To the Student

HOW TO SUCCEED IN YOUR PHYSICS CLASS

It's true—how much you get out of your studies depends on how much you put in. Success in a physics class requires:

- Commitment of time and perseverance
- Knowing and motivating yourself
- Getting organized
- Managing your time

This section will help you learn how to be effective in these areas, as well as offer guidance in:

- Getting the most out of your lecture
- Finding extra help when you need it
- Getting the most out of your textbook
- How to study for an exam

Commitment of Time and Perseverance

A good rule of thumb is to allow 2 hours of study time for every hour you spend in lecture. For instance, a 3-hour lecture deserves 6 hours of study time per week. If you commit to studying for this course daily, you're investing a little less than one hour per day, including the weekend.

Learning and mastering takes time and patience. Nothing worthwhile comes easily. Be committed to your studies and you will reap the benefits in the long run. A regular, sustained effort is much more effective than sporadic bouts of cramming.

Knowing and Motivating Yourself

What kind of learner are you? When are you most productive? Know yourself and your limits, and work within them. Know how to motivate yourself to give your all to your studies and achieve your goals.

There are many types of learners, and no right or wrong way of learning. Which category do you fall into?

Begin each of the tasks assigned in your course with the goal of understanding the material. Simply completing the assignment does not mean that learning has taken place. Your fellow students, your instructor, and this textbook can all be important resources in broadening your knowledge.

- **Visual learner** You respond best to "seeing" processes and information. Focus on text illustrations and graphs. Use course handouts and the animations on the course and text websites to help you. Draw diagrams in your notes to illustrate concepts.
- **Auditory learner** You work best by listening to—and possibly recording—the lecture and by talking information through with a study partner.
- **Tactile/Kinesthetic Learner** You learn best by being "hands on." You'll benefit by applying what you've learned during lab time. Writing and drawing are physical activities, so don't neglect taking notes on your reading and the lecture to explain the content in your own words. Try pacing while you read the text. Stand up and write on a chalkboard during discussions in your study group.

Identify your own personal preferences for learning and seek out the resources that will best help you with your studies. Also remember, even though you have a preferred style of learning, most learners benefit when they engage in all styles of learning.

Getting Organized

It's simple, yet it's fundamental. It seems the more organized you are, the easier things come. Take the time before your course begins to analyze your life and your study habits. Get organized now and you'll find you have a little more time—and a lot less stress.

- **Find a calendar system that works for you.** The best kind is one that you can take with you everywhere. To be truly organized, you should integrate all aspects of your life into this one calendar—school, work, and leisure. Some people also find it helpful to have an additional monthly calendar posted by their desk for "at a glance" dates and to have a visual planner. If you do this, be sure you are consistently synchronizing both calendars so as not to miss anything. *More tips for organizing your calendar can be found in the time management discussion below.*

- By the same token, **keep everything for your course or courses in one place**—and at your fingertips. A three-ring binder works well because it allows you to add or organize handouts and notes from class in any order you prefer. Incorporating your own custom tabs helps you flip to exactly what you need at a moment's notice.
- **Find your space.** Find a place that helps you be organized and focused. If it's your desk in your dorm room or in your home, keep it clean. Clutter adds confusion and stress and wastes time. Perhaps your "space" is at the library. If that's the case, keep a backpack or bag that's fully stocked with what you might need—your text, binder or notes, pens, highlighters, Post-its, phone numbers of study partners. [*Hint:* A good place to keep phone numbers is in your "one place for everything calendar."]

Add extra "padding" into your personal deadlines. If you have a report due on Friday, set a goal for yourself to have it done on Wednesday. Then, take time on Thursday to look over your project with a fresh eye. Make any corrections or enhancements and have it ready to turn in on Friday.

Managing Your Time

Managing your time is the single most important thing you can do to help yourself, but it's probably one of the most difficult tasks to successfully master.

In college, you are expected to work much harder and to learn much more than you ever have before. To be successful you need to invest in your education with a commitment of time. We all lead busy lives, but we all make choices as to how we spend our time. Choose wisely.

- **Know yourself and when you'll be able to study most efficiently.** When are you most productive? Are you a night owl? Or an early bird? Plan to study when you are most alert and can have uninterrupted segments. This could include a quick 5-minute review before class or a one-hour problem-solving study session with a friend.
- **Create a set daily study time for yourself.** Having a set schedule helps you commit to studying and helps you plan instead of cram. Find—and use—a planner that is small enough that you can take it with you everywhere. This may be a simple paper calendar or an electronic version. They all work on the same premise: **organize *all* of your activities in one place**.
- **Schedule study time using shorter, focused blocks with small breaks.** Doing this offers two benefits: (1) You will be less fatigued and gain more from your effort and (2) Studying will seem less overwhelming, and you will be less likely to procrastinate.
- **Plan time for leisure, friends, exercise, and sleep.** Studying should be your main focus, but you need to balance your time—and your life.
- **Log your homework deadlines and exam dates** in your personal calendar.
- Try to **complete tasks ahead of schedule**. This will give you a chance to carefully review your work before it is due. You'll feel less stressed in the end.
- **Know where help can be found.** At the beginning of the semester, find your instructor's office hours, your lab partner's contact information, and the "Help Desk" or Learning Resource Center if your course offers one. Make use of all of the support systems that your college or university has to offer. Ask questions both in class and during your instructor's office hours. Don't be shy—your instructor is there to help you learn.
- **Prioritize!** In your calendar or planner, highlight or number key projects; do them first, and then cross them off when you've completed them. Give yourself a pat on the back for getting them done!
- **Review your calendar and reprioritize *daily.***
- **Resist distractions by setting and sticking to a designated study time.**
- **Multitask when possible.** You may find a lot of extra time you didn't think you had. Review material in your head or think about how to tackle a tough problem while walking to class or doing laundry.

Plan to study and plan for leisure. Being well balanced will help you focus when it is time to study.

Try combining social time with studying in a group, or social time with mealtime or exercise. Being a good student doesn't mean you have to be a hermit. It does mean you need to know how to smartly budget your time.

Getting the Most Out of Lectures

Your instructors want you to succeed. They put a lot of effort into preparing their lectures and other materials designed to help you learn. Attending class is one of the simplest, most valuable things you can do to help yourself. But it doesn't end there—getting the most out of your lectures means being organized. Here's how:

Prepare Before You Go to Class Study the text on the lecture topic *before* attending class. Familiarizing yourself with the material gives you the ability to take notes selectively rather than scrambling to write everything down. You'll be able to absorb more of the subtleties and difficult points from the lecture. You may also develop some good questions to ask your instructor.

Don't feel overwhelmed by this task. Spend time the night before class gaining a general overview of the topics for the next lecture using your syllabus. If your schedule does not allow this, plan to arrive at class 5–15 minutes before lecture. Bring your text with you and skim the chapter before lecture begins.

Don't try to read an entire chapter in one sitting; study one or two sections at a time. It's difficult to maintain your concentration in a long session with so many new concepts and skills to learn.

Be a Good Listener Most people think they are good listeners, but few really are. Are you?

Important points to remember:

- You can't listen if you are talking.
- You aren't listening if you are daydreaming or constantly distracted by other concerns.
- Listening and comprehending are two different things. Listen carefully in class. The language of science is precise; be sure you understand your instructor. If you don't understand something your instructor is saying, ask a question or jot a note and visit the instructor during office hours. You are likely doing others a favor when you ask questions because there are probably others in the class who have the same questions.

Take Good Notes

- Use a standard size notebook, or better yet, a three-ring binder with loose leaf notepaper. The binder will allow you to organize and integrate your notes and handouts, integrate easy-to-reference tabs, and the like.
- Color-code your notes. Use one color of ink pen to take your initial notes. You can annotate later using a pencil, which can be erased if need be.
- Start a new page with each lecture or note-taking session.
- Label each page with the date and a heading for each day.
- Focus on main points and try to use an outline format to take notes to capture key ideas and organize sub-points.
- Take your text to lecture, and keep it open to the topics being discussed. You can also take brief notes in your textbook margin or reference textbook pages in your notebook to help you study later.
- Review and edit your notes shortly after class—within 24 hours—to make sure they make sense and that you've recorded core thoughts. You may also want to compare your notes with a study partner later to make sure neither of you have missed anything.
- This is a very IMPORTANT point: *You can and should also add notes from your reading of the textbook.*

Get a Study Partner Find a few study partners and get together regularly. Four or five study partners to a group is a good number. Too many students make the group unwieldy, but you want enough students to ensure the group can meet even if one or two people can't make it. Having study partners has many benefits. First, they can help you keep your commitment to this class. By having set study dates, you can combine study and social time, and maybe even make it fun! In addition, you now have several minds to help digest the information from the lecture and the text:

- Talk through concepts and go over the difficulties you may be having. Take turns explaining things to each other. You learn a tremendous amount when you teach someone else.
- Compare your notes and solutions with the Practice Problems.
- Try a new approach to a problem or look at the problem from the perspective of your partner. There are often many ways to do the same problem. You can benefit from the insights of others—and they from you—but resist the temptation to simply copy solutions. You need to learn how to solve the problem yourself.
- Quiz each other and discuss some of the Conceptual Questions from the end of the chapter.
- Don't take advantage of your study partner by skipping class or skipping study dates. You obviously won't have a study partner—or a friend—much longer if it's not a mutually beneficial arrangement!

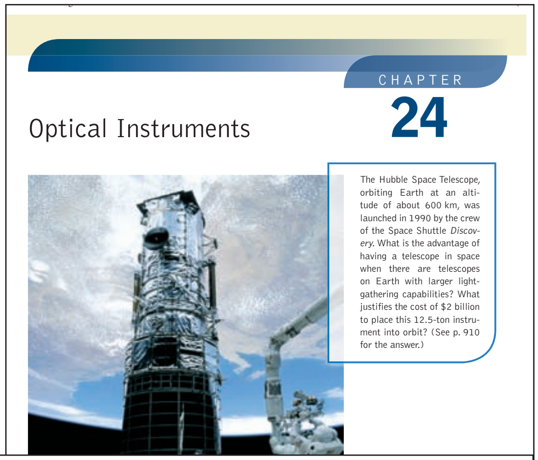
Getting the Most Out of Your Textbook

We hope that you enjoy your physics course using this text. While studying physics does require hard work, we have tried to remove the obstacles that sometimes make introductory physics unnecessarily difficult. We have also tried to reveal the beauty inherent in the principles of physics and how these principles are manifest all around you.

In our years of teaching experience, we have found that studying physics is a skill that must be learned. It's much more effective to *study* a physics textbook, which involves active participation on your part, than to read through passively. Even though active study takes more time initially, in the long run it will save you time; you learn more in one active study session than in three or four superficial readings.

As you study, take particular note of the following elements:

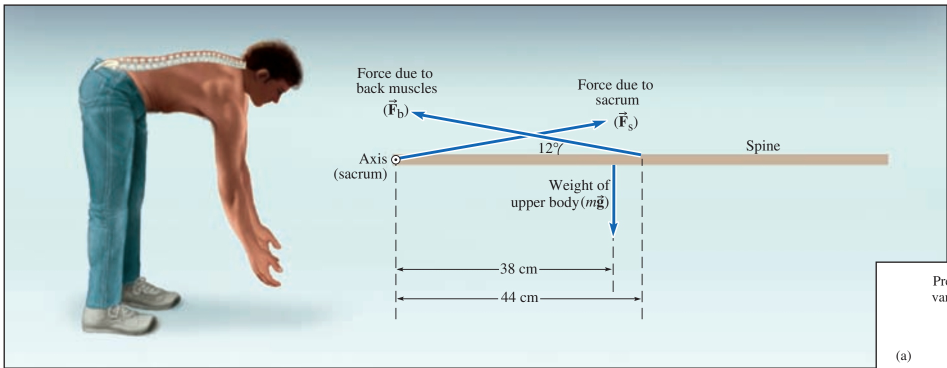
Consider the **chapter opener**. It will help you make the connection between the physics you are about to study and how it affects the world around you. Each chapter opener includes a photo and vignette designed to pique your interest in the chapter. The vignette describes the situation shown in the photo and asks you to consider the relevant physics. The question is then answered within the chapter. Look for the reduced opener photo and question on the referenced page.

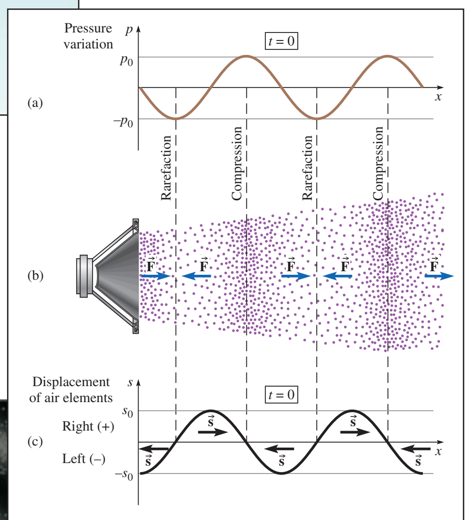


Evaluate the **Concepts & Skills to Review** on the first page of each chapter. It lists important material from previous chapters that you should understand before you start reading. If you have problems recalling any of the concepts, you can revisit the sections referenced in the list.

Concepts & Skills to Review

- distinction between real and virtual images (Section 23.6)
- magnification (Section 23.8)
- refraction (Section 23.3)
- thin lenses (Section 23.9)
- finding images with ray diagrams (Section 23.6)
- small-angle approximations (Appendix A.7)





Study the figures and graphs carefully. **Some elaborate illustrations** and more straightforward **diagrammatic illustrations** are used in combination throughout the text to help you grasp concepts. Complex illustrations help you visualize the most difficult concepts. When looking at graphs, try to see the wealth of information displayed. Ask yourself about the physical meaning of the slope, the area under the curve, the overall shape of the graph, the vertical and horizontal intercepts, and any maxima and minima.

CONNECTION:

Rotational and translational kinetic energies have the same form: $\frac{1}{2}$inertia × speed^2.

Marginal **Connections** headings and summaries adjacent to the coverage in the main text identify areas where important concepts are revisited. Consider the notes carefully to help you recognize how a previously introduced concept is being applied to the current discussion.

Checkpoint questions appear in applicable sections of the text to allow you to test your understanding of the concept explored within the current section. The answers to the Checkpoints are found at the end of the chapter so that you can confirm your knowledge without jumping too quickly to the provided answer.

CHECKPOINT 8.2

You are trying to loosen a nut, without success. Why might it help to switch to a wrench with a longer handle?

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icons identify opportunities for you to access additional information or explanation of topics of interest online.

Various **Reinforcement Notes** appear in the margin to emphasize the important points in the text.

Definition of displacement:

$$\Delta\vec{\mathbf{r}} = \vec{\mathbf{r}}_f - \vec{\mathbf{r}}_i \qquad (3\text{-}1)$$

Reminder: the symbol Δ stands for *the change in*. If the initial value of a quantity Q is Q_i and the final value is Q_f, then $\Delta Q = Q_f - Q_i$. ΔQ is read "delta Q."

Important **Equations** are numbered for easier reference. Equations that correspond to important laws are boxed for quick identification.

Statements of important physics **Rules and Laws** are boxed to highlight the most important and central concepts.

The Law of Conservation of Energy

The total energy in the universe is unchanged by any physical process:

total energy before = total energy after.

Problem-Solving Strategy for Newton's Second Law

- Decide what objects will have Newton's second law applied to them.
- Identify all the *external* forces acting on that object.
- Draw an FBD to show all the forces acting on the object.
- Choose a coordinate system. If the direction of the net force is known, choose axes so that the net force (and the acceleration) are along one of the axes.
- Find the net force by adding the forces as vectors.
- Use Newton's second law to relate the net force to the acceleration.
- Relate the acceleration to the change in the velocity vector during a time interval of interest.

Boxed **Problem-Solving Strategies** give detailed information on solving a particular type of problem. These are supplied for the most fundamental physical rules and laws.

A **problem-solving tip** will guide you in applying problem-solving techniques.

A **warning note** describes possible points of confusion or any common misconceptions that may apply to a particular concept.

x-axis: $a_x = 0$	**y-axis: constant a_y**	
$\Delta v_x = 0$ (v_x is constant)	$\Delta v_y = a_y \Delta t$	(4-7)
$\Delta x = v_x \Delta t$	$\Delta y = \frac{1}{2}(v_{fy} + v_{iy})\,\Delta t$	(4-8)
	$\Delta y = v_{iy}\,\Delta t + \frac{1}{2}a_y(\Delta t)^2$	(4-9)
	$v_{fy}^2 - v_{iy}^2 = 2a_y\,\Delta y$	(4-10)

Why are only two equations shown in the column for the x-axis? The other two are redundant when $a_x = 0$.

Note that there is no mixing of components in Eqs. (4-7) through (4-10). Each equation pertains either to the x-components or to the y-components; none contains the x-component of one vector quantity and the y-component of another. The only quantity that appears in both x- and y-component equations is the time interval—a scalar.

An object in free fall near the Earth's surface has a constant acceleration. As long as air resistance is negligible, the constant downward pull of gravity gives the object a constant downward acceleration equal to $\vec{\mathbf{g}}$. In Section 4.3 we considered objects in free fall, but only when they had no horizontal velocity component, so they moved straight up or straight down. Now we consider objects (called **projectiles**) in free fall that have a *nonzero* horizontal velocity component. The motion of a projectile takes place in a vertical plane.

Suppose some medieval marauders are attacking a castle. They have a catapult that propels large stones into the air to bombard the walls of the castle (Fig. 4.23). Picture a stone leaving the catapult with initial velocity $\vec{\mathbf{v}}_i$. ($\vec{\mathbf{v}}_i$ is the *initial* velocity for the time interval during which it moves as a projectile. It is also the *final* velocity for the time interval during which it is in contact with the catapult.) The **angle of elevation** is the angle of

Example 6.4

Bungee Jumping

A bungee jumper makes a jump in the Gorge du Verdon in southern France. The jumping platform is 182 m above the bottom of the gorge. The jumper weighs 780 N. If the jumper falls to within 68 m of the bottom of the gorge, how much work is done by the bungee cord on the jumper during his descent? Ignore air resistance.

Strategy Ignoring air resistance, only two forces act on the jumper during the descent: gravity and the tension in the cord. Since the jumper has zero kinetic energy at both the highest and lowest points of the jump, the change in kinetic energy for the descent is zero. Therefore, the total work done by the two forces on the jumper must equal zero.

Solution Let W_g and W_c represent the work done on the jumper by gravity and by the cord. Then

$$W_{total} = W_g + W_c = \Delta K = 0$$

The work done by gravity is

$$W_g = F_y \Delta y = -mg\, \Delta y$$

where the weight of the jumper is $mg = 780$ N. With $y = 0$ at the bottom of the gorge, the vertical component of the displacement is

$$\Delta y = y_f - y_i = 68 \text{ m} - 182 \text{ m} = -114 \text{ m}$$

Then the work done by gravity is

$$W_g = -(780 \text{ N}) \times (-114 \text{ m}) = +89 \text{ kJ}$$

The work done by the cord is $W_c = W_{total} - W_g = -89$ kJ.

Discussion The work done by gravity is positive, since the force and the displacement are in the same direction (downward). If not for the negative work done by the cord, the jumper would have a kinetic energy of 89 kJ after falling 114 m.

The length of the bungee cord is not given, but it does not affect the answer. At first the jumper is in free fall as the cord plays out to its full length; only then does the cord begin to stretch and exert a force on the jumper, ultimately bringing him to rest again. Regardless of the length of the cord, the total work done by gravity and by the cord must be zero since the change in the jumper's kinetic energy is zero.

Practice Problem 6.4 The Bungee Jumper's Speed

Suppose that during the jumper's descent, at a height of 111 m above the bottom of the gorge, the cord has done −21.7 kJ of work on the jumper. What is the jumper's speed at that point?

CHECKPOINT 6.3

Kinetic energy and work are related. Can kinetic energy ever be negative? Can work ever be negative?

6.4 GRAVITATIONAL POTENTIAL ENERGY (1)

Gravitational Potential Energy When Gravitational Force Is Constant

Toss a stone up with initial speed v_i. Ignoring air resistance, how high does the stone go? We can solve this problem with Newton's second law, but let's use work and energy instead. The stone's initial kinetic energy is $K_i = \frac{1}{2}mv_i^2$. For an upward displacement Δy, gravity does negative work $W_{grav} = -mg\, \Delta y$. No other forces act, so this is the total work done on the stone. The stone is momentarily at rest at the top, so $K_f = 0$. Then

When you come to an **Example**, pause after you've read the problem. Think about the strategy you would use to solve the problem. See if you can work through the problem on your own. Now study the ***Strategy***, ***Solution***, and ***Discussion*** in the textbook. Sometimes you will find that your own solution is right on the mark; if not, you can focus your attention on the areas of misunderstanding or any mistakes you may have made.

Work the ***Practice Problem*** after each Example to practice applying the physics concepts and problem-solving skills you've just learned. Check your answer with the one given at the end of the chapter. If your answer isn't correct, review the previous section in the textbook to try to find your mistake.

Application headings identify places in the text where physics can be applied to other areas of your life. Familiar topics and interests are discussed in the accompanying text, including examples from biology, archaeology, astronomy, sports, and the everyday world. The biology/life science examples have a special icon.

Banked Curves To help prevent cars from going into a skid or losing control, the roadway is often banked (tilted at a slight angle) around curves so that the outer portion of the road—the part farthest from the center of curvature—is higher than the inner portion. Banking changes the angle and magnitude of the normal force, $\vec{\mathbf{N}}$, so that it has a horizontal component N_x directed toward the center of curvature (in the

Application of radial acceleration and contact forces: banked roadways

Application of the manometer: measuring blood pressure

Try the ***Physics at Home*** experiments in your dorm room or at home. They reinforce key physics concepts and help you see how these concepts operate in the world around you.

PHYSICS AT HOME

Drop a very tiny speck of dust or lint into a container of water and push the speck below the surface. The motion of the speck—called *Brownian motion*—is easily observed as it is pushed and bumped about randomly by collisions with water molecules. The water molecules themselves move about randomly, but at much higher speeds than the speck of dust due to their much smaller mass.

Master the Concepts

- Fluids are materials that flow and include both liquids and gases. A liquid is nearly incompressible, whereas a gas expands to fill its container.
- Pressure is the perpendicular force per unit area that a fluid exerts on any surface with which it comes in contact ($P = F/A$). The SI unit of pressure is the pascal ($1 \text{ Pa} = 1 \text{ N/m}^2$).
- The average air pressure at sea level is 1 atm = 101.3 kPa.
- Pascal's principle: A change in pressure at any point in a confined fluid is transmitted everywhere throughout the fluid.
- The average density of a substance is the ratio of its mass to its volume

$$\rho = \frac{m}{V} \quad (9\text{-}2)$$

- The specific gravity of a material is the ratio of its density to that of water at 4°C.
- Pressure variation with depth in a static fluid:

$$P_2 = P_1 + \rho g d \quad (9\text{-}3)$$

where point 2 is a depth d

- Instruments to measure pr... and the barometer. The ... sure of the atmosphere. ... pressure difference.

equal in magnitude to the weight of the volume of fluid displaced by the object:

$$F_B = \rho g V \quad (9\text{-}7)$$

where V is the volume of the part of the object that is submerged and ρ is the density of the fluid.

- In steady flow, the velocity of the fluid *at any point* is constant in time. In laminar flow, the fluid flows in neat layers so that each small portion of fluid that passes a particular point follows the same path as every other portion of fluid that passes the same point. The path that the fluid follows, starting from any point, is called a streamline. Laminar flow is steady. Turbulent flow is chaotic and unsteady. The viscous force opposes the flow of the fluid; it is the counterpart to the frictional force for solids.
- An ideal fluid exhibits laminar flow, has no viscosity, and is incompressible. The flow of an ideal fluid is governed by two principles: the continuity equation and Bernoulli's equation.

Write your *own* chapter summary or outline, adding notes from class where appropriate, and then compare it with the ***Master the Concepts*** provided at the end of the chapter. This will help you identify the most important and fundamental concepts in each chapter.

Along with working the problems assigned by your instructor, try quizzing yourself on the **Multiple-Choice Questions.** Check your answers against the answers at the end of the book. Consider the **Conceptual Questions** to check your qualitative understanding of the key ideas from the chapter. Try writing some responses to practice your writing skills and to help prepare for any essay problems on the exam.

5.1 Description of Uniform Circular Motion

1. A carnival swing is fixed on the end of an 8.0-m-long beam. If the swing and beam sweep through an angle of 120°, what is the distance through which the riders move?
2. A soccer ball of diameter 31 cm rolls without slipping at a linear speed of 2.8 m/s. Through how many revolutions has the soccer ball turned as it moves a linear distance of 18 m?
3. Find the average angular speed of the second hand of a

When working the **Problems** and **Comprehensive Problems** assigned by your instructor, pay special attention to the explanatory paragraph below the Problem heading and the keys accompanying each problem.

Problems

- Combination conceptual/quantitative problem
- Biological or medical application
- ✦ Challenging problem
- Blue # Detailed solution in the Student Solutions Manual
- 1 2 Problems paired by concept
- Text website interactive or tutorial

5.1 Description of Uniform Circular Motion

1. A carnival swing is fixed on the end of an 8.0-m-l... beam. If the swing and beam sweep through an angl... 120... mov...

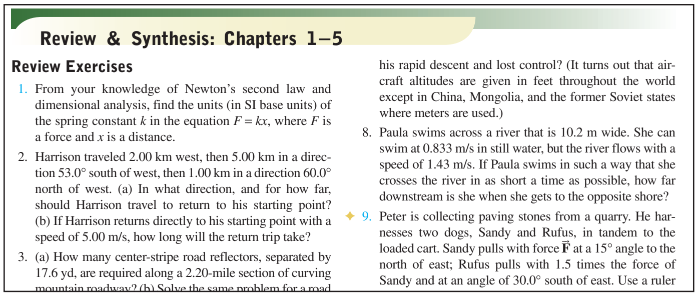
✦114. A student's head is bent over her physics book. The head weighs 50.0 N and is supported by the muscle force $\vec{\mathbf{F}}_m$ exerted by the neck extensor muscles and by the contact force $\vec{\mathbf{F}}_c$ exerted at the atlantooccipital joint. Given that the magnitude of $\vec{\mathbf{F}}_m$ is 60.0 N and is directed 35° below the horizontal, find (a) the magnitude and (b) the direction of $\vec{\mathbf{F}}_c$.

- ***Paired Problems*** are connected with a bracket. Your instructor may assign the even-numbered problem, which has no answer at the end of the book. However, working the connected odd-numbered problem will allow you to check your answer at the back of the book and apply what you have learned to working the even-numbered problem.
- Problem numbers highlighted in blue have a solution available in the ***Student Solutions Manual*** if you need additional help or would like to double-check your work.
- The ***difficulty level*** for each problem is indicated. The least difficult problems and problems of intermediate difficulty have no diamond. The more challenging problems have one diamond ✦.

Read through all of the assigned problems and budget your time accordingly.

- indicates a combination **Conceptual and Quantitative** problem.
- indicates a problem with a biological or medical application.
- indicates a problem that has an accompanying interactive or tutorial online.

While working your solutions to problems, try to **keep your work in symbolic form** until the very end. Symbolic solutions will allow you to view which factors affect the results and how the answer would change should any one of the variables in the problem change their value. In this fashion, your solution to any one problem becomes a solution to a whole series of similar problems. Substituting values into your final symbolic solution will then enable you to judge if your answer is reasonable and provide greater ease in troubleshooting your error if it is not. Always perform a "reality check" at the end of each problem. Did you obtain a reasonable answer given the question being asked?



Review & Synthesis: Chapters 1–5

Review Exercises

1. From your knowledge of Newton's second law and dimensional analysis, find the units (in SI base units) of the spring constant k in the equation $F = kx$, where F is a force and x is a distance.
2. Harrison traveled 2.00 km west, then 5.00 km in a direction 53.0° south of west, then 1.00 km in a direction 60.0° north of west. (a) In what direction, and for how far, should Harrison travel to return to his starting point? (b) If Harrison returns directly to his starting point with a speed of 5.00 m/s, how long will the return trip take?
3. (a) How many center-stripe road reflectors, separated by 17.6 yd, are required along a 2.20-mile section of curving mountain roadway? (b) Solve the same problem for a road

his rapid descent and lost control? (It turns out that aircraft altitudes are given in feet throughout the world except in China, Mongolia, and the former Soviet states where meters are used.)

8. Paula swims across a river that is 10.2 m wide. She can swim at 0.833 m/s in still water, but the river flows with a speed of 1.43 m/s. If Paula swims in such a way that she crosses the river in as short a time as possible, how far downstream is she when she gets to the opposite shore?
9. Peter is collecting paving stones from a quarry. He harnesses two dogs, Sandy and Rufus, in tandem to the loaded cart. Sandy pulls with force $\vec{\mathbf{F}}$ at a 15° angle to the north of east; Rufus pulls with 1.5 times the force of Sandy and at an angle of 30.0° south of east. Use a ruler

After a group of related chapters, you will find a **Review & Synthesis** section. This section will provide ***Review Exercises*** that require you to combine two or more concepts learned in the previous chapters. Working these problems will help you to prepare for cumulative exams. This section also contains ***MCAT Review*** exercises. These problems were written for the actual MCAT exam and will provide additional practice if this exam is part of your future plans.

How to Study for an Exam

- Be an active learner:
  - read
  - be an active participant in class; ask questions
  - apply what you've learned; think through scenarios rather than memorizing your notes
- Finish reading all material—text, notes, handouts—at least three days prior to the exam.
- Three days prior to the exam, set aside time each day to do self-testing, work practice problems, and review your notes. Useful tools to help:
  - end-of-chapter summaries
  - questions and practice problems
  - text website
  - your professor's course website
  - the Student Solutions Manual
  - your study partner
- Analyze your weaknesses, and create an "I don't know this yet" list. Focus on strengthening these areas and narrow your list as you study.
- If you find that you were unable to allow the full three days to study for the exam, the most important thing you can do is try some practice problems that are similar to those your instructor assigned for homework. Choose odd-numbered problems so that you can check your answer. The Review & Synthesis problems are designed to help you prepare for exams. Try to solve each problem under exam conditions—use a formula sheet, if your instructor provides one with the exam, but don't look at the book or your notes. If you can't solve the problem, then you have found an area of weakness. Study the material needed to solve that problem and closely related material. Then try another similar problem.
- VERY IMPORTANT—Be sure to sleep and eat well before the exam. Staying up late and memorizing the night before an exam doesn't help much in physics. On a physics exam, you will be asked to demonstrate reasoning and analytical skills acquired by much practice. If you are fatigued or hungry, you won't perform at your highest level.

We hope that these suggestions will help you get the most out of your physics course. After many years working with students, both in the classroom and one-on-one in a self-paced course, we wrote this book so you could benefit from our experience. In *College Physics*, we have tried to address the points that have caused difficulties for our students in the past. We also wish to share with you some of the pleasure and excitement we have found in learning about the physical laws that govern our world.

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