NINTH EDITION

Applied Physics

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APPLIED PHYSICS

NINTH EDITION

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FORMULAS FROM PHYSICS

Velocity and Acceleration

$s = vt$

$\Delta v = at$

$v_{avg} = \frac{v_f + v_i}{2}$

$a_{avg} = \frac{v_f - v_i}{t}$

$s = v_i t + \frac{1}{2} a_{avg} t^2$

$v_f = v_i + a_{avg} t$

$s = \frac{1}{2}(v_f + v_i)t$

$2a_{avg}s = v_f^2 - v_i^2$

Force

$F = ma$

$F_f = \mu F_N$

$F_w = mg$

$p = mv$

impulse $= Ft = \Delta p = mv_f - mv_i$

$\tau = Fs_t$

Noncurrent Forces

The sum of all parallel forces must be zero. The sum of the clockwise torques must equal the sum of the counterclockwise torques.

Work and Energy

$W = Fs$

$W = Fs \cos \theta$

$P = \frac{W}{t}$

$\text{PE} = mgh$

$\text{KE} = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

Rotational Motion

$\theta = \frac{s}{r}$

$\omega = \frac{\theta}{t}$

$v = \omega r$

$\alpha = \frac{\Delta\omega}{t}$

$\tau = I\alpha$

$L = I\omega$

$F = \frac{mv^2}{r}$

$P = \tau\omega$

$NT_1T_2T_3T_4 \cdots = nt_1t_2t_3t_4 \cdots$

$ND_1D_2D_3D_4 \cdots = nd_1d_2d_3d_4 \cdots$

Simple Machines

Law of Simple Machines:

resistance force × resistance distance = effort force × effort distance

$F_R \cdot s_R = F_E \cdot s_E$

$\text{MA} = \frac{\text{resistance force}}{\text{effort force}}$

$\text{MA}_{\text{lever}} = \frac{\text{effort arm}}{\text{resistance arm}}$

$\text{MA}_{\text{wheel and axle}} = \frac{\text{radius of effort}}{\text{radius of resistance}}$

$\text{MA}_{\text{pulley}}$ = number of strands holding the resistance

$\text{MA}_{\text{inclined plane}} = \frac{\text{length of plane}}{\text{height of plane}}$

$\text{MA}_{\text{screw}} = \frac{2\pi r}{\text{pitch}}$

Universal Gravitation

$F_G = G\frac{m_1m_2}{r^2}$

$v = \sqrt{\frac{Gm}{r}}$

$T = 2\pi\sqrt{\frac{r^3}{Gm}}$

Matter

$S = \frac{F}{A}$

$\frac{F}{\Delta l} = k$

$D_m = \frac{m}{V}$

$D_w = \frac{F_w}{V}$

specific gravity $= \frac{D_{\text{material}}}{D_{\text{water}}}$

Fluids

$P = \frac{F}{A}$

$P = hD_w$

$F_t = AhD_w$

$F_s = \frac{1}{2}AhD_w$

$P_{abs} = P_{ga} + P_{atm}$

$Q = vA$

Temperature and Heat

$T_F = \frac{9}{5}T_C + 32°$

$T_C = \frac{5}{9}(T_F - 32°)$

$T_R = T_F + 460°$

$T_K = T_C + 273$

$Q = cm\Delta T$

$Q = cw\Delta T$

$\Delta l = \alpha l \Delta T$

$\Delta A = 2\alpha A \Delta T$

$\Delta V = 3\alpha V \Delta T$

$\Delta V = \beta V \Delta T$

$L_f = \frac{Q}{m} \quad L_f = \frac{Q}{w}$

$L_v = \frac{Q}{m} \quad L_v = \frac{Q}{w}$

$\frac{V}{T} = \frac{V'}{T'}$

$\frac{V}{V'} = \frac{P'}{P}$

$\frac{D}{D'} = \frac{P}{P'}$

$\frac{VP}{T} = \frac{V'P'}{T'}$

Wave Motion and Sound

$T = 2\pi\sqrt{\frac{l}{g}}$

$f = \frac{1}{T}$

$v = \lambda f$

$v = 331 \text{ m/s} + (0.61 \text{ m/s °C})T$

$f' = f\left(\frac{v}{v \pm v_s}\right)$

Electricity

$$F = \frac{kq_1q_2}{r^2}$$

$$R = \frac{\rho L}{A}$$

$$I = \frac{V}{R}$$

Series Circuits

(a) $I = I_1 = I_2 = I_3 = \cdots$

(b) $R = R_1 + R_2 + R_3 + \cdots$

(c) $E = V_1 + V_2 + V_3 + \cdots$

Parallel Circuits

(a) $I = I_1 + I_2 + I_3 + \cdots$

(b) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$

(c) $E = V_1 = V_2 = V_3 = \cdots$

Cells in Series

(a) $I = I_1 = I_2 = I_3 = \cdots$

(b) $r = r_1 + r_2 + r_3 + \cdots$

(c) $E = E_1 + E_2 + E_3 + \cdots$

Cells in Parallel

(a) $I = I_1 + I_2 + I_3 + \cdots$

(b) $r = \frac{r \text{ of one cell}}{\text{number of like cells}}$

(c) $E = E_1 = E_2 = E_3 = \cdots$

$V = E - Ir$

$$P = VI = I^2R = \frac{V^2}{R}$$

Magnetism

$$B = \frac{\mu_0 I}{2\pi R}$$

$$B = \pi_0 In$$

Transformers

$$\frac{V_P}{V_S} = \frac{N_P}{N_S}$$

$$\frac{I_S}{I_P} = \frac{N_P}{N_S}$$

ac Circuits

$$X_L = 2\pi fL$$

$$I = \frac{E}{X_L}$$

$$I = \frac{E}{Z}$$

$$Z = \sqrt{R^2 + X_L^2}$$

$$\tan\phi = \frac{X_L}{R}$$

$$X_C = \frac{1}{2\pi fC}$$

$$Z = \sqrt{R^2 + X_C^2}$$

$$\tan\phi = \frac{X_C}{R}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Light

$$c = \lambda f$$

$$E = hf$$

$$E = \frac{I}{4\pi r^2}$$

$$\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$$

$$M = \frac{h_i}{h_o} = \frac{-s_i}{s_o}$$

$$n = \frac{\sin i}{\sin r} = \frac{\text{speed of light in vacuum}}{\text{speed of light in substance}}$$

$$\sin i_c = \frac{1}{n}$$

Modern Physics

$$E = -\frac{kZ^2}{n^2}$$

$$E = \Delta mc^2$$

$$Q = (M_p - M_d - m_\alpha)c^2$$

$$N = N_0 e^{-\lambda t}$$

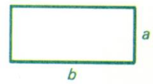
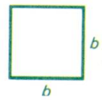
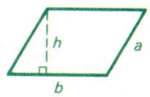
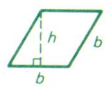
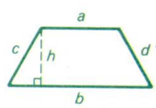
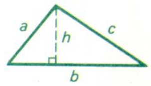
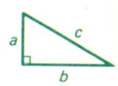
$$T_{1/2} = \frac{0.693}{\lambda}$$

$$A = \lambda N = \lambda N_0 e^{-\lambda t} = A_0 e^{-\lambda t}$$

FORMULAS FROM GEOMETRY

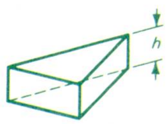
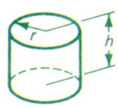
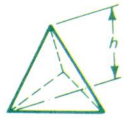
Plane Figures

In the following, a, b, c, d, and h are lengths of sides and altitudes, respectively.

		Perimeter	*Area*
Rectangle		$P = 2(a + b)$	$A = ab$
Square		$P = 4b$	$A = b^2$
Parallelogram		$P = 2(a + b)$	$A = bh$
Rhombus		$P = 4b$	$A = bh$
Trapezoid		$P = a + b + c + d$	$A = \left(\frac{a+b}{2}\right)h$
Triangle		$P = a + b + c$	$A = \frac{1}{2}bh$
Right triangle		$c^2 = a^2 + b^2$ or $c = \sqrt{a^2 + b^2}$	
		Circumference	*Area*
Circle		$C = \pi d$	$A = \pi r^2 \quad d = 2r$
		$C = 2\pi r$	$A = \frac{\pi d^2}{4}$

Geometric Solids

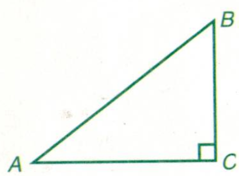
In the following, B, r, and h are the area of base, length of radius, and height, respectively.

		Volume	*Lateral Surface Area*
Prism		$V = Bh$	
Cylinder		$V =$ [illegible] h	$A = 2\pi rh$
		$V = \frac{\pi d^2 h}{4}$	
Pyramid		$V = \frac{1}{3}Bh$	
Cone		$V = \frac{1}{3}\pi r^2 h$	$A = \pi rs$, s is the slant height.
Sphere		$V = \frac{4}{3}\pi r^3$	$A = 4\pi r^2$
		$V = \frac{\pi}{6}d^3$	

COMMON PHYSICAL DATA

Title of Physical Data	Symbol	Value
Acceleration due to gravity on the earth	g_{earth}	$9.80\ m/s^2$
Gravitational constant	G	$6.67 \times 10^{-11}\ N\ m^2/kg^2$
Mass of the earth	m_{earth}	$5.97 \times 10^{24}\ kg$
Radius of the earth	r_{earth}	$6.38 \times 10^{6}\ m$
Speed of light	c	$3.00 \times 10^{8}\ m/s$
Electrostatic proportionality constant	k	$9.00 \times 10^{9}\ N\ m^2/C^2$
Planck's constant	h	$6.626 \times 10^{-34}\ J\ s$
Charge of an electron	e^-	$-1.60 \times 10^{-19}\ C$
Charge of a proton	e^+	$+1.60 \times 10^{-19}\ C$
Mass of an electron	m_e	$9.1094 \times 10^{-31}\ kg$
Mass of a proton	m_p	$1.6726 \times 10^{-27}\ kg$
Mass of a neutron	m_n	$1.6749 \times 10^{-27}\ kg$

FORMULAS FROM RIGHT-TRIANGLE TRIGONOMETRY



$$\sin A = \frac{\text{side opposite angle } A}{\text{hypotenuse}}$$

$$\cos A = \frac{\text{side adjacent to angle } A}{\text{hypotenuse}}$$

$$\tan A = \frac{\text{side opposite angle } A}{\text{side adjacent to angle } A}$$

METRIC SYSTEM PREFIXES

Multiple or Submultiple[a] Decimal Form	Power of 10	Prefix[b]	Prefix Symbol	Pronunciation	Meaning
1,000,000,000,000	10^{12}	tera	T	tĕr′ă	One trillion times
1,000,000,000	10^{9}	giga	G	jĭg′ă	One billion times
1,000,000	10^{6}	mega	M	mĕg′ă	One million times
1,000	10^{3}	kilo	k	kĭl′ō	One thousand times
100	10^{2}	hecto	h	hĕk′tō	One hundred times
10	10^{1}	deka	da	dĕk′ă	Ten times
0.1	10^{-1}	deci	d	dĕs′ĭ	One tenth of
0.01	10^{-2}	centi	c	sĕnt′ĭ	One hundredth of
0.001	10^{-3}	milli	m	mĭl′ĭ	One thousandth of
0.000001	10^{-6}	micro	μ	mī′krō	One millionth of
0.000000001	10^{-9}	nano	n	năn′ō	One billionth of
0.000000000001	10^{-12}	pico	p	pē′kō	One trillionth of

[a] Factor by which the unit is multiplied.
[b] The same prefixes are used with all SI metric units.

Applied Physics, ninth edition, formerly *Physics for Career Education*, provides comprehensive and practical coverage of physics for students needing an applied physics approach or considering a vocational–technical career. It emphasizes physical concepts as applied to industrial–technical fields and uses common applications to improve the physics and mathematics competence of the student. This ninth edition has been carefully reviewed and special efforts have been taken to emphasize clarity and accuracy of presentation.

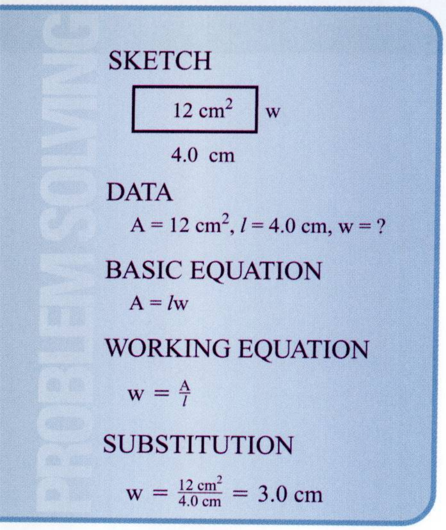
This text is divided into five major areas: mechanics, matter and heat, wave motion and sound, electricity and magnetism, and light and modern physics.

Key Features

- Real-world applications are used to motivate students.
- Topic coverage is clear and to the point.
- A unique problem-solving format is consistently used throughout the text.
- Detailed, well-illustrated examples in the problem-solving format support student understanding of skills and concepts.
- Problems and questions assist student learning, with extensive problem sets at the end of most sections that provide students with ample opportunity for practice.
- A four-color format with numerous drawings, diagrams, and photographs is used to illustrate the application of physics in the real world and improve student interest and comprehension.
- Try This Activity features provide students with opportunities to experiment with physics concepts. Activities involve a demonstration or mini-activity that can be performed by students on their own to experience a physics concept, allowing for more active versus passive learning.
- Physics Connections features apply physics to familiar real-world situations and events. These brief readings help students bridge the gap between what is taught in the chapter and real-world technical applications.
- Applied Concepts features provide application-based questions at the end of chapters that develop problem-solving skills in real-life physics applications.
- There is comprehensive discussion and consistent use of the results of working with measurements and significant digits.
- Biographical sketches of important scientists appear in most chapters.
- Answers to odd-numbered problems within the chapters and all chapter review questions and problems are given in Appendix E.
- A comprehensive glossary is given as a one-stop reference in Appendix D.
- Basic scientific calculator instructions are presented in Appendix B.
- A basic math review provides students with a refresher of the math needed for the course in Appendix A.

Changes made in this ninth edition include:

- More than 120 mostly metric problems and some problems of interest to automotive/diesel and construction students have been added at the request of reviewers.
- More than 60 new photos are included.
- Problem Solving is covered in a separate chapter again, at the request of reviewers.
- The Vectors chapter has been reorganized and revised at the request of reviewers.
- Fourteen Try This Activity features have been added.



- Eight Physics Connections features have been added.
- The topic of collisions in two dimensions has been added to Section 6.2.
- Numerous improvements have been made throughout the text.

Examples of Key Features

Unique Problem-Solving Method

This textbook teaches students to use a proven effective problem-solving methodology. The consistent use of this method trains students to make a sketch, identify the data elements, select the appropriate equation, solve for the unknown quantity, and substitute the data in the working equation. An icon that outlines the method is placed in the margin of most problem sets as a reminder to students.

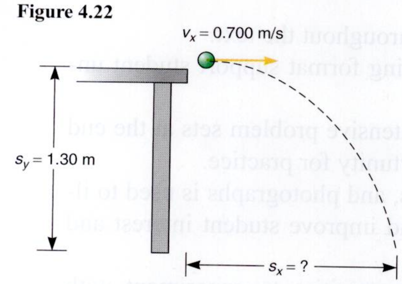
Figure P.1 and Figure P.2 show examples illustrating how the problem-solving method is used in the text. See Section 2.3 for the detailed presentation of the problem-solving method.

Figure P.1

EXAMPLE 1

A ball rolls at a constant speed of 0.700 m/s as it reaches the end of a 1.30-m-high table (Fig. 4.22). How far from the edge of the table does the ball land?

Sketch: **Figure 4.22**



Data:

$$v_{iy} = 0 \text{ m/s} \qquad v_x = 0.700 \text{ m/s}$$
$$s_y = 1.30 \text{ m} \qquad s_x = ?$$

Basic Equations:

$$s_y = v_{iy}t + \tfrac{1}{2}a_y t^2 \qquad s_x = v_x t$$

Working Equations (with $v_{iy} = 0$):

$$t = \sqrt{\frac{2s_y}{a}} \qquad s_x = v_x t$$

Substitution:

$$t = \sqrt{\frac{2(1.30 \text{ m})}{9.80 \text{ m/s}^2}} = 0.515 \text{ s}$$

$$s_x = (0.700 \text{ m/s})(0.515 \text{ s}) = 0.361 \text{ m}$$

Figure P.2

EXAMPLE 4

Juan and Sonja use a push mower to mow a lawn. Juan, who is taller, pushes at a constant force of 33.1 N on the handle at an angle of 55.0° with the ground. Sonja, who is shorter, pushes at a constant force of 23.2 N on the handle at an angle of 35.0° with the ground. Assume they each push the mower $3\bar{0}00$ m. Who does more work and by how much?

Sketch:

Data:

Juan	Sonja
$F = 33.1$ N	$F = 23.2$ N
$s = 3\bar{0}00$ m	$s = 3\bar{0}00$ m
$\theta = 55.0°$	$\theta = 35.0°$
$W = ?$	$W = ?$

Basic Equation:

$W = Fs\cos\theta$ $\qquad$ $W = Fs\cos\theta$

Working Equation: Same $\qquad$ Same

Substitution:

$$W = (33.1\text{ N})(3\bar{0}00\text{ m})\cos 55.0°$$
$$= 57,\bar{0}00\text{ N m}$$
$$= 57,\bar{0}00\text{ J} \qquad (1\text{ N m} = 1\text{ J})$$

$$W = (23.2\text{ N})(3\bar{0}00\text{ m})\cos 35.0°$$
$$= 57,\bar{0}00\text{ N m}$$
$$= 57,\bar{0}00\text{ J}$$

They do the same amount of work. However, Juan must exert more energy because he pushes into the ground more than Sonja, who pushes more in the direction of the motion.

Worked Examples

Worked examples are consistently displayed in the problem-solving format and used to illustrate and clarify basic concepts and problems. Since many students learn by example, a large number of examples are provided. The example in Figure P.3 shows how conversion factors are displayed and used.

Figure P.3

EXAMPLE 2

Find the depth in a lake at which the pressure is 105 lb/in^2.

Data:

$$P = 105\text{ lb/in}^2$$
$$D_w = 62.4\text{ lb/ft}^3$$
$$h = ?$$

Basic Equation:

$$P = hD_w$$

Working Equation:

$$h = \frac{P}{D_w}$$

Substitution:

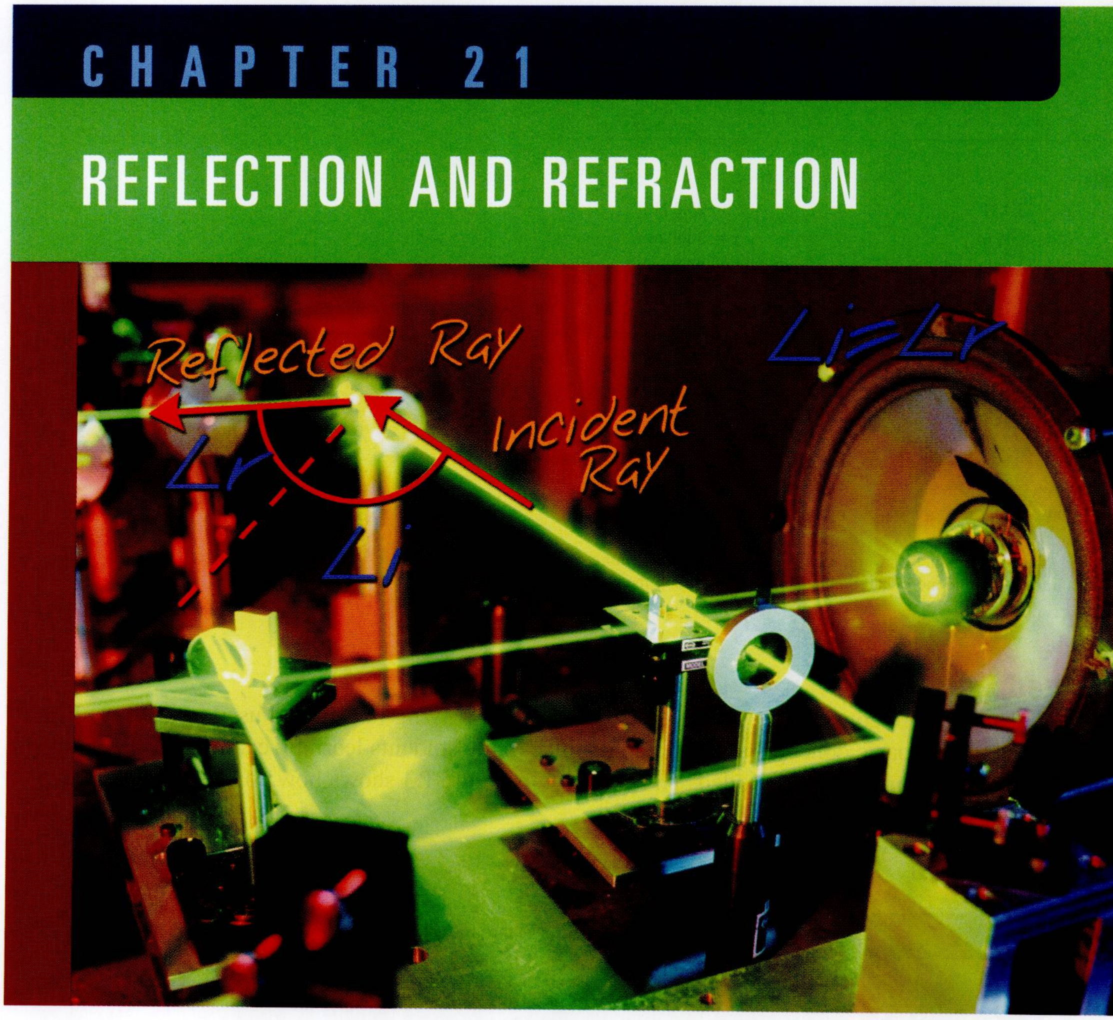
$$h = \frac{105\text{ lb/in}^2}{62.4\text{ lb/ft}^3}$$
$$= 1.68\frac{\text{ft}^3}{\text{in}^2}$$
$$= 1.68\frac{\cancel{\text{ft}^3}^{\,\text{ft}}}{\cancel{\text{in}^2}} \times \left(\frac{12\ \cancel{\text{in.}}}{1\ \cancel{\text{ft}}}\right)^2$$
$$= 242\text{ ft}$$

$$\frac{\text{lb/in}^2}{\text{lb/ft}^3} = \frac{\text{lb}}{\text{in}^2} \div \frac{\text{lb}}{\text{ft}^3} = \frac{\cancel{\text{lb}}}{\text{in}^2} \times \frac{\text{ft}^3}{\cancel{\text{lb}}} = \frac{\text{ft}^3}{\text{in}^2}$$

High-Interest Chapter Openers

Chapter opening photos feature topics of interest to students with hand-written formula notes relating the action in the photo to a physical principle discussed in the chapter.

Figure P.4



The nature of light may still be somewhat of a mystery. However, its characteristics have been the subject of intensive study for hundreds of years. Light may be transmitted, reflected, or absorbed by a medium.

Anyone wearing glasses can appreciate the refraction of light as it bends upon passing from one medium to another. The index of refraction is a tool that the scientist uses to describe the ability of certain substances to bend light as it passes through them.

Our examination of the behavior of light begins with the study of images and reflection.

Try This Activity

These activities provide students with opportunities to experiment with physics concepts. Activities involve a demonstration or mini-activity that can be performed by students on their own to experience a physics concept, allowing for active versus passive learning.

Figure P.5

TRY THIS ACTIVITY

Free Fall in a Vacuum

Drop a piece of paper and a book at the same time and note the relative time it takes for each to hit the floor. Now place that paper on top of the book as shown in Fig. 4.14. (***Note:*** The top surface area of the book must be larger than that of the paper.) What happens to the time it takes the book and paper to fall? What does this show about objects falling in a vacuum? (A vacuum is a space in which there is no air resistance present.)

Figure 4.14 Place the paper on top of the book. The book must be larger than the paper.

Physics Connections

These features apply physics to familiar real-world situations and events. These brief readings help students bridge the gap between what is taught in the chapter and real-world technical applications.

Figure P.6

PHYSICS CONNECTIONS

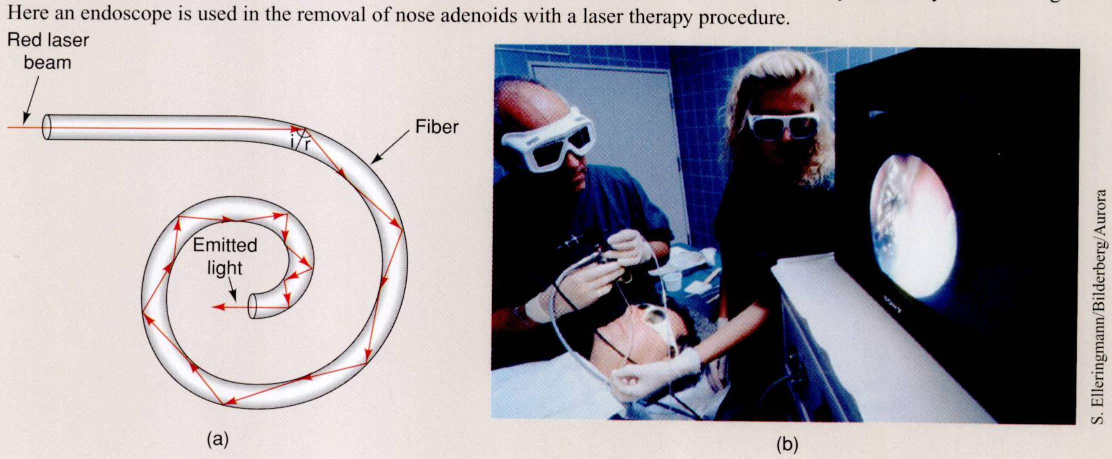
Fiber Optic Cables

Most transmission of information travels as electric impulses through electric and telephone lines and fiber optic cables. Electric signals travel relatively slowly, cause wires to heat up, and need transformers to boost the voltage of signals traveling over long distances. Electric signals and wires are being replaced with light signals traveling through flexible, low-cost strands of glass. Because light travels through glass optical fibers, there is no electrical resistance to weaken the signal, and the signal travels at the speed of light, which is much faster than the speed of conventional electric signals. Such advances in fiber optics communications are revolutionizing the way we communicate.

Light traveling in the same medium travels in a straight line, whereas fiber optic cables can transmit a signal while twisting and turning, because of total internal reflection. The angle at which the light strikes the cladding of the fiber is always greater than the critical angle of the cladding and the core. The low critical angle allows the light to continually reflect and travel great distances without needing to be reamplified. In order for the cable to maintain a low critical angle, the glass must contain no imperfections or bubbles that would cause the light to be directed out or backward through the cable (see Fig. 21.26).

Fiber optic cables are used in telecommunications, computer networks, and medicine. A few strands of glass fiber can carry thousands of separate digital telephone conversations by slightly altering the frequency of the light for each phone conversation. A digital signal transmitted at one frequency cannot be confused by a signal carried at another frequency. Many computer networks and internal components in computers use fiber optic cables to carry data. By eliminating electric wiring, the fiber optic cable helps to reduce the temperature inside computers and servers. Finally, physicians use fiber optic bundles to perform minimally invasive procedures. A tool called an endoscope, composed of a bundle of fiber optic cables, transmits light into a patient's body while another bundle of fibers on the endoscope functions as a digital camera. The camera picks up the image and sends it back through the fiber optic cable to a monitor in the operating room.

Figure 21.26 (a) The red laser light entering the fiber optic cable is totally internally reflected, which results in the light emerging at the end of the cable. (b) An endoscope is a bundle of fiber optic cables used in many minimally invasive surgeries. Here an endoscope is used in the removal of nose adenoids with a laser therapy procedure.



Applied Concepts

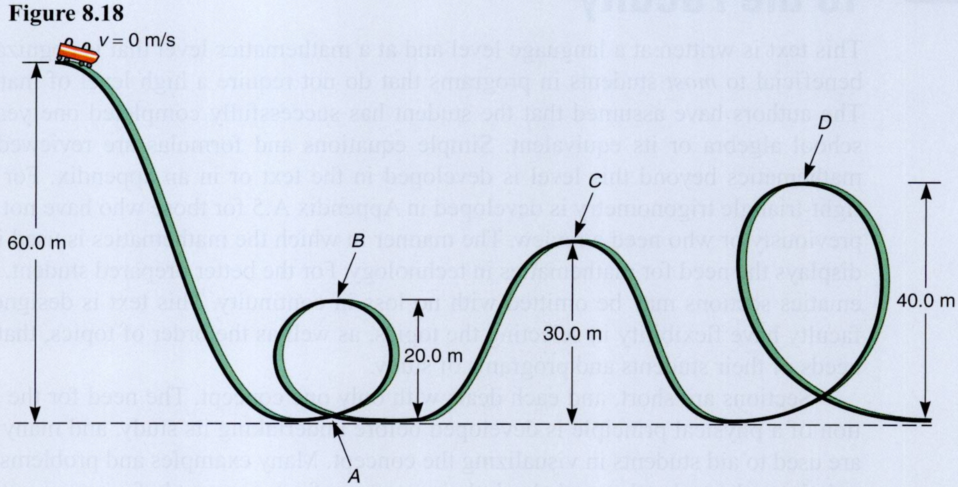
Application-based questions at the end of each chapter develop problem-solving skills in real-life physics applications

Figure P.7

APPLIED CONCEPTS

1. Rosita needs to purchase a sump pump for her basement. (a) If the pump must carry 10.0 kg of water to a height of 2.75 m each minute, what minimum wattage pump is needed? (b) What three main factors determine power for a sump pump?
2. A roller coaster designer must carefully balance the desire for excitement and the need for safety. The most recent design is shown in Fig. 8.18. (a) If a 355-kg roller coaster car has zero velocity on the top of the first hill, determine its potential energy. (b) What is the velocity of the roller coaster car at the specified locations in the design? (c) Explain the relationship between velocity and the position on the track throughout the ride. (Consider the track to be frictionless.)

Figure 8.18



3. A 22,500-kg Navy fighter jet flying 235 km/h must catch an arresting cable to land safely on the runway strip of an aircraft carrier. (a) How much energy must the cable absorb to stop the fighter jet? (b) If the cable allows the jet to move 115 m before coming to rest, what is the average force that the cable exerts on the jet? (c) If the jet were given more than 115 m to stop, how would the force applied by the cable change?
4. The hydroelectric plant at the Itaipu Dam, located on the Parana River between Paraguay and Brazil, uses the transfer of potential to kinetic energy of water to generate electricity. (a) If 1.00×10^6 gallons of water (3.79×10^6 kg) flows down 142 m into the turbines each second, how much power does the hydroelectric power plant generate? (For comparison purposes, the Hoover Dam generates 1.57×10^6 W of power.) (b) How much power could the plant produce if the Itaipu Dam were twice its actual height? (c) Explain why the height of a dam is important for hydroelectric power plants.
5. A 1250-kg wrecking ball is lifted to a height of 12.7 m above its resting point. When the wrecking ball is released, it swings toward an abandoned building and makes an indentation of 43.7 cm in the wall. (a) What is the potential energy of the wrecking ball at a height of 12.7 m? (b) What is its kinetic energy as it strikes the wall? (c) If the wrecking ball transfers all of its kinetic energy to the wall, how much force does the wrecking ball apply to the wall? (d) Why should a wrecking ball strike a wall at the lowest point in its swing?

Ancillaries

- Companion Laboratory Manual (0-13-110353-9)
- Online Instructor's Resource Manual with Complete Solutions
- Online PowerPoint transparencies
- Test Item File
- The Prentice Hall TestGen, which provides the Test Item File on CD-ROM

Online Instructor's Manual

To access supplementary materials online, instructors need to request an instructor access code. Go to www.pearsonhighered.com/irc, where you can register for an instructor access code. Within 48 hours after registering, you will receive a confirming e-mail, including an instructor access code. Once you have received your code, go to the site and log on for full instructions on downloading the materials you wish to use.

To the Faculty

This text is written at a language level and at a mathematics level that is cognizant of and beneficial to *most* students in programs that do not require a high level of mathematics. The authors have assumed that the student has successfully completed one year of high school algebra or its equivalent. Simple equations and formulas are reviewed and any mathematics beyond this level is developed in the text or in an appendix. For example, right-triangle trigonometry is developed in Appendix A.5 for those who have not studied it previously or who need a review. The manner in which the mathematics is used in the text displays the need for mathematics in technology. For the better prepared student, the mathematics sections may be omitted with no loss in continuity. This text is designed so that faculty have flexibility in selecting the topics, as well as the order of topics, that meet the needs of their students and programs of study.

Sections are short, and each deals with only one concept. The need for the investigation of a physical principle is developed before undertaking its study, and many diagrams are used to aid students in visualizing the concept. Many examples and problems are given to help students develop and check their mastery of one concept before moving to another.

This text is designed to be used in a vocational–technical program in a community college, a technical institute, or a high school for students who plan to pursue a technical career or in a general physics course where an applied physics approach is preferred. The topics were chosen with the assistance of technicians and management in several industries and faculty consultants. Suggestions from users and reviewers of the previous edition were used extensively in this edition.

A general introduction to physics is presented in Chapter 0. Chapter 1 introduces students to basic units of measurement. For students who lack a metric background or who need a review, an extensive discussion of the metric system is given in Chapter 1, where it is shown how the results of measurements are approximate numbers, which are then used consistently throughout the text. Those who need to review some mathematical skills are referred to the appendices as necessary. Chapter 2 introduces students to a problem-solving method that is consistently used in the rest of the text. Vectors are developed in Chapter 3, followed by a comprehensive study of motion, force, work and energy, rotational energy, simple machines, and universal gravitation and satellite motion.

The treatment of matter includes a discussion of the three states of matter, density, fluids, pressure, and Pascal's principle. The treatment of heat includes temperature, specific heat, thermal expansion, change of state, and ideal gas laws.

The section on wave motion and sound deals with basic wave characteristics, the nature and speed of sound, the Doppler effect, and resonance.

The section on electricity and magnetism begins with a brief discussion of static electricity, followed by an extensive treatment of dc circuits and sources, Ohm's law, and series

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