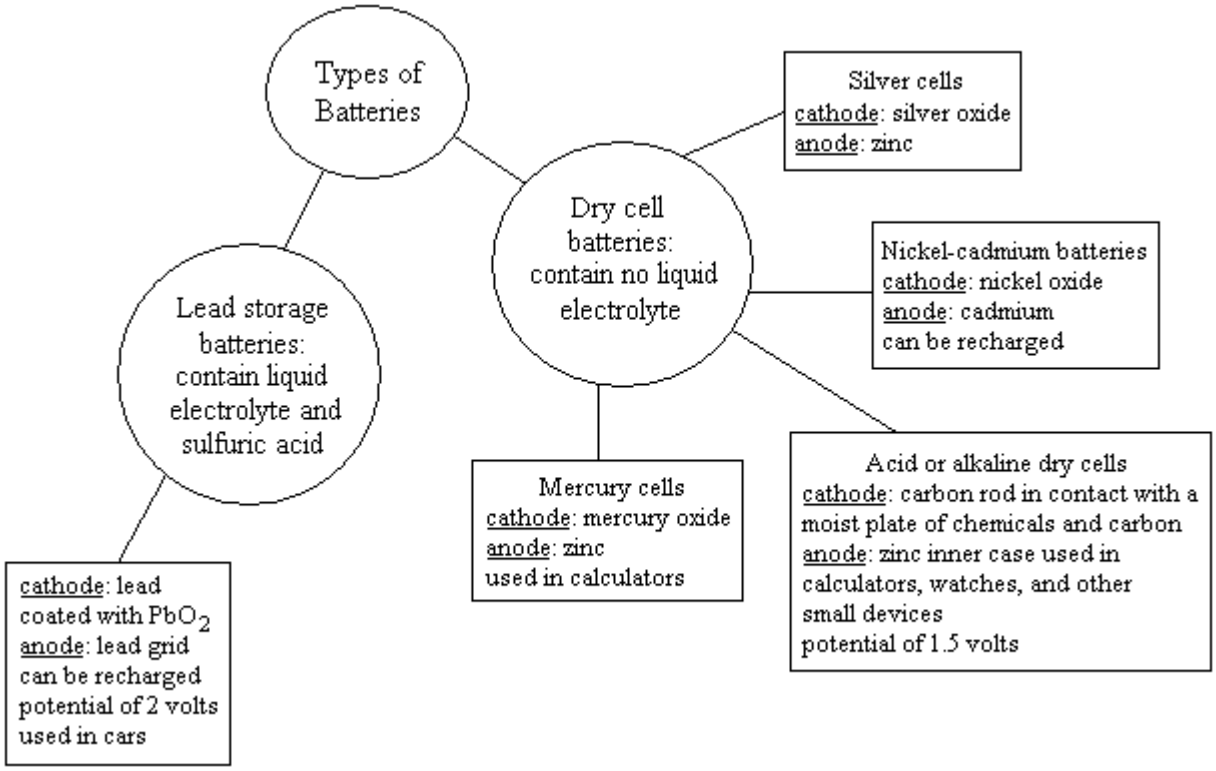
Key Terms

electrochemistry	electrochemical battery (galvanic cell)	anode
cathode	electrolysis	potential
lead storage batteries	dry cell batteries	corrosion
cathodic protection		

Summary

Electrochemistry is the study of the interchange of chemical and electrical energy. Electrochemistry involves two types of processes: the production of an electric current from an oxidation–reduction reaction and the use of an electric current to produce a chemical change. When an oxidation–reduction reaction occurs with the reactants in the same solution, the electrons are transferred directly, and no usable energy is produced. An *electrochemical battery,* or *galvanic cell,* is a device in which chemical energy is transformed into useful electrical energy. In a galvanic cell, the oxidizing and reducing agents are placed in separate compartments. The electrons flow through a wire that runs between them. This electron flow produces a current that can be used to power devices. Oxidation occurs at the *anode* of a cell. Reduction occurs at the *cathode.*

A battery is a galvanic cell, or group of cells, that serves as a source of electric current.



Corrosion involves the oxidation of metals and usually results in a loss of strength and attractiveness. As a result, people have developed various ways to prevent corrosion. Also, most metals develop a thin oxide coating that protects their internal atoms from further oxidation.

The process in which a current is forced through a cell to produce a chemical change that otherwise would not occur is called *electrolysis.* Water can be broken down into oxygen and hydrogen by means of electrolysis. Electrolysis also is used to separate useful metals from their ores.

Additional Active Reading Questions

1. What type of reactions involves the transfer of one or more electrons?

2. What are oxidation states?

3. What two types of processes does electrochemistry involve?

4. How is energy produced in a galvanic cell?

5. List three types of dry cell batteries.

6. Why is it important to prevent corrosion?

7. What is the name for the process in which a current is forced through a cell to produce a chemical change that would not occur otherwise?