

Chapter Learning Objectives

Chapter 1

1.1 Science Is a Way of Understanding the Natural World

Learning Objective: Describe the nature of science and the scientific method.

1.2 The Discovery of the Buckyball

Learning Objective: Provide an example of the scientific method in action.

1.3 Technology Is Applied Science

Learning Objective: Relate technology to the furthering of science and vice versa.

1.4 We Are Still Learning about the Natural World

Learning Objective: Distinguish between scientific facts, hypotheses, laws, and theories.

1.5 Chemistry Is Integral to Our Lives

Learning Objective: Describe chemistry as a central science with an emphasis in applied research.

1.6 Scientists Measure Physical Quantities

Learning Objective: Convert the units of a known physical quantity.

Chapter 2

2.1 The Submicroscopic World Is Super-Small

Learning Objective: Describe the particulate nature of matter.

2.2 Discovering the Atom

Learning Objective: Describe the evidence for the particulate nature of matter.

2.3 Mass Is How Much and Volume Is How Spacious

Learning Objective: Distinguish between mass, weight, and volume.

2.4 Density Is the Ratio of Mass to Volume

Learning Objective: Calculate the density of a material.

2.5 Energy Is the Mover of Matter

Learning Objective: Differentiate between potential and kinetic energy.

2.6 Temperature Is a Measure of How Hot—Heat It Is Not

Learning Objective: Distinguish between heat and temperature.

2.7 The Phase of a Material Depends on the Motion of Its Particles

Learning Objective: Describe the particulate nature of three phases of matter.

2.8 Gas Laws Describe the Behavior of Gases

Learning Objective: Describe how the volume of a gas is affected by pressure, temperature, and number of particles.

Chapter 3

3.1 Matter Has Physical and Chemical Properties

Learning Objective: Describe how materials can be identified by their physical and chemical properties.

3.2 Elements Are Made of Atoms

Learning Objective: Recognize the elements of the periodic table as the fundamental building blocks of matter.

3.3 The Periodic Table Helps Us to Understand the Elements

Learning Objective: Identify how elements are organized in the periodic table.

3.4 Elements Can Combine to Form Compounds

Learning Objective: Contrast compounds with the elements from which they are created.

3.5 There Is A System for Naming Compounds Learning Objective: List three guidelines used to name compounds.

3.6 Most Materials Are Mixtures

Learning Objective: Recognize mixtures and show how they can be separated by physical means.

3.7 Matter Can Be Classified as Pure or Impure

Learning Objective: Classify the states of matter under the categories of pure and impure.

3.8 The Advent of Nanotechnology

Learning Objective: Show how nanotechnology is a novel and promising application of chemistry.

Chapter 4

4.1 Physical and Conceptual Models

Learning Objective: Distinguish between models that describe physical attributes and those that describe the behavior of a system.

4.2 The Electron Was the First Subatomic Particle Discovered

Learning Objective: Identify experiments leading to the discovery of the electron.

4.3 The Mass of an Atom Is Concentrated in its Nucleus

Learning Objective: Defend Rutherford's conclusion that each atom contains a densely packed positively charged center.

4.4 The Atomic Nucleus Is Made of Protons and Neutrons

Learning Objective: Describe the structure of the atomic nucleus and how the atomic mass of an element is calculated.

4.5. Light Is a Form of Energy

Learning Objective: Describe the nature and range of electromagnetic waves.

4.6 Atomic Spectra and the Quantum Hypothesis

Learning Objective: Recount how the quantum nature of energy led to Bohr's planetary model of the atom.

4.7 Electrons Exhibit Wave Properties

Learning Objective: Summarize how electrons, when confined to an atom, behave as self-reinforcing wave-like entities.

4.8 The Shell Model Helps to Explain the Periodic Table

Learning Objective: Show how atomic orbitals of similar energy can be grouped into a series of shells that can be used to explain the periodic table.

4.9. The Periodic Table Helps Us Predict Properties of Elements

Learning Objective: Use the shell model to explain periodic trends.

Chapter 5

5.1 Radioactivity—The Disintegration of the Atomic Nucleus

Learning Objective: Identify three forms of radioactivity and their effects on living tissue.

5.2 Radioactivity Is a Natural Phenomenon

Learning Objective: Identify the natural sources, the units, and the applications of radioactivity.

5.3 Radioactivity Results from an Imbalance of Forces

Learning Objective: Describe how the strong nuclear force acts to hold nucleons together in the atomic nucleus.

5.4 Radioactive Elements Transmute to Different Elements

Learning Objective: Name the isotope that results from a series of alpha and beta decays.

5.5 The Shorter the Half-Life, the Greater the Radioactivity

Learning Objective: Recognize how a radioactive element can be identified by the rate at which it decays.

5.6 Isotopic Dating Measures the Ages of Materials

Learning Objective: Review how the age of ancient artifacts can be determined by measuring the amounts of remaining radioactivity they contain.

5.7 Nuclear Fission—The Splitting of Atomic Nuclei

Learning Objective: Describe the process by which large atomic nuclei can split in half leading to the production of energy.

5.8 The Mass-Energy Relationship: $E=MC^2$

Learning Objective: Show how the mass of a nucleon depends upon the identity of the nucleus within which it is contained.

5.9 Nuclear Fusion—The Combining of Atomic Nuclei

Learning Objective: Describe the process by which small nuclei can join together leading to the production of energy, such as occurs in the Sun.

Chapter 6

6.1 Electron-Dot Structures

Learning Objective: Identify paired and unpaired electrons within an electron-dot structure.

6.2 Atoms Can Lose or Gain Electrons to Become Ions

Learning Objective: Use the periodic table to predict the type of ion an atom tends to form.

6.3 Ionic Bonds Result from a Transfer of Electrons

Learning Objective: Describe how ions combine to form ionic compounds.

6.4 The Electrons of Metallic Bonds Are Loosely Held

Learning Objective: Relate the properties of a metal to how the atoms of that metal are chemically bonded.

6.5 Covalent Bonds Result from a Sharing of Electrons

Learning Objective: Describe how atoms combine to form covalent compounds.

6.6 Valence Electrons Determine Molecular Shape

Learning Objective: Predict the shape of a small molecule using the valence-shell electron-pair repulsion model.

6.7 Polar Covalent Bonds—Uneven Sharing of Electrons

Learning Objective: Differentiate between ionic, polar covalent, and nonpolar covalent chemical bonds.

6.8 Molecular Polarity—Uneven Distribution of Electrons

Learning Objective: Recognize the important role that molecular interactions play in determining the physical properties of a material.

Chapter 7

7.1 Four Different Types of Dipole Attractions

Learning Objective: Identify four different types of dipole attractions and their role in determining the physical properties of a material.

7.2 A Solution Is a Single-Phase Homogeneous Mixture

Learning Objective: Describe the formation of saturated and unsaturated solutions from a molecular point of view.

7.3 Concentration Is Given as Moles per Liter

Learning Objective: Describe the components of a solution and calculate a solution's concentration.

7.4 Solubility Is How Well a Solute Dissolves

Learning Objective: Discuss how solutes dissolve in solvents and how solubility changes with temperature.

7.5 Soaps Work by Being Both Polar and Nonpolar

Learning Objective: Describe the mechanism by which soaps and detergents clean and how this mechanism is foiled by hard water.

7.6 Softening Hard Water

Learning Objective: Describe how dissolved ions can be removed from hard water.

7.7 Purifying the Water We Drink

Learning Objective: Identify the industrial means by which water is purified.

Chapter 8

8.1 Water Molecules Form an Open Crystalline Structure in Ice

Learning Objective: Relate the physical properties of ice to its crystalline structure.

8.2 Freezing and Melting Go On at the Same Time

Learning Objective: Identify the molecular processes involved in the freezing and melting of water, the impact of a solute on these processes, and why water is most dense at 4°C.

8.3 Liquid Water's Behavior Results from the Stickiness of Its Molecules

Learning Objective: Describe how cohesive and adhesive forces within water give rise to surface tension and capillary action.

8.4 Water Molecules Move Freely Between the Liquid and Gaseous Phases

Learning Objective: Show, on a molecular level, how evaporation and condensation lead to cooling and warming effects, respectively, and how they relate to the process of boiling.

8.5 It Takes a Lot of Energy to Change the Temperature of Liquid Water

Learning Objective: Describe how the formation and breaking of hydrogen bonds are responsible for water's high specific heat and relate this to global climate.

8.6 A Phase Change Requires the Input or Output of Energy.

Learning Objective: Identify the molecular processes that occur as a substance, such as water, changes phase and how this necessarily involves the input or output of energy.

Chapter 9

9.1 Chemical Reactions Are Represented by Chemical Equations

Learning Objective: Identify whether a chemical equation is balanced or not balanced.

9.2 Counting Atoms and Molecules by Mass

Learning Objective: Correlate the formula mass of a substance with the number of molecules or atoms that substance contains.

9.3 Converting Between Grams and Moles

Learning Objective: Use the concept of moles to calculate the mass of reactants needed to produce a given mass of products.

9.4 Chemical Reactions Can Be Exothermic or Endothermic

Learning Objective: Calculate the amount of energy released or absorbed by a chemical reaction using the bond energies of reactants and products.

9.5 Chemical Reactions Are Driven by Entropy

Learning Objective: Recognize that all chemical reactions are driven by the tendency of energy to disperse.

9.6 Chemical Reactions Can Be Slow or Fast

Learning Objective: Describe the requirements that must be met in order for a chemical reaction to occur.

9.7 Catalysts Speed Up the Destruction of Stratospheric Ozone

Learning Objective: Discuss how a catalyst can speed up a chemical reaction using the destruction of stratospheric ozone as an example.

Chapter 10

10.1 Acids Donate Protons and Bases Accept Them

Learning Objective: Identify when a chemical behaves as an acid or a base.

10.2 Some Acids and Bases Are Stronger Than Others

Learning Objective: Describe how the strength of an acid or base affects the number of ions in solution.

10.3 Solutions Can Be Acidic, Basic, or Neutral

Learning Objective: Calculate the pH of a solution given the hydronium ion concentration.

10.4 Buffer Solutions Resist Changes in pH

Learning Objective: Describe the chemical nature of a buffer solution and how it resists changes in pH.

10.5 Rainwater Is Acidic

Learning Objective: Identify sources of acidity in rainwater and how this acidity can impact the environment.

10.6 Carbon Dioxide Acidifies the Oceans

Learning Objective: Describe the impact atmospheric carbon dioxide has on the ocean's pH and mineral composition.

Chapter 11

11.1 Losing and Gaining Electrons

Learning Objective: Identify when a chemical undergoes oxidation or reduction.

11.2 Harnessing the Energy of Flowing Electrons

Learning Objective: Show how electricity can be generated using materials that tend to lose or gain electrons.

11.3 Batteries Consume Chemicals to Generate Electricity

Learning Objective: Describe how oxidation and reduction occur within a device that generates electricity.

11.4 Fuel Cells Consume Fuel to Generate Electricity

Learning Objective: Identify how a fuel cell generates electricity.

11.5 Photovoltaics Transform Light into Electricity

Learning Objective: Describe the nature of n-type and p-type silicon and how they can be used to create a photovoltaic cell.

11.6 Electrolysis Produces Chemical Change

Learning Objective: Describe examples of electrolysis as an application of oxidation/reduction reactions.

11.7 Metal Compounds Can Be Converted to Metals

Learning Objective: Review the oxidation-reduction chemistry involved in the creation of common metals.

11.8 Oxygen Is Responsible for Corrosion and Combustion

Learning Objective: Compare and contrast the processes of corrosion and combustion.

Chapter 12

12.1 Hydrocarbons Contain Only Carbon and Hydrogen

Learning Objective: Identify the structures of hydrocarbons.

12.2 Unsaturated Hydrocarbons Have Multiple Bonds

Learning Objective: Identify the structures of unsaturated hydrocarbons.

12.3 Functional Groups Give Organic Compounds Character

Learning Objective: Discuss the significance of heteroatoms in organic compounds.

12.4 Alcohols, Phenols, and Ethers Contain Oxygen

Learning Objective: Review the general properties of alcohols, phenols, and ethers.

12.5 Amines and Alkaloids Contain Nitrogen

Learning Objective: Review the general properties of amines and alkaloids.

12.6 Carbonyl Containing Compounds

Learning Objective: Review the general properties of carbonyl compounds.

12.7 An Example of Organic Synthesis

Learning Objective: Summarize the retro-synthetic strategy used to plan the synthesis of a complex organic molecule.

12.8 Organic Molecules Can Link to Form Polymers

Learning Objective: Describe how polymers are synthesized from monomers.

12.9 A Brief History of Plastics

Learning Objective: Recount the history of the development of plastics starting from the early 1900s.

Chapter 13

13.1 Biomolecules Are Produced and Utilized in Cells

Learning Objective: Identify the basic components of a cell and the four major classes of biomolecules.

13.2 Carbohydrates Give Structure and Energy

Learning Objective: Recognize the molecular structures of simple and complex carbohydrates.

13.3 Lipids Are Insoluble in Water

Learning Objective: Compare and contrast the properties of fats and steroids.

13.4 Proteins Are Polymers of Amino Acids

Learning Objective: Classify the structure of a protein based on the organization of its amino acids and describe how enzymes work.

13.5 Nucleic Acids Code for Proteins

Learning Objective: Identify nucleic acids as polymers of nucleotides and describe how they code for the building of proteins.

13.6 Vitamins Are Organic, Minerals Are Inorganic

Learning Objective: Distinguish vitamins from minerals and the roles they play in our nutrition.

13.7 Metabolism Is the Cycling of Biomolecules Through the Body

Learning Objective: Classify metabolic reactions as either catabolic or anabolic.

13.8 The Food Pyramid Summarizes a Healthful Diet

Learning Objective: Describe how the body utilizes carbohydrates, fats, and proteins.

Chapter 14

14.1 Medicines Are Drugs That Benefit the Body

Learning Objective: Classify drugs by their origin and describe the synergistic effect.

14.2 The Lock-and-Key Model Guides the Synthesis of New Medicines

Learning Objective: Describe the lock and key model and how it is used in the development of new medicines.

14.3 Chemotherapy Cures the Host by Killing the Disease

Learning Objective: Describe how chemotherapy protects us from bacterial and viral infections as well as cancer.

14.4 The Nervous System Is a Network of Neurons

Learning Objective: Summarize how a nerve impulse travels along a neuron and across the synapse to an

adjacent neuron using neurotransmitters.

14.5 Psychoactive Drugs Alter the Mind or Behavior

Learning Objective: Describe how stimulants, hallucinogens, and depressants work and the problems that occur with the abuse of these chemicals.

14.6 Pain Relievers Inhibit the Transmission or Perception of Pain

Learning Objective: Compare and contrast how anesthetics, analgesics, and endorphins act to alleviate pain.

14.7 Medicines for the Heart

Learning Objective: Describe how statins, vasodilators, beta-blockers, and calcium channel blockers help to protect the heart.

Chapter 15

15.1 Humans Eat at All Trophic Levels

Learning Objective: Describe the flow of energy and nutrients between trophic levels.

15.2 Plants Require Nutrients

Learning Objective: Distinguish between the macro- and micronutrients needed by plants.

15.3 Soil Fertility Is Determined by Soil Structure and Nutrient Retention

Learning Objective: Identify what makes for healthy soil.

15.4 Natural and Synthetic Fertilizers Help Restore Soil Fertility

Learning Objective: Describe the origins of straight and mixed fertilizers.

15.5 Pesticides Kill Insects, Weeds, and Fungi

Learning Objective: Describe the benefits and risks of insecticides, herbicides, and fungicides.

15.6 There Is Much to Learn from Past Agricultural Practices

Learning Objective: Provide examples of poor agricultural practices.

15.7 High Agricultural Yields Can Be Sustained with Proper Practices

Learning Objective: Provide examples of sustainable agricultural practices.

Chapter 16

16.1 Water On the Move

Learning Objective: Describe how water circulates through the hydrologic cycle.

16.2 Collectively, We Consume Huge Amounts of Water

Learning Objective: Review water consumption trends in the United States.

16.3 Human Activities Can Pollute Water

Learning Objective: Identify sources of water pollution and explain the significance of biochemical oxygen demand.

16.4 Wastewater Treatment

Learning Objective: Identify the four stages of wastewater treatment

16.5 The Earth's Atmosphere Is a Mixture of Gases

Learning Objective: Describe the formation and composition of Earth's atmosphere.

16.6 Human Activities Have Increased Air Pollution

Learning Objective: Differentiate aerosols from particulates and industrial smog from photochemical smog.

16.7 Carbon Dioxide Helps Keep the Earth Warm

Learning Objective: Describe the greenhouse effect and potential environmental impacts of increased levels of atmospheric carbon dioxide.

Chapter 17

17.1 Electricity Is a Convenient Form of Energy

Learning Objective: Provide a brief overview of how electricity is generated and distributed and how its consumption is measured.

17.2 Fossil Fuels Are a Widely Used but Limited Energy Source

Learning Objective: Describe the chemical nature of fossil fuels and their advantages and disadvantages.

17.3 Issues of the Nuclear Industry

Learning Objective: Describe the benefits and hazards of nuclear energy as generated by nuclear fission.

17.4 What Are Sustainable Energy Sources?

Learning Objective: Describe the ideal sustainable energy source.

17.5 Water Can Be Used to Generate Electricity

Learning Objective: Identify three energy sources that allow water to be used to generate electricity.

17.6 Biomass Is Chemical Energy

Learning Objective: Review how biomass can be used to create fuel or electricity.

17.7 Energy Can Be Harnessed from Sunlight

Learning Objective: Provide examples of how direct sunlight can be used as a source of useful energy.

17.8 Solar Energy Can Be Stored as Hydrogen

Learning Objective: Describe the prospects of hydrogen as a carrier of energy.