Preface

College Physics is intended for a two-semester college course in introductory physics using algebra and trigonometry. Our main goals in writing this book are

- to present the basic concepts of physics that students need to know for later courses and future careers,
- to emphasize that physics is a tool for understanding the real world, and
- to teach transferable problem-solving skills that students can use throughout their lives.

We have kept these goals in mind while developing the main themes of the book.

NEW TO THE FOURTH EDITION

Although the fundamental philosophy of the book has not changed, detailed feedback from instructors and students using the previous editions has enabled us to continually fine-tune our approach. Some of the most important enhancements in the fourth edition include:

"This is one of the most thorough and informative texts on the subject that I have seen. Great effort has been made to aid and guide the student in learning physics and to explain the relevance of physics to the real world. I wish I had this book when I first learned physics."

Dr. Michael Pravica
The University of Nevada–Las Vegas

- To help students see that the physics they are learning is relevant to their careers, the fourth edition includes 111 new **biomedical applications** in the end-of-chapter Problems, 12 new biomedical Examples, and 10 new text discussions of biomedical applications.
- A **list of selected biomedical applications** appears on the first page of each chapter.
- Eighty-nine new **Ranking Tasks** have been included in the Checkpoints, Practice Problems, and end-of-chapter Problems.
- New **Checkpoints** have been added to the text to give students more frequent opportunities to pause and test their understanding of a new concept.
- Every chapter includes a set of **Collaborative Problems** that can be used in cooperative group problem solving.
- The **Connections** have been enhanced and expanded to help students see the bigger picture—that what may seem like a new concept may really be an extension, application, or specialized form of a concept previously introduced. The goal is for students to view physics as a small set of fundamental concepts that can be applied in many different situations, rather than as a collection of loosely related facts or equations.
- Most marginal notes from the previous edition have been incorporated into the text for better flow of ideas and a less cluttered presentation.
- Multiple-Choice Questions that are well-suited to use with **student response systems** are identified with a "clicker" icon. Answers to even-numbered questions are not given, for instructors who track student performance using "clickers."

Some chapter-specific revisions to the text include:

- In **Chapter 1,** the general guidelines for problem solving have been expanded.
- In **Chapter 2,** the introduction of forces as interaction partners in Section 2.1 now includes an explicit reference to Newton's third law. More prominence is given to the specific identification of forces; the student is asked to state *on* what object and *by* what other object a force is exerted. A Connection has been added to reinforce the central theme in Newton's laws that, no matter what *kinds* of forces are acting on an object, we always add them the same way (as vectors) to find the net force.

- **Chapter 3** introduces motion diagrams earlier and uses them extensively. Students are asked to construct or to interpret motion diagrams in Checkpoints, Examples, Practice Problems, and end-of-chapter Problems.
- **Chapters 4 and 5** continue the increased emphasis on motion diagrams. Motion with constant acceleration is now introduced first with motion diagrams, before other representations (graphs and equations). In Chapter 4, a new Connection comments on the seemingly different interpretations of g (the gravitational field strength).
- **Chapter 6** is enhanced with a new problem-solving strategy box on how to choose between alternative problem-solving approaches (energy vs. Newton's second law). The explanation of why the change in gravitational potential energy is the *negative* of the work done by gravity is simpler and more intuitive. Chapter 6 also uses energy graphs more frequently.
- **Chapter 7** now includes a text discussion of ballistocardiography.
- **Chapter 11** discusses the use of seismic waves by animals to communicate and to sense their environment. The presentation of interference and phase difference has been simplified.
- **Chapter 12** contains an expanded discussion of audible frequency ranges for various animals. The presentation of the (nonrelativistic) Doppler effect is more straightforward, with emphasis on the relative velocities of the wave with respect to source and observer. A new problem-solving strategy box for the Doppler effect has been added.
- **Chapters 16 and 17** include a description of hydrogen bonds in water, DNA, and proteins. A simplified model of the hydrogen bond as interactions between point charges enables the student to make realistic estimates of the forces involved and of the binding energy of a hydrogen bond. A discussion of gel electrophoresis has also been added to Chapter 16.
- **Chapter 18** includes an enhanced discussion of the resistivity of water and how it depends strongly on the concentrations of ions.
- In **Chapter 19,** the visual depiction of the right-hand rule is clearer, and an alternative "wrench rule" is introduced. The explanation of how a cyclotron works is clearer.
- **Chapter 20's** treatment of inductance has been streamlined, with the quantitative material on *mutual* inductance moved to the text website.
- **Chapter 22** explains more plainly Maxwell's achievement in unifying the laws of electricity and magnetism, showing that EM waves exist and that electric and magnetic fields are real, not just convenient mathematical tools. The chapter includes discussions of IR detection by animals and the biological effects of UV exposure, as well as an improved explanation of how polarizers work.
- **Chapter 25** simplifies the discussion of phase differences for constructive and destructive interference.
- **Chapter 29** mentions other modes of radioactive decay such as proton emission and double beta emission. The text discusses the accidents at the Fukushima Daiichi nuclear power plant due to the 2011 Tōhoku tsunami.
- **Chapter 30** now includes brief descriptions of inflation and of the Higgs field.

Please see your McGraw-Hill sales representative for a more detailed list of revisions.

COMPREHENSIVE COVERAGE

Students should be able to get the whole story from the book. The previous editions have been tested in our self-paced course, where students must rely on the textbook as their primary learning resource. Nonetheless, completeness and clarity are equally advantageous when the book is used in a more traditional classroom setting. *College Physics* frees the instructor from having to try to "cover" everything. The instructor can then tailor class time to more important student needs—reinforcing difficult concepts, working through Example problems, engaging the students in peer instruction and cooperative learning activities, describing applications, or presenting demonstrations.

A CONCEPTS-FIRST APPROACH

"It [Giambattista, Richardson, and Richardson] is a well organized textbook written in simple language. I found this book useful to those instructors who want their students to read the text besides [just] the lecture notes."

Dr. Bijaya Aryal
Lake Superior State University

Some students approach introductory physics with the idea that physics is just the memorization of a long list of equations and the ability to plug numbers into those equations. We want to help students see that a relatively small number of basic physics concepts are applied to a wide variety of situations. Physics education research has shown that students do not automatically acquire conceptual understanding; the concepts must be explained and the students given a chance to grapple with them. Our presentation, based on years of teaching this course, blends conceptual understanding with analytical skills. The "concepts-first" approach helps students develop intuition about how physics works; the "formulas" and problem-solving techniques serve as *tools for applying the concepts.* The **Conceptual Examples** and **Conceptual Practice Problems** in the text and a variety of ranking tasks and Conceptual and Multiple-Choice Questions at the end of each chapter give students a chance to check and to enhance their conceptual understanding.

INTRODUCING CONCEPTS INTUITIVELY

We introduce key concepts and quantities in an informal way by establishing why the quantity is needed, why it is useful, and why it needs a precise definition. Then we make a transition from the informal, intuitive idea to a formal definition and name. Concepts motivated in this way are easier for students to grasp and remember than are concepts introduced by seemingly arbitrary, formal definitions.

For example, in Chapter 8, the idea of rotational inertia emerges in a natural way from the concept of rotational kinetic energy. Students can understand that a rotating rigid body has kinetic energy due to the motion of its particles. We discuss why it is useful to be able to write this kinetic energy in terms of a single quantity common to all the particles (the angular speed), rather than as a sum involving particles with many different speeds. When students understand why rotational inertia is defined the way it is, they are better prepared to move on to the more difficult concepts of torque and angular momentum.

We avoid presenting definitions or formulas without any motivation. When an equation is not derived in the text, we at least describe where the equation comes from or give a plausibility argument. For example, Section 9.9 introduces Poiseuille's law with two identical pipes in series to show why the volume flow rate must be proportional to the pressure drop per unit length. Then we discuss why $\Delta V/\Delta t$ is proportional to the fourth power of the radius (rather than to r^2, as it would be for an ideal fluid).

"[Giambattista, Richardson, and Richardson] is one of the best Physics books I have seen. The text is very well written and structured. The explanations are clear and the multiple step-by-step problems are easy to follow. The real world applications and illustrations make the text alive."

Dr. Catalina Boudreaux
The University of Texas–San Antonio

Similarly, we have found that the definitions of the displacement and velocity vectors seem arbitrary and counterintuitive to students if introduced without any motivation. Therefore, we precede any discussion of kinematic quantities with an introduction to Newton's laws, so students know that forces determine how the state of motion of an object changes. Then, when we define the kinematic quantities to give a precise definition of acceleration, we can apply Newton's second law quantitatively to see how forces affect the motion. We give particular attention to laying the conceptual groundwork for a concept when its name is a common English word such as *velocity* or *work.*

INNOVATIVE ORGANIZATION

As part of our concepts-first approach, the organization of this text differs in a few places from that of most textbooks. The most significant reorganization is in the treatment of forces and motion. In *College Physics,* the central theme of Chapters 2–4 is *force and Newton's laws*. Kinematics is introduced in Chapters 3 and 4 as a tool to understand how forces affect motion.

Chapter 2 sets the conceptual framework for what follows by introducing forces and Newton's laws. Interaction pairs, the concept behind Newton's third law, are built in from the start (see Section 2.1). Force is used as a prototypical vector quantity—intuitively, when you combine two forces, the effect depends on the directions as well as the magnitudes. Introducing forces earlier gives students more time to develop the crucial skills they need to analyze forces, construct free-body diagrams, and add forces as vectors to find the net force—for the time-being in *equilibrium situations only.* No rates of change to grapple with yet and no quadratic equations to solve!

One benefit of this approach is that Chapter 2 contains very few "formulas"; instead it teaches physics *concepts* and necessary math *skills.* The beginning of the text sets up student expectations that are hard to change later, and we want students to know that physics is not about manipulating equations, but rather is about reasoning skills and fundamental concepts.

Chapter 3 begins to address the question: How does an object move when the net force acting on it is *nonzero*? Newton's second law provides the *motivation* for defining acceleration, and the kinematics is integrated into the context of Newton's laws. The students have already learned about vector quantities, so there's no need to go through kinematics twice (once in one dimension and then again in two or three dimensions). Correct and consistent vector notation is used even when an object moves along a straight line. For example, we carefully distinguish components from magnitudes by writing "$v_x = -5$ m/s" and never "$v = -5$ m/s," even if the object moves only along the *x*-axis. Several professors, after trying this approach, reported a reduction in the number of students struggling with vector components.

Pure kinematics (divorced from forces and Newton's laws) is deemphasized in Chapter 3. Many of the examples and problems in Chapter 3 involve the *connection* between kinematics and the forces acting on an object. Students continue to practice crucial skills they learned in Chapter 2, such as analyzing forces and constructing free-body diagrams.

Chapter 4 then examines an important case—what happens when the net force is *constant*? This is presented as a continuation of what came before—students continue to analyze forces and use Newton's second law. The idealized motion of a projectile is presented as just that—an idealization that is *approximately* true when forces other than gravity are negligible. We want to reinforce the idea that physics explains how the real world works, not give the impression that physics is a self-contained system unconnected from reality.

"I like the [Giambattista, Richardson, and Richardson] approach and I will argue in its favor . . . I would call it a fresh start."
Dr. Klaus Honscheild
Ohio State University

"I like the order of the arrangement of the chapters better than the current text. I like the text and the chapter, it is well written and well prepared."
Dr. Donald Whitney
Hampton University

WRITTEN IN CLEAR AND FRIENDLY STYLE

We have kept the writing down-to-earth and conversational in tone—the kind of language an experienced teacher uses when sitting at a table working one-on-one with a student. We hope students will find the book pleasant to read, informative, and accurate without seeming threatening, and filled with analogies that make abstract concepts easier to grasp. We want students to feel confident that they can learn by studying the textbook.

Although we agree that learning correct physics terminology is essential, we chose to avoid all *unnecessary* jargon—terminology that just gets in the way of the student's understanding. For example, we never use the term *centripetal force,* since its use sometimes leads students to add a spurious "centripetal force" to their free-body diagrams. Likewise, we use *radial component of acceleration* because it is less likely to introduce or reinforce misconceptions than *centripetal acceleration.*

ACCURACY ASSURANCE

The authors and the publisher acknowledge the fact that inaccuracies can be a source of frustration for both the instructor and students. Therefore, throughout the writing and production of this edition, we have worked diligently to eliminate errors and inaccuracies. Kurt Norlin of LaurelTech, a division of DiacriTech, conducted an independent accuracy check and worked all end-of-chapter questions and problems in the final draft of the manuscript. He then coordinated the resolution of discrepancies between accuracy checks, ensuring the accuracy of the text and the end-of-book answers.

The page proofs of the text were proofread against the manuscript to ensure the correction of any errors introduced when the manuscript was typeset. The end-of-chapter questions and problems, and problem answers were checked for accuracy by Fellers Math & Science at the page proof stage after the manuscript was typeset. This last round of corrections was then cross-checked against the solutions manuals.

PROVIDING STUDENTS WITH THE TOOLS THEY NEED

Problem-Solving Approach

Problem-solving skills are central to an introductory physics course. We illustrate these skills in the Example problems. Lists of problem-solving strategies are sometimes useful; we provide such strategies when appropriate. However, the most elusive skills—perhaps the most important ones—are subtle points that defy being put into a neat list. To develop real problem-solving expertise, students must learn how to think critically and analytically. Problem solving is a multidimensional, complex process; an algorithmic approach is not adequate to instill real problem-solving skills.

Strategy We begin each Example with a discussion—in language that the students can understand—of the *strategy* to be used in solving the problem. The strategy illustrates the kind of analytical thinking students must do when attacking a problem: How do I decide what approach to use? What laws of physics apply to the problem and which of them are *useful* in this solution? What clues are given in the statement of the question? What information is implied rather than stated outright? If there are several valid approaches, how do I determine which is the most efficient? What assumptions can I make? What kind of sketch or graph might help me solve the problem? Is a simplification or approximation called for? If so, how can I tell if the simplification is valid? Can I make a preliminary estimate of the answer? Only after considering these questions can the student effectively solve the problem.

"I understood the math, mostly because it was worked out step-by-step, which I like."
Student, Bradley University

Solution Next comes the detailed *solution* to the problem. Explanations are intermingled with equations and step-by-step calculations to help the student understand the approach used to solve the problem. We want the student to be able to follow the mathematics without wondering, "Where did that come from?"

Discussion The numerical or algebraic answer is not the end of the problem; our Examples end with a *discussion.* Students must learn how to determine whether their answer is consistent and reasonable by checking the order of magnitude of the answer, comparing the answer with a preliminary estimate, verifying the units, and doing an independent calculation when more than one approach is feasible. When several different approaches are possible, the discussion looks at the advantages and disadvantages of each approach. We also discuss the implications of the answer—what can we learn from it? We look at special cases and look at "what if" scenarios. The discussion sometimes generalizes the problem-solving techniques used in the solution.

Practice Problem After each Example, a Practice Problem gives students a chance to gain experience using the same physics principles and problem-solving tools. By comparing their answers with those provided at the end of each chapter, students can gauge their understanding and decide whether to move on to the next section.

Our many years of experience in teaching the college physics course in a one-on-one setting has enabled us to anticipate where we can expect students to have difficulty.

In addition to the consistent problem-solving approach, we offer several other means of assistance to the student throughout the text. A boxed problem-solving strategy gives detailed information on solving a particular type of problem, and an icon for problem-solving tips draws attention to techniques that can be used in a variety of contexts. A hint in a worked Example or end-of-chapter problem provides a clue on what approach to use or what simplification to make. A warning icon emphasizes an explanation that clarifies a possible point of confusion or a common student misconception.

An important problem-solving skill that many students lack is the ability to extract information from a graph or to sketch a graph without plotting individual data points. Graphs often help students visualize physical relationships more clearly than they can with algebra alone. We emphasize the use of graphs and sketches in the text, in worked examples, and in the problems.

Using Approximation, Estimation, and Proportional Reasoning

College Physics is forthright about the constant use of simplified models and approximations in solving physics problems. One of the most difficult aspects of problem solving that students need to learn is that some kind of simplified model or approximation is usually required. We discuss how to know when it is reasonable to ignore friction, treat g as constant, ignore viscosity, treat a charged object as a point charge, or ignore diffraction.

Some Examples and Problems require the student to make an estimate—a useful skill both in physics problem solving and in many other fields. Similarly, we teach proportional reasoning as not only an elegant shortcut but also as a means to understanding patterns. We frequently use percentages and ratios to give students practice in using and understanding them.

Showcasing an Innovative Art Program

In every chapter we have developed a system of illustrations, ranging from simpler diagrams to elaborate and beautiful illustrations, that brings to life the connections between physics concepts and the complex ways in which they are applied. We believe these illustrations, with subjects ranging from three-dimensional views of electric field lines to the biomechanics of the human body and from representations of waves to the distribution of electricity in the home, will help students see the power and beauty of physics.

"The text uses modern examples, color, ancillary materials, and problems appropriate to the expectations for the typical college physics student in this course, which allows a balance of instructor emphasis on conceptual physics and refinement of problem-solving skills."

Dr. Donald Whitney
Hampton University

Helping Students See the Relevance of Physics in Their Lives

Students in an introductory college physics course have a wide range of backgrounds and interests. We stimulate interest in physics by relating its principles to applications relevant to students' lives and in line with their interests. The text, Examples, and end-of-chapter problems draw from the everyday world; from familiar technological applications; and from other fields such as biology, medicine, archaeology, astronomy, sports, environmental science, and geophysics. (Applications in the text are identified with a text heading or marginal note. An icon ( ) identifies applications in the biological or medical sciences.)

The **Everyday Physics Demos** give students an opportunity to explore and see physics principles operate in their everyday lives. These activities are chosen for their simplicity and for their effectiveness in demonstrating physics principles.

Each **Chapter Opener** includes a photo and vignette, designed to capture student interest and maintain it throughout the chapter. The vignette describes the situation shown in the photo and asks the student to consider the relevant physics. A reduced version of the chapter opener photo and question indicate where the vignette topic is addressed within the chapter.

Focusing on the Concepts

By identifying areas where important concepts are revisited, the **Connections** allow us to focus on the basic, core concepts of physics and reinforce for students that all of physics is based on a few, fundamental ideas. A marginal Connections heading and summary adjacent to the coverage in the main text help students easily recognize that a previously introduced concept is being applied to the current discussion.

The exercises in the **Review & Synthesis** sections help students see how the concepts in the previously covered group of chapters are interrelated. These exercises are also intended to help students prepare for tests, in which they must solve problems without having the section or chapter title given as a clue.

Checkpoint questions encourage students to pause and test their understanding of the concept explored within the current section. The answers to the Checkpoints are found at the end of the chapter so that students can confirm their knowledge without jumping too quickly to the provided answer.

Applications are clearly identified as such in the text with a complete listing in the front matter. With Applications, students have the opportunity to see how physics concepts are experienced through their everyday lives.

connect icons identify opportunities for students to access additional information or explanation of topics of interest online. This will help students to focus even further on just the very fundamental, core concepts in their reading of the text.

ADDITIONAL RESOURCES FOR INSTRUCTORS AND STUDENTS

McGraw-Hill ConnectPlus® Physics

Mc Graw Hill connect plus+ PHYSICS

McGraw-Hill ConnectPlus® Physics to accompany *College Physics* offers online electronic homework, an eBook, and a myriad of resources for both instructors and students. Instructors can create homework with easy-to-assign, algorithmically generated problems from the text. This feature also offers the simplicity of automatic grading and reporting.

- The end-of-chapter problems and Review & Synthesis exercises appear in the online homework system in diverse formats and with various tools.
- The online homework system incorporates new and exciting interactive tools and problem types: ranking problems, a graphing tool, a free-body diagram drawing tool, symbolic entry, a math palette, and multipart problems.
- Mimicking the interaction with a tutor or professor by providing students with detailed explanations and probing questions, several comprehensive tutorial problems cover the main topics of the course. These give students a way to help learn the concepts in a careful, thoughtful way and guide them to a deeper understanding of the material.

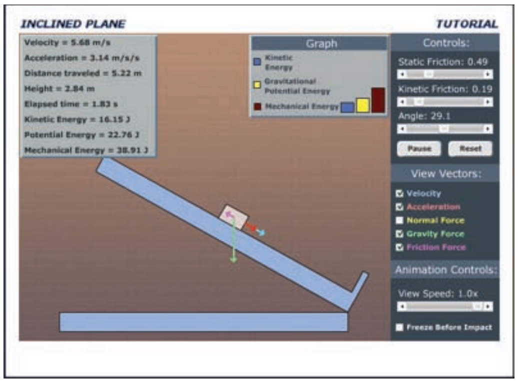
Instructors also have access to PowerPoint lecture outlines, an Instructor's Resource Guide with solutions, suggested demonstrations, electronic images from the text, clicker questions, quizzes, tutorials, interactive simulations, and many other resources directly tied to text-specific materials in *College Physics.* Students have access to self-quizzing, interactive simulations, tutorials, selected answers for the text's problems, and more.

See www.mhhe.com/grr to learn more and to register.

Online Physics Education Research Workbook

To help professors integrate new research on how students learn, Drs. Athula Herat and Ben Shaevitz of Slippery Rock University have written a workbook to accompany *College Physics.* This workbook contains questions and ideas for classroom exercises that will get students thinking about physics in new and comprehensive ways. Students are led to discover physics for themselves, leading to a deeper intuitive understanding of the material. A group of professors who use new ideas from Physics Education Research in the classroom reviewed the workbook and suggested changes and new problems. By providing the workbook in an online format, professors are free to use as much or little of the material as they choose.

Electronic Media Integrated with the ConnectPlus eBook



McGraw-Hill is proud to bring you a unique assortment of outstanding interactives and tutorials. These activities offer a fresh and dynamic method to teach the physics basics by providing students with activities that work with real data. connect icons identify areas in the text where additional understanding can be gained through work with an interactive or tutorial on the text's website.

The interactives allow students to manipulate parameters and gain a better understanding of the more difficult physics concepts by watching the effect of these manipulations. Each interactive includes

- Analysis tool (interactive model)
- Tutorial describing its function
- Content describing its principle themes

The ConnectPlus Physics website contains interactive quizzes. An online instructor's guide for each interactive includes a complete overview of the content and navigational tools, references to the textbook for further study, and suggested end-of-chapter follow-up questions.

The tutorials, developed and integrated by Raphael Littauer of Cornell University, provide the opportunity for students to approach a concept in steps. Detailed feedback is provided when students enter an incorrect response, which encourages students to further evaluate their responses and helps them progress through the problem.

Electronic Book Images and Assets for Instructors

Build instructional materials wherever, whenever, and however you want!

Accessed from the ConnectPlus Physics website to accompany *College Physics*, an online digital library containing photos, artwork, interactives, and other media types can be used to create customized lectures, visually enhanced tests and quizzes, compelling course websites, or attractive printed support materials. Assets are copyrighted by McGraw-Hill Higher Education, but can be used by instructors for classroom purposes. The visual resources in this collection include

- **Art** Full-color digital files of all illustrations in the book can be readily incorporated into lecture presentations, exams, or custom-made classroom materials. In addition, all files are preinserted into PowerPoint slides for ease of lecture preparation.
- **Active Art Library** These key art pieces—formatted as PowerPoint slides—allow you to illustrate difficult concepts in a step-by-step manner. The artwork is broken into small, incremental pieces, so you can incorporate the illustrations into your lecture in whatever sequence or format you desire.
- **Photos** The photos collection contains digital files of photographs from the text, which can be reproduced for multiple classroom uses.
- **Worked Example Library, Table Library, and Numbered Equations Library** Access the worked Examples, tables, and equations from the text in electronic format for inclusion in your classroom resources.
- **Interactives** Flash files of the physics interactives described earlier are included so that you can easily make use of the interactives in a lecture or classroom setting.

Also residing on the ConnectPlus Physics website are

- **PowerPoint Lecture Outlines** Ready-made presentations that combine art and lecture notes are provided for each chapter of the text.
- **PowerPoint Slides** For instructors who prefer to create their lectures from scratch, all illustrations and photos are preinserted by chapter into blank PowerPoint slides.

Computerized Test Bank Online

A comprehensive bank of test questions in multiple-choice format at a variety of difficulty levels is provided within a computerized test bank powered by McGraw-Hill's flexible electronic testing program—EZ Test Online (www.eztestonline.com). EZ Test Online allows you to create paper and online tests or quizzes in this easy-to-use program!

Imagine being able to create and access your test or quiz anywhere, at any time without installing the testing software. Now, with EZ Test Online, instructors can select questions from multiple McGraw-Hill test banks or create their own, and then either print the test for paper distribution or give it online. See www.mhhe.com/grr for more information.

Electronic Books

If you or your students are ready for an alternative version of the traditional textbook, McGraw-Hill brings you innovative and inexpensive electronic textbooks. By purchasing E-books from McGraw-Hill, students can save as much as 50% on selected titles delivered on the most advanced E-book platforms available.

E-books from McGraw-Hill are smart, interactive, searchable, and portable, with such powerful built-in tools as detailed searching, highlighting, note taking, and student-to-student or instructor-to-student note sharing. E-books from McGraw-Hill will help students to study smarter and quickly find the information they need. E-books also save students money. Contact your McGraw-Hill sales representative to discuss E-book packaging options.

Personal Response Systems

Personal response systems, or "clickers," bring interactivity into the classroom or lecture hall. Wireless response systems give the instructor and students immediate feedback from the entire class. The wireless response pads are essentially remotes that are easy to use and engaging, allowing instructors to motivate student preparation, interactivity, and active learning. Instructors receive immediate feedback to gauge which concepts students understand. Questions covering the content of the *College Physics* text (formatted in PowerPoint) are available on the ConnectPlus Physics website for *College Physics.*

Instructor's Resource Guide

The *Instructor's Resource Guide* includes many unique assets for instructors, such as demonstrations, suggested reform ideas from physics education research, and ideas for incorporating just-in-time teaching techniques. The accompanying Instructor's Solutions Manual includes answers to the end-of-chapter Conceptual Questions and complete, worked-out solutions for all the end-of-chapter Problems from the text. The Instructors Resource Guide is available in the Instructor Resources on the ConnectPlus Physics website to accompany *College Physics.*

ALEKS®

ALEKS Math Prep for *College Physics*

ALEKS Math Prep for *College Physics* is a web-based program that provides targeted coverage of critical mathematics material necessary for student success in *College Physics.* ALEKS uses artificial intelligence and adaptive questioning to assess precisely a student's preparedness and deliver personalized instruction on the exact topics the student is most ready to learn. Through comprehensive explanations, practice, and feedback, ALEKS enables students to quickly fill individual knowledge gaps in order to build a strong foundation of critical math skills.

Use ALEKS Math Prep for *College Physics* during the first six weeks of the term to see improved student confidence and performance, as well as fewer dropouts.

ALEKS Math Prep for *College Physics* Features:

- **Artificial Intelligence:** Targets gaps in student knowledge
- **Individualized Assessment and Learning:** Ensure student mastery
- **Adaptive, Open-Response Environment:** Avoids multiple-choice
- **Dynamic, Automated Reports:** Monitor student and class progress

Please visit www.aleks.com/highered/math for more information about ALEKS.

Student Solutions Manual

The *Student Solutions Manual* contains complete worked-out solutions to selected end-of-chapter problems and questions, selected Review & Synthesis problems, and the MCAT Review Exercises from the text. The solutions in this manual follow the problem-solving strategy outlined in the text's Examples and also guide students in creating diagrams for their own solutions.

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