The Learning System

To achieve the goals stated, this text includes a variety of features that should make your study of *Integrated Science* more effective and enjoyable. These aids are included to help you clearly understand the concepts and principles that serve as the foundation of the integrated sciences.

Overview to Integrated Science

Chapter 1 provides an overview or orientation to integrated science in general, and this text in particular. It also describes the fundamental methods and techniques used by scientists to study and understand the world around us.

Multidisciplinary Approach

Chapter Outlines

The chapter outline includes all the major topic headings and subheadings within the body of the chapter. It gives you a quick glimpse of the chapter's contents and helps you locate sections dealing with particular topics.

Core Concept Map

NEW! The concept map identifies a core idea for the chapter and shows how the topics in the chapter are related to this core idea. It also outlines that idea's relationship to other science disciplines throughout the text. The core concept map, combined with the chapter outline and overview, help you to see the big picture of the chapter content and the even bigger picture of how that content relates to other science discipline areas.

Chapter Overviews

Each chapter begins with an introductory overview. The overview previews the chapter's contents and what you can expect to learn from reading the chapter. It adds to the general outline of the chapter by introducing you to the concepts to be covered. It also expands upon the core concept map, facilitating in the integration of topics. Finally, the overview will help you to stay focused and organized while reading the chapter for the first time. After reading this introduction, browse through the chapter, paying particular attention to the topic headings and illustrations so that you get a feel for the kinds of ideas included within the chapter.

Applying Science to the Real World

Concepts Applied

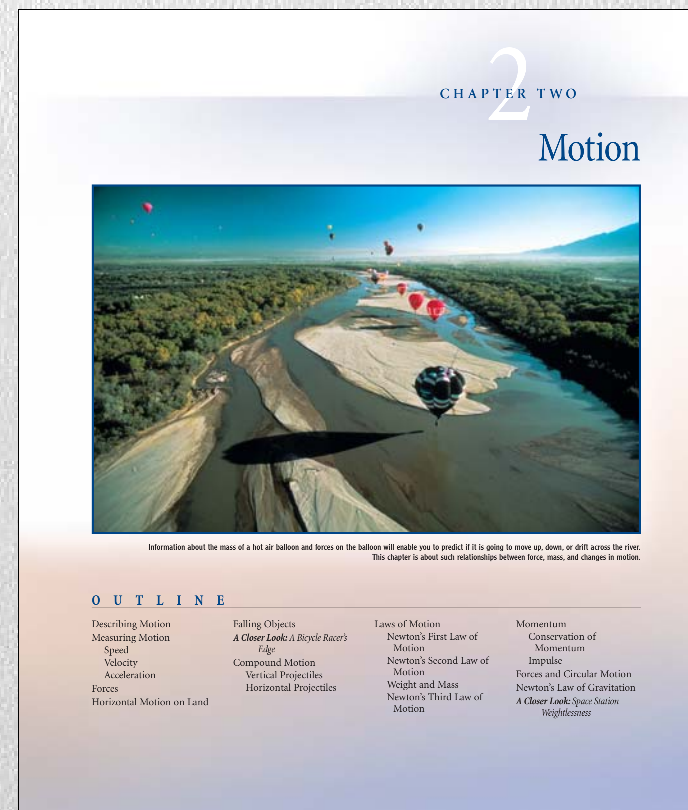
As you look through each chapter, you will find one or more Concepts Applied boxes. These activities are simple exercises that you can perform at home or in the classroom to demonstrate important concepts and reinforce your understanding of them. This feature also describes the application of those concepts to your everyday life.

Science and Society

NEW! These readings relate the chapter's content to current societal issues. Many of these boxes also include Questions to Discuss that provide an opportunity to discuss issues with your peers.

Myths, Mistakes, and Misunderstandings

NEW! These brief boxes provide short, scientific explanations to dispel a societal myth or a home experiment or project that



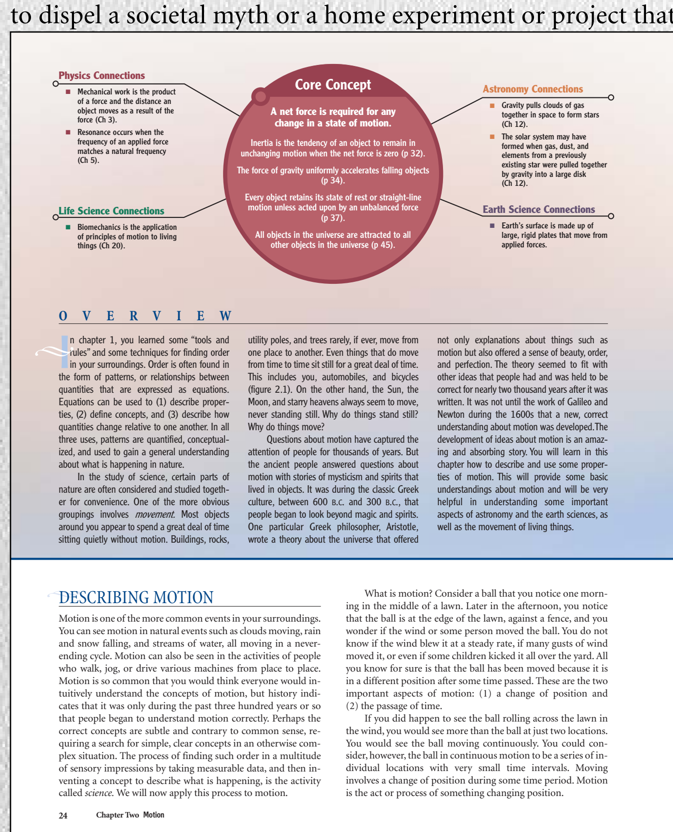
CHAPTER TWO 2

Motion

Information about the mass of a hot air balloon and forces on the balloon will enable you to predict if it is going to move up, down, or drift across the river. This chapter is about such relationships between force, mass, and changes in motion.

OUTLINE

Describing Motion
Measuring Motion
  Speed
  Velocity
  Acceleration
Forces
Horizontal Motion on Land
Falling Objects
***A Closer Look:** A Bicycle Racer's Edge*
Compound Motion
  Vertical Projectiles
  Horizontal Projectiles
Laws of Motion
  Newton's First Law of Motion
  Newton's Second Law of Motion
  Weight and Mass
  Newton's Third Law of Motion
Momentum
  Conservation of Momentum
  Impulse
Forces and Circular Motion
Newton's Law of Gravitation
***A Closer Look:** Space Station Weightlessness*



Physics Connections
- Mechanical work is the product of a force and the distance an object moves as a result of the force (Ch 3).
- Resonance occurs when the frequency of an applied force matches a natural frequency (Ch 5).

Core Concept

A net force is required for any change in a state of motion.

Inertia is the tendency of an object to remain in unchanging motion when the net force is zero (p 32).

The force of gravity uniformly accelerates falling objects (p 34).

Every object retains its state of rest or straight-line motion unless acted upon by an unbalanced force (p 37).

All objects in the universe are attracted to all other objects in the universe (p 45).

Astronomy Connections
- Gravity pulls clouds of gas together in space to form stars (Ch 12).
- The solar system may have formed when gas, dust, and elements from a previously existing star were pulled together by gravity into a large disk (Ch 12).

Life Science Connections
- Biomechanics is the application of principles of motion to living things (Ch 20).

Earth Science Connections
- Earth's surface is made up of large, rigid plates that move from applied forces.

OVERVIEW

In chapter 1, you learned some "tools and rules" and some techniques for finding order in your surroundings. Order is often found in the form of patterns, or relationships between quantities that are expressed as equations. Equations can be used to (1) describe properties, (2) define concepts, and (3) describe how quantities change relative to one another. In all three uses, patterns are quantified, conceptualized, and used to gain a general understanding about what is happening in nature.

In the study of science, certain parts of nature are often considered and studied together for convenience. One of the more obvious groupings involves *movement.* Most objects around you appear to spend a great deal of time sitting quietly without motion. Buildings, rocks, utility poles, and trees rarely, if ever, move from one place to another. Even things that do move from time to time sit still for a great deal of time. This includes you, automobiles, and bicycles (figure 2.1). On the other hand, the Sun, the Moon, and starry heavens always seem to move, never standing still. Why do things stand still? Why do things move?

Questions about motion have captured the attention of people for thousands of years. But the ancient people answered questions about motion with stories of mysticism and spirits that lived in objects. It was during the classic Greek culture, between 600 B.C. and 300 B.C., that people began to look beyond magic and spirits. One particular Greek philosopher, Aristotle, wrote a theory about the universe that offered not only explanations about things such as motion but also offered a sense of beauty, order, and perfection. The theory seemed to fit with other ideas that people had and was held to be correct for nearly two thousand years after it was written. It was not until the work of Galileo and Newton during the 1600s that a new, correct understanding about motion was developed. The development of ideas about motion is an amazing and absorbing story. You will learn in this chapter how to describe and use some properties of motion. This will provide some basic understandings about motion and will be very helpful in understanding some important aspects of astronomy and the earth sciences, as well as the movement of living things.

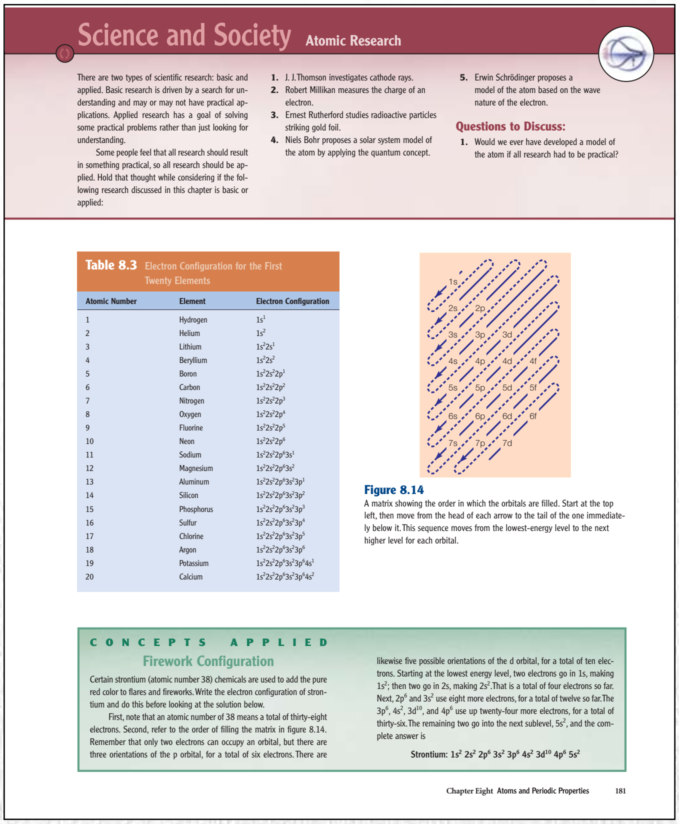
DESCRIBING MOTION

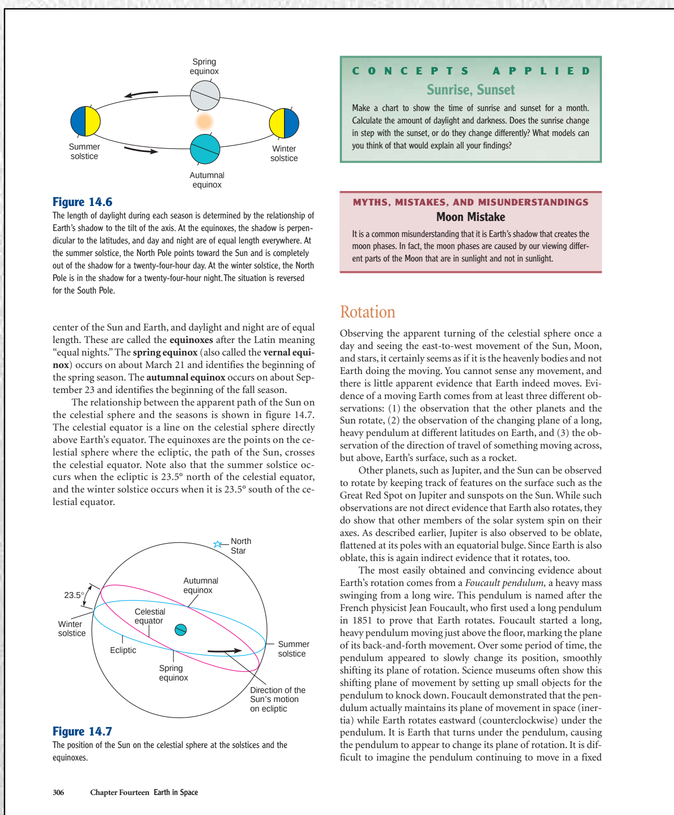
Motion is one of the more common events in your surroundings. You can see motion in natural events such as clouds moving, rain and snow falling, and streams of water, all moving in a never-ending cycle. Motion can also be seen in the activities of people who walk, jog, or drive various machines from place to place. Motion is so common that you would think everyone would intuitively understand the concepts of motion, but history indicates that it was only during the past three hundred years or so that people began to understand motion correctly. Perhaps the correct concepts are subtle and contrary to common sense, requiring a search for simple, clear concepts in an otherwise complex situation. The process of finding such order in a multitude of sensory impressions by taking measurable data, and then inventing a concept to describe what is happening, is the activity called *science.* We will now apply this process to motion.

What is motion? Consider a ball that you notice one morning in the middle of a lawn. Later in the afternoon, you notice that the ball is at the edge of the lawn, against a fence, and you wonder if the wind or some person moved the ball. You do not know if the wind blew it at a steady rate, if many gusts of wind moved it, or even if some children kicked it all over the yard. All you know for sure is that the ball has been moved because it is in a different position after some time passed. These are the two important aspects of motion: (1) a change of position and (2) the passage of time.

If you did happen to see the ball rolling across the lawn in the wind, you would see more than the ball at just two locations. You would see the ball moving continuously. You could consider, however, the ball in continuous motion to be a series of individual locations with very small time intervals. Moving involves a change of position during some time period. Motion is the act or process of something changing position.

24 Chapter Two Motion





enables you to dispel the myth on your own.

Closer Look and Connections

Each chapter of *Integrated Science* also includes one or more **Closer Look** readings that discuss topics of special human or environmental concern, topics concerning interesting technological applications, or topics on the cutting edge of scientific research. These readings enhance the learning experience by taking a more detailed look at related topics and adding concrete examples to help you better appreciate the real-world applications of science.

In addition to the **Closer Look** readings, each chapter contains concrete interdisciplinary **Connections** that are highlighted. **Connections** will help you better appreciate the interdisciplinary nature of the sciences. The **Closer Look** and **Connections** readings are informative materials that are supplementary in nature. These boxed features highlight valuable information beyond the scope of the text and relate intrinsic concepts discussed to real-world issues, underscoring the relevance of integrated science in confronting the many issues we face in our day-to-day lives. They are identified with the following icons:

> *"A Closer Look: The Compact Disc was, again, an excellent application of optics to everyday life and to something modern students thrive on—CDs and DVDs."*
>
> —Treasure Brasher, West Texas A&M University

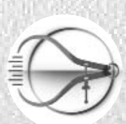
> *"Connections—wonderful!!!. . . .great addition. . . . A Closer Look . . . excellent. Clear, interesting, good figures. You have presented crucial information in a straightforward and uncompromising way."*
>
> —Megan M. Hoffman, Berea College

General: This icon identifies interdisciplinary topics that cross over several categories; for example, life sciences and technology.

Life: This icon identifies interdisciplinary life science topics, meaning connections concerning all living organisms collectively: plant life, animal life, marine life, and any other classification of life.

Technology: This icon identifies interdisciplinary technology topics, that is, connections concerned with the application of science for the comfort and well being of people, especially through industrial and commercial means.

Measurement, Thinking, Scientific Methods: This icon identifies interdisciplinary concepts and understandings concerned with people trying to make sense out of their surroundings by making observations, measuring, thinking, developing explanations for what is observed, and experimenting to test those explanations.



Environmental Science: This icon identifies interdisciplinary concepts and understandings about the problems caused by human use of the natural world and remedies for those problems.

End-of-Chapter Features

At the end of each chapter you will find the following materials:

- *Summary:* highlights the key elements of the chapter
- *Summary of Equations* (chapters 1–9, 11): highlights the key equations to reinforce your retention of them
- *Key Terms:* page-referenced where you will find the terms defined in context
- *Applying the Concepts:* a multiple choice quiz to test your comprehension of the material covered
- *Questions for Thought:* designed to challenge you to demonstrate your understandings of the topic
- *Parallel Exercises* (chapters 1–9, 11): There are two groups of parallel exercises, Group A and Group B. The Group A parallel exercises have complete solutions worked out, along with useful comments in appendix D. The Group B parallel exercises are

SUMMARY

Stars are theoretically born in clouds of hydrogen gas and dust in the space between other stars. Gravity pulls huge masses of hydrogen gas together into a *protostar,* a mass of gases that will become a star. The protostar contracts, becoming increasingly hotter at the center, eventually reaching a temperature high enough to start *nuclear fusion* reactions between hydrogen atoms. Pressure from hot gases balances the gravitational contraction, and the average newborn star will shine quietly for billions of years. The average star has a dense, hot *core* where nuclear fusion releases radiation, a less dense *radiation zone* where radiation moves outward, and a thin *convection zone* that is heated by the radiation at the bottom, then moves to the surface to emit light to space.

The brightness of a star is related to the amount of energy and light it is producing, the size of the star, and the distance to the star. The *apparent magnitude* is the brightness of a star as it appears to you. To compensate for differences in brightness due to distance, astronomers calculate the brightness that stars would have at a standard distance. This standard-distance brightness is called the *absolute magnitude.*

Stars appear to have different colors because they have different surface temperatures. A graph of temperature by spectral types and brightness by absolute magnitude is called the *Hertzsprung-Russell diagram,* or H-R diagram for short. Such a graph shows that normal, mature stars fall on a narrow band called the *main sequence* of stars. Where a star falls on the main sequence is determined by its brightness and temperature, which in turn are determined by the mass of the star. Other groups of stars on the H-R diagram have different sets of properties that are determined by where they are in their evolution.

The life of a star consists of several stages, the longest of which is the *main sequence* stage after a relatively short time as a *protostar.* After using up the hydrogen in the core, a star with an average mass expands to a *red giant,* then blows off the outer shell to become a *white dwarf star,* which slowly cools to a black lump of carbon. The blown-off outer shell forms a *planetary nebula,* which disperses over time to become the gas and dust of interstellar space. More massive stars collapse into *neutron stars* or *black holes* after a violent *supernova* explosion.

Galaxies are the basic units of the universe. The Milky Way galaxy has three distinct parts: (1) the *galactic nucleus,* (2) a rotating *galactic disk,* and (3) a *galactic halo.* The galactic disk contains subgroups of stars that move together as *galactic clusters.* The halo contains symmetrical and tightly packed clusters of millions of stars called *globular clusters.*

All the billions of galaxies can be classified into groups of four structures: *elliptical, spiral, barred,* and *irregular.* Evidence from four different astronomical and physical "clocks" indicates that the galaxies formed some 13.7 billion years ago, expanding ever since from a common origin in a *big bang.* The *big bang theory* describes how the universe began by expanding.

KEY TERMS

absolute magnitude (p. **261**)
apparent magnitude (p. **260**)
big bang theory (p. **269**)
black hole (p. **266**)
Cepheid variable (p. **263**)
convection zone (p. **260**)
core (p. **260**)
dark energy (p. **270**)
dark matter (p. **271**)
galactic clusters (p. **267**)
galaxy (p. **266**)
globular clusters (p. **267**)
Hertzsprung-Russell diagram (p. **262**)
light-year (p. **259**)
main sequence stars (p. **262**)
nebulae (p. **259**)
neutron star (p. **265**)
protostar (p. **259**)
pulsar (p. **266**)
radiation zone (p. **260**)
red giant stars (p. **262**)
supernova (p. **265**)
white dwarf stars (p. **263**)

APPLYING THE CONCEPTS

1. Stars twinkle and planets do not twinkle because
a. planets shine by reflected light, and stars produce their own light.
b. all stars are pulsing light sources.
c. stars appear as point sources of light, and planets are disk sources.
d. All of the above are correct.
2. Which of the following stars would have the longer life spans?
a. the less massive
b. between the more massive and the less massive
c. the more massive
d. All have the same life span.
3. A bright blue star on the main sequence is probably
a. very massive.
b. less massive.
c. between the more massive and the less massive.
d. None of the above is correct.
4. The basic property of a main sequence star that determines most of its other properties, including its location on the H-R diagram, is
a. brightness.
b. color.
c. temperature.
d. mass.
5. All the elements that are more massive than the element iron were formed in a
a. nova.
b. white dwarf.
c. supernova.
d. black hole.

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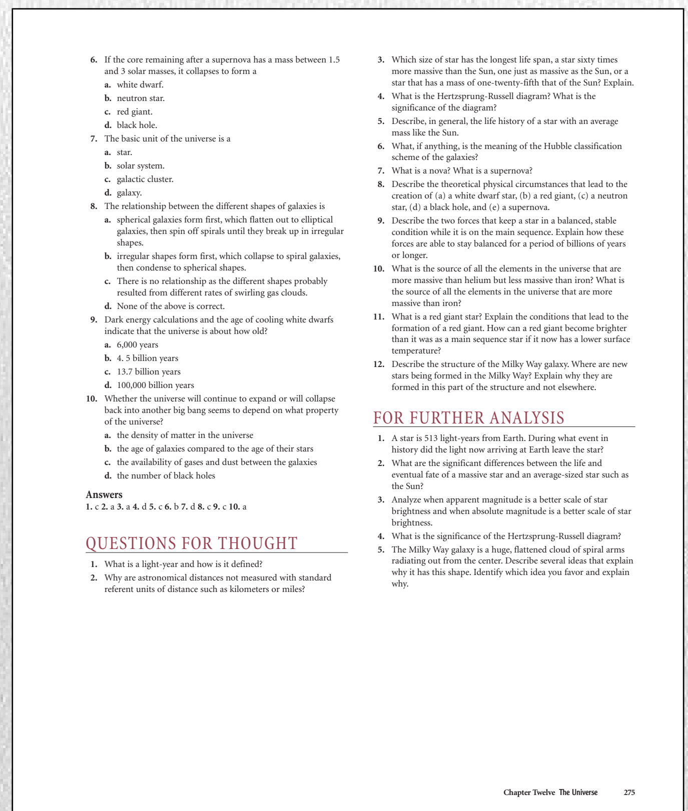

6. If the core remaining after a supernova has a mass between 1.5 and 3 solar masses, it collapses to form a
a. white dwarf.
b. neutron star.
c. red giant.
d. black hole.
7. The basic unit of the universe is a
a. star.
b. solar system.
c. galactic cluster.
d. galaxy.
8. The relationship between the different shapes of galaxies is
a. spherical galaxies form first, which flatten out to elliptical galaxies, then spin off spirals until they break up in irregular shapes.
b. irregular shapes form first, which collapse to spiral galaxies, then condense to spherical shapes.
c. There is no relationship as the different shapes probably resulted from different rates of swirling gas clouds.
d. None of the above is correct.
9. Dark energy calculations and the age of cooling white dwarfs indicate that the universe is about how old?
a. 6,000 years
b. 4. 5 billion years
c. 13.7 billion years
d. 100,000 billion years
10. Whether the universe will continue to expand or will collapse back into another big bang seems to depend on what property of the universe?
a. the density of matter in the universe
b. the age of galaxies compared to the age of their stars
c. the availability of gases and dust between the galaxies
d. the number of black holes

Answers
1. c **2.** a **3.** a **4.** d **5.** c **6.** b **7.** d **8.** c **9.** c **10.** a

QUESTIONS FOR THOUGHT

1. What is a light-year and how is it defined?
2. Why are astronomical distances not measured with standard referent units of distance such as kilometers or miles?
3. Which size of star has the longest life span, a star sixty times more massive than the Sun, one just as massive as the Sun, or a star that has a mass of one-twenty-fifth that of the Sun? Explain.
4. What is the Hertzsprung-Russell diagram? What is the significance of the diagram?
5. Describe, in general, the life history of a star with an average mass like the Sun.
6. What, if anything, is the meaning of the Hubble classification scheme of the galaxies?
7. What is a nova? What is a supernova?
8. Describe the theoretical physical circumstances that lead to the creation of (a) a white dwarf star, (b) a red giant, (c) a neutron star, (d) a black hole, and (e) a supernova.
9. Describe the two forces that keep a star in a balanced, stable condition while it is on the main sequence. Explain how these forces are able to stay balanced for a period of billions of years or longer.
10. What is the source of all the elements in the universe that are more massive than helium but less massive than iron? What is the source of all the elements in the universe that are more massive than iron?
11. What is a red giant star? Explain the conditions that lead to the formation of a red giant. How can a red giant become brighter than it was as a main sequence star if it now has a lower surface temperature?
12. Describe the structure of the Milky Way galaxy. Where are new stars being formed in the Milky Way? Explain why they are formed in this part of the structure and not elsewhere.

FOR FURTHER ANALYSIS

1. A star is 513 light-years from Earth. During what event in history did the light now arriving at Earth leave the star?
2. What are the significant differences between the life and eventual fate of a massive star and an average-sized star such as the Sun?
3. Analyze when apparent magnitude is a better scale of star brightness and when absolute magnitude is a better scale of star brightness.
4. What is the significance of the Hertzsprung-Russell diagram?
5. The Milky Way galaxy is a huge, flattened cloud of spiral arms radiating out from the center. Describe several ideas that explain why it has this shape. Identify which idea you favor and explain why.

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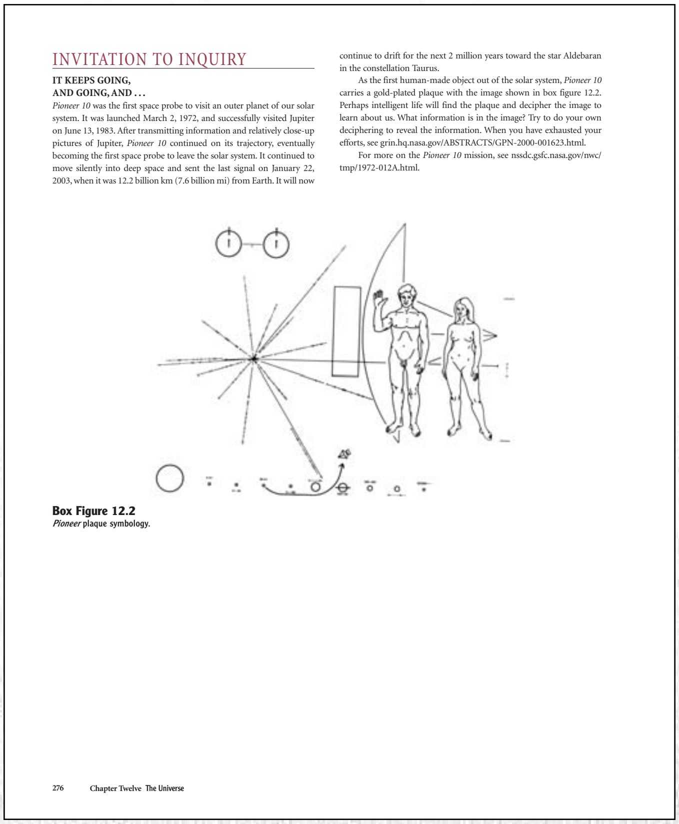
- **NEW!** *For Further Analysis:* exercises include analysis or discussion questions, independent investigations, and activities intended to emphasize critical thinking skills and societal issues, and develop a deeper understanding of the chapter content.

- **NEW!** *Invitation to Inquiry:* exercises that consist of short, open-



INVITATION TO INQUIRY

IT KEEPS GOING, AND GOING, AND . . .

Pioneer 10 was the first space probe to visit an outer planet of our solar system. It was launched March 2, 1972, and successfully visited Jupiter on June 13, 1983. After transmitting information and relatively close-up pictures of Jupiter, *Pioneer 10* continued on its trajectory, eventually becoming the first space probe to leave the solar system. It continued to move silently into deep space and sent the last signal on January 22, 2003, when it was 12.2 billion km (7.6 billion mi) from Earth. It will now continue to drift for the next 2 million years toward the star Aldebaran in the constellation Taurus.

As the first human-made object out of the solar system, *Pioneer 10* carries a gold-plated plaque with the image shown in box figure 12.2. Perhaps intelligent life will find the plaque and decipher the image to learn about us. What information is in the image? Try to do your own deciphering to reveal the information. When you have exhausted your efforts, see grin.hq.nasa.gov/ABSTRACTS/GPN-2000-001623.html.

For more on the *Pioneer 10* mission, see nssdc.gsfc.nasa.gov/nwc/tmp/1972-012A.html.

Box Figure 12.2
Pioneer **plaque symbology.**

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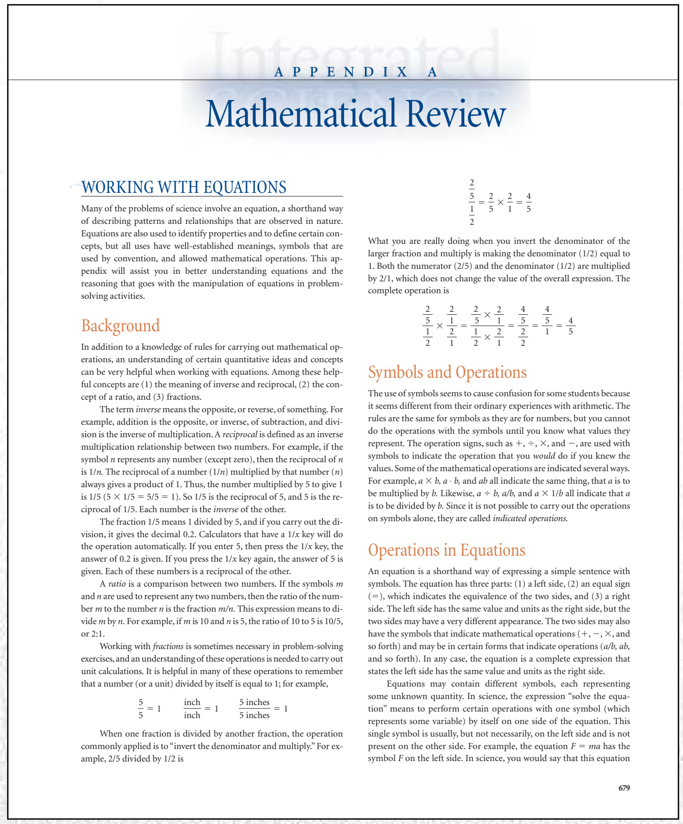

APPENDIX A

Mathematical Review

WORKING WITH EQUATIONS

Many of the problems of science involve an equation, a shorthand way of describing patterns and relationships that are observed in nature. Equations are also used to identify properties and to define certain concepts, but all uses have well-established meanings, symbols that are used by convention, and allowed mathematical operations. This appendix will assist you in better understanding equations and the reasoning that goes with the manipulation of equations in problem-solving activities.

Background

In addition to a knowledge of rules for carrying out mathematical operations, an understanding of certain quantitative ideas and concepts can be very helpful when working with equations. Among these helpful concepts are (1) the meaning of inverse and reciprocal, (2) the concept of a ratio, and (3) fractions.

The term *inverse* means the opposite, or reverse, of something. For example, addition is the opposite, or inverse, of subtraction, and division is the inverse of multiplication. A *reciprocal* is defined as an inverse multiplication relationship between two numbers. For example, if the symbol n represents any number (except zero), then the reciprocal of n is $1/n$. The reciprocal of a number ($1/n$) multiplied by that number (n) always gives a product of 1. Thus, the number multiplied by 5 to give 1 is 1/5 ($5 \times 1/5 = 5/5 = 1$). So 1/5 is the reciprocal of 5, and 5 is the reciprocal of 1/5. Each number is the *inverse* of the other.

The fraction 1/5 means 1 divided by 5, and if you carry out the division, it gives the decimal 0.2. Calculators that have a $1/x$ key will do the operation automatically. If you enter 5, then press the $1/x$ key, the answer of 0.2 is given. If you press the $1/x$ key again, the answer of 5 is given. Each of these numbers is a reciprocal of the other.

A *ratio* is a comparison between two numbers. If the symbols m and n are used to represent any two numbers, then the ratio of the number m to the number n is the fraction m/n. This expression means to divide m by n. For example, if m is 10 and n is 5, the ratio of 10 to 5 is 10/5, or 2:1.

Working with *fractions* is sometimes necessary in problem-solving exercises, and an understanding of these operations is needed to carry out unit calculations. It is helpful in many of these operations to remember that a number (or a unit) divided by itself is equal to 1; for example,

$$\frac{5}{5} = 1 \qquad \frac{\text{inch}}{\text{inch}} = 1 \qquad \frac{5\ \text{inches}}{5\ \text{inches}} = 1$$

When one fraction is divided by another fraction, the operation commonly applied is to "invert the denominator and multiply." For example, 2/5 divided by 1/2 is

$$\frac{\frac{2}{5}}{\frac{1}{2}} = \frac{2}{5} \times \frac{2}{1} = \frac{4}{5}$$

What you are really doing when you invert the denominator of the larger fraction and multiply is making the denominator (1/2) equal to 1. Both the numerator (2/5) and the denominator (1/2) are multiplied by 2/1, which does not change the value of the overall expression. The complete operation is

$$\frac{\frac{2}{5}}{\frac{1}{2}} \times \frac{\frac{2}{1}}{\frac{2}{1}} = \frac{\frac{2}{5} \times \frac{2}{1}}{\frac{1}{2} \times \frac{2}{1}} = \frac{\frac{4}{5}}{\frac{2}{2}} = \frac{\frac{4}{5}}{1} = \frac{4}{5}$$

Symbols and Operations

The use of symbols seems to cause confusion for some students because it seems different from their ordinary experiences with arithmetic. The rules are the same for symbols as they are for numbers, but you cannot do the operations with the symbols until you know what values they represent. The operation signs, such as $+$, $\div$, $\times$, and $-$, are used with symbols to indicate the operation that you *would* do if you knew the values. Some of the mathematical operations are indicated several ways. For example, $a \times b$, $a \cdot b$, and ab all indicate the same thing, that a is to be multiplied by b. Likewise, $a \div b$, a/b, and $a \times 1/b$ all indicate that a is to be divided by b. Since it is not possible to carry out the operations on symbols alone, they are called *indicated operations.*

Operations in Equations

An equation is a shorthand way of expressing a simple sentence with symbols. The equation has three parts: (1) a left side, (2) an equal sign (=), which indicates the equivalence of the two sides, and (3) a right side. The left side has the same value and units as the right side, but the two sides may have a very different appearance. The two sides may also have the symbols that indicate mathematical operations ($+$, $-$, $\times$, and so forth) and may be in certain forms that indicate operations (a/b, ab, and so forth). In any case, the equation is a complete expression that states the left side has the same value and units as the right side.

Equations may contain different symbols, each representing some unknown quantity. In science, the expression "solve the equation" means to perform certain operations with one symbol (which represents some variable) by itself on one side of the equation. This single symbol is usually, but not necessarily, on the left side and is not present on the other side. For example, the equation $F = ma$ has the symbol F on the left side. In science, you would say that this equation

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ended activities that allow you to apply investigative skills to the material in the chapter.

> *"I look for summaries that touch on all the high points and that lead students to recognize the most important aspects of the chapter. Any exercises should take the material that the students have learned and require applying that material to a new situation. . . . I also appreciate having a number of objective-type questions that the students can answer to see if they have mastered the terminology and data presented in the chapter. The end-of-chapter material is well done."*
>
> —Jay R. Yett, Orange Coast College

End-of-Text Material

At the back of the text, you will find appendices that will give you additional background details, charts, and answers to chapter exercises. There are also a glossary of all key terms, an index organized alphabetically by subject matter, and special tables printed on the inside covers for reference use.

> *". . . many books addressing similar disciplines have a tendency to talk over a student's head, making a student frustrated further in a class they do not want to be attending. . . . Personally I would admit that Integrated Science has a slight edge. The glossary seems up-to-date and centers in on words many nonscience majors may not understand."*
>
> —David J. DiMattio, St. Bonaventure University

GLOSSARY

A

abiotic factors nonliving parts of an organism's environment

absolute humidity a measure of the actual amount of water vapor in the air at a given time—for example, in grams per cubic meter

absolute magnitude a classification scheme to compensate for the distance differences to stars; calculations of the brightness that stars would appear to have if they were all at a defined, standard distance

absolute scale temperature scale set so that zero is at the theoretical lowest temperature possible, which would occur when all random motion of molecules has ceased

absolute zero the theoretical lowest temperature possible, which occurs when all random motion of molecules has ceased

abyssal plain the practically level plain of the ocean floor

acceleration a change in velocity per change in time; by definition, this change in velocity can result from a change in speed, a change in direction, or a combination of changes in speed and direction

accretion disk fat bulging disk of gas and dust from the remains of the gas cloud that forms around a protostar

acetylcholine a neurotransmitter secreted into the synapse by many axons and received by dendrites

acetylcholinesterase an enzyme present in the synapse that destroys acetylcholine

achondrites homogeneously textured stony meteorites

acid any substance that is a proton donor when dissolved in water; generally considered a solution of hydronium ions in water that can neutralize a base, forming a salt and water

acid-base indicator a vegetable dye used to distinguish acid and base solutions by a color change

acquired characteristics characteristics an organism gains during its lifetime that are not genetically determined and therefore cannot be passed on to future generations

active transport use of a carrier molecule to move molecules through a cell membrane in a direction opposite that of the concentration gradient; the carrier requires an input of energy other than the kinetic energy of the molecules

adenine a double-ring nitrogenous-base molecule in DNA and RNA; the complementary base of thymine or uracil

adenosine triphosphate (ATP) a molecule formed from the building blocks of adenine, ribose, and phosphates; it functions as the primary energy carrier in the cell

aerobic cellular respiration the biochemical pathway that requires oxygen and converts food, such as carbohydrates, to carbon dioxide and water; during this conversion, it releases the chemical-bond energy as ATP molecules

air mass a large, more or less uniform body of air with nearly the same temperature and moisture conditions throughout

air mass weather the weather experienced within a given air mass; characterized by slow, gradual changes from day to day

alcohol an organic compound with a general formula of ROH, where R is one of the hydrocarbon groups; for example, methyl or ethyl

aldehyde an organic molecule with the general formula RCHO, where R is one of the hydrocarbon groups; for example, methyl or ethyl

alkali metals members of family IA of the periodic table, having common properties of shiny, low-density metals that can be cut with a knife and that react violently with water to form an alkaline solution

alkaline earth metals members of family IIA of the periodic table, having common properties of soft, reactive metals that are less reactive than alkali metals

alkanes hydrocarbons with single covalent bonds between the carbon atoms

alkenes hydrocarbons with a double covalent carbon-carbon bond

alkyne hydrocarbon with a carbon-carbon triple bond

alleles alternative forms of a gene for a particular characteristic (e.g., attached-earlobe and free-earlobe are alternative alleles for ear shape)

alpha particle the nucleus of a helium atom (two protons and two neutrons) emitted as radiation from a decaying heavy nucleus; also known as an alpha ray

alpine glaciers glaciers that form at high elevations in mountainous regions

alternating current an electric current that first moves one direction, then the opposite direction with a regular frequency

alternation of generations a term used to describe that aspect of the life cycle in which there are two distinctly different forms of an organism; each form is involved in the production of the other, and only one form is involved in producing gametes

alveoli tiny sacs that are part of the structure of the lungs where gas exchange takes place

amino acids organic molecules that join to form polypeptides and proteins

amp unit of electric current; equivalent to C/s

ampere full name of the unit amp

amplitude the extent of displacement from the equilibrium condition; the size of a wave from the rest (equilibrium) position

anaphase the third stage of mitosis, characterized by dividing of the centromeres and movement of the chromosomes to the poles

androgens male sex hormones produced by the testes that cause the differentiation of typical internal and external genital male anatomy

angle of incidence angle of an incident (arriving) ray or particle to a surface; measured from a line perpendicular to the surface (the normal)

angle of reflection angle of a reflected ray or particle from a surface; measured from a line perpendicular to the surface (the normal)

angular momentum quantum number in the quantum mechanics model of the atom, one of four descriptions of the energy state of an electron wave; this quantum number describes the energy sublevels of electrons within the main energy levels of an atom

annular eclipse occurs when the penumbra reaches the surface of Earth; as seen from Earth, the Sun forms a bright ring around the disk of the Moon

anorexia nervosa a nutritional deficiency disease characterized by severe, prolonged weight loss for fear of becoming obese

Antarctic Circle parallel identifying the limit toward the equator where the Sun appears above the horizon all day for six months during the summer; located at 66.5°S latitude

anther the sex organ in plants that produces the pollen that contains the sperm

antibody a globular protein molecule made by the body in response to the presence of a foreign or harmful molecule called an antigen; these molecules are capable of

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