Chapter 1 Supplement

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:

- 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 and Perseverance

Learning and mastering takes time and patience. A regular, sustained effort is much more effective than sporadic bouts of cramming.

Getting Organized

Take the time before your course begins to analyze your life and your study habits. Get organized at the beginning of the semester and you'll find you have 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.
- By the same token, **keep everything for your physics course 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, pencils, erasers, calculator, and laptop or tablet.

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 work without being interrupted. This could include a quick 5 minute review before class or a 1 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.
- **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***.

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 to 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 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 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 subpoints.
- 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 one another. 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 one another 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 won't have a study partner or friend much longer if it's not a mutually beneficial arrangement!

Getting the Most Out of Your Textbook

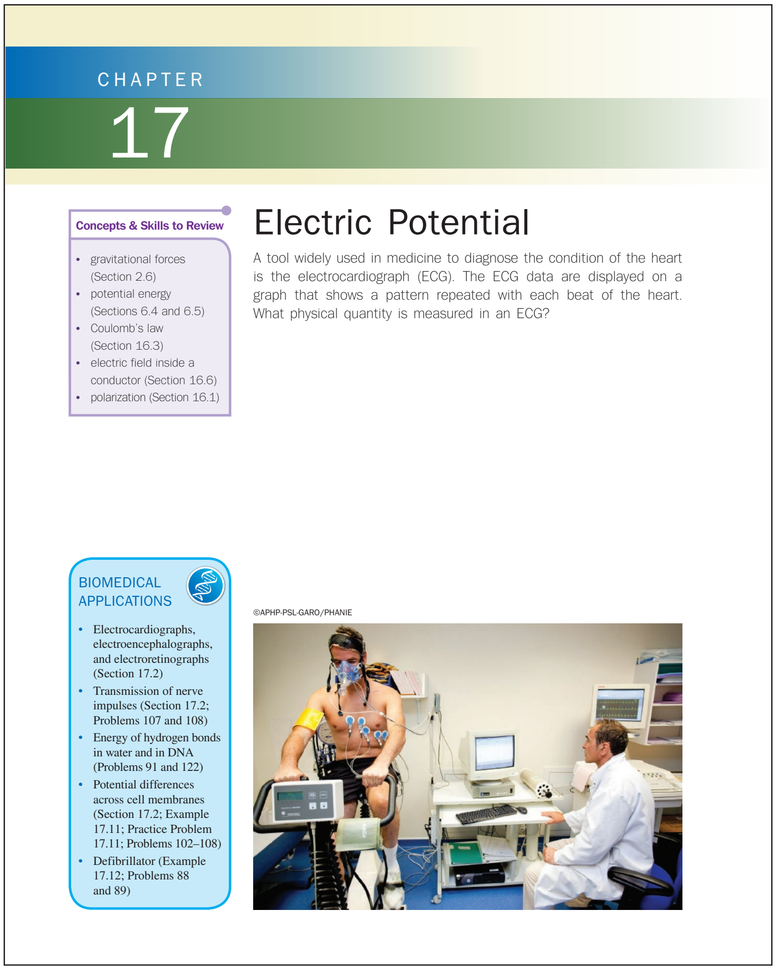
Although studying physics does require hard work, it can also be rewarding. This textbook is carefully designed to remove obstacles that sometimes make introductory physics unnecessarily difficult, while revealing the beauty inherent in the principles of physics and in how the principles illuminate the world around you.

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 repeated 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.

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.


CHAPTER 17

Electric Potential

Concepts & Skills to Review

- gravitational forces (Section 2.6)
- potential energy (Sections 6.4 and 6.5)
- Coulomb's law (Section 16.3)
- electric field inside a conductor (Section 16.6)
- polarization (Section 16.1)

A tool widely used in medicine to diagnose the condition of the heart is the electrocardiograph (ECG). The ECG data are displayed on a graph that shows a pattern repeated with each beat of the heart. What physical quantity is measured in an ECG?

BIOMEDICAL APPLICATIONS

- Electrocardiographs, electroencephalographs, and electroretinographs (Section 17.2)
- Transmission of nerve impulses (Section 17.2; Problems 107 and 108)
- Energy of hydrogen bonds in water and in DNA (Problems 91 and 122)
- Potential differences across cell membranes (Section 17.2; Example 17.11; Practice Problem 17.11; Problems 102–108)
- Defibrillator (Example 17.12; Problems 88 and 89)

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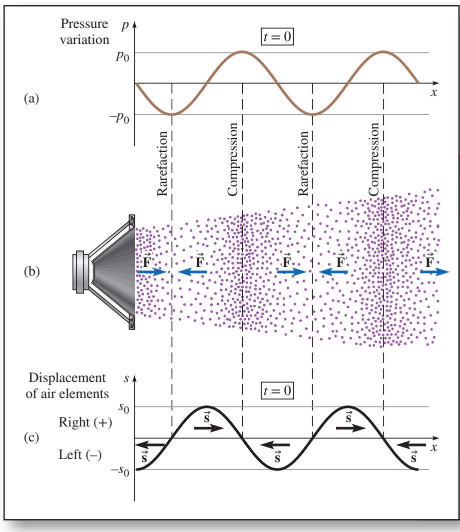
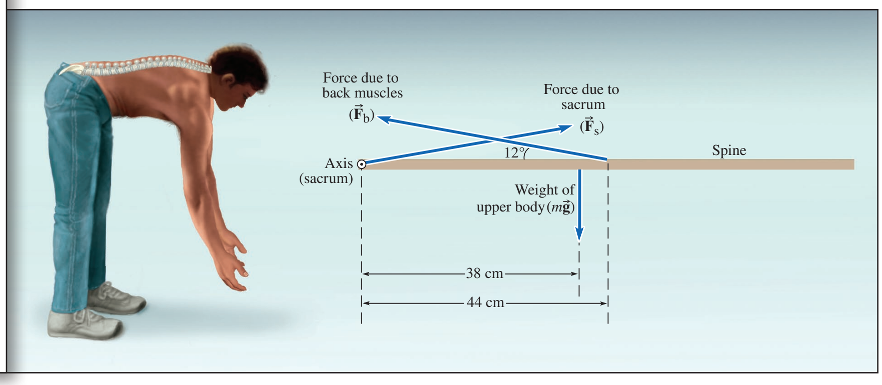
Study the figures and graphs carefully. When looking at graphs, try to see the wealth of information displayed. Ask yourself about the physical meaning of the slope, the area under the curve, the overall shape of the graph, the vertical and horizontal intercepts, and any maxima and minima.





CONNECTION:

The loop rule is just energy conservation written in a convenient form for circuits.

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?

Definition of electric field

$$\vec{\mathbf{E}} = \frac{\vec{\mathbf{F}}_E}{q} \tag{16-5}$$

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

The Law of Conservation of Energy

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

total energy before = total energy after.

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

Problem-Solving Strategy for Collisions Involving Two Objects

1. Draw before and after diagrams of the collision.
2. Collect and organize information on the masses and velocities of the two objects before and after the collision. Express the velocities in component form (with correct algebraic signs).
3. Set the sum of the momenta of the two before the collision equal to the sum of the momenta after the collision. Write one equation for each component:

$$m_1v_{1ix} + m_2v_{2ix} = m_1v_{1fx} + m_2v_{2fx} \tag{7-26}$$

$$m_1v_{1iy} + m_2v_{2iy} = m_1v_{1fy} + m_2v_{2fy} \tag{7-27}$$

4. If the collision is known to be perfectly inelastic, set the final velocities equal:

$$v_{1fx} = v_{2fx} \quad \text{and} \quad v_{1fy} = v_{2fy} \tag{7-28}$$

5. If the collision is known to be perfectly elastic, then either set the final kinetic energy equal to the initial kinetic energy:

$$\frac{1}{2}m_1v_{1i}^2 + \frac{1}{2}m_2v_{2i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2 \tag{7-29}$$

or set the relative speeds equal. For a one-dimensional collision along the x-axis, we would write

$$v_{2ix} - v_{1ix} = -(v_{2fx} - v_{1fx}) \tag{7-30}$$

6. Solve for the unknown quantities.

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.

Example 6.9

Archery Practice

To draw back a *simple* bow, the force the archer exerts on the string continues to increase as the displacement of the string increases and the bow bends slightly. The force-versus-position graph of Fig. 6.28 describes such a bow. Calculate the work done by the archer on the string as he draws the string back 40.0 cm.

Strategy The work done by the archer is the area under the force-versus-position graph. This time, instead of counting rectangles, we can calculate the triangular area formed by the force-versus-position graph.

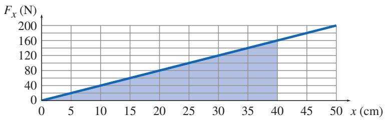


Figure 6.28

A simple bow requires a force proportional to the displacement of the string.

Solution We want to find the work done by the archer to draw the string back 40.0 cm, so the base of the triangle is 40.0 cm. The altitude of the triangle is the force at 40.0 cm: 160 N. The area of a triangle is $\frac{1}{2}$(base × altitude), so

$$W = \frac{1}{2}(0.400 \text{ m} \times 160 \text{ N}) = +32 \text{ J}$$

Discussion To check, we can count the number of rectangles (including the half rectangles) that lie under the graph. There are 32 rectangles and each represents 20 N × 0.05 m = 1 J of work, so the answer is correct.

By doing 32 J of work on the bowstring, the archer stores this much energy in the bow. When the arrow is released, the bowstring does 32 J of work on the arrow, giving the arrow a kinetic energy of 32 J.

Practice Problem 6.9 A Gentle Pull

How much work would you do to draw the string of the *compound* bow (see Fig. 6.26) back 10.0 cm?

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.

Application: Transmission of Nerve Impulses A nerve cell or *neuron* consists of a cell body and a long extension, called an *axon* (Fig. 17.14a). Human axons are 10 to 20 μm in diameter. When the axon is in its resting state, negative ions on the inner surface of the membrane and positive ions on the outer surface cause the fluid inside to be at a potential of about −85 mV relative to the fluid outside.

Try the **Everyday Physics Demos** 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.

EVERYDAY PHYSICS DEMO

A DVD (or CD) can be used as a reflection grating, since it has a large number of equally spaced reflective tracks. Hold a DVD at an angle so that the side without the label reflects light from the Sun or another light source. Tilt it back and forth slightly and look for the rainbow of colors that results from the interference of light reflecting from the narrowly spaced grooves. Next place the DVD, label side down, on the floor directly below a ceiling light. Look down at the DVD as you slowly walk away from it. The first-order maxima form a band of colors (violet to red). Once you are a meter or so away, gradually lower your head to the floor, watching it the whole time. You have now observed from $\theta = 0$ to $\theta = 90°$. Count how many orders of maxima you see for the different colors. Now estimate the spacing between tracks on the DVD.

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.

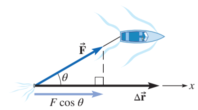
Along with working the problems assigned by your instructor, try quizzing yourself on the **Multiple-Choice Questions**. Check your answers against the answers at the end of the book. Consider the **Conceptual Questions** to check your qualitative understanding of the key ideas from the chapter. Try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

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.

Master the Concepts

- Conservation law: a physical law phrased in terms of a quantity that does not change with time.
- The law of conservation of energy: the total energy of the universe is unchanged by any physical process.
- Work is an energy transfer due to the application of a force. The work done by a force on an object can be positive, negative, or zero. Positive work increases the object's energy; negative work decreases it. The work done by a constant force $\vec{F}$ acting on an object during a displacement $\Delta\vec{r}$ is

$$W = F\,\Delta r \cos\theta \qquad (6\text{-}2)$$



where θ is the angle between $\vec{F}$ and $\Delta\vec{r}$. If $\vec{F}$ or $\Delta\vec{r}$ is parallel to the x-axis,

$$W = F_x\,\Delta x \qquad (6\text{-}3)$$

- When several forces act on an object, the total work is the sum of the work done by each force individually.
- Translational kinetic energy is the energy associated with motion of the object as a whole. The translational kinetic energy of an object of mass m moving with speed v is

$$K = \frac{1}{2}mv^2 \qquad (6\text{-}14)$$

energy; they just change one form of mechanical energy into another. The work done by nonconservative forces is equal to the change in mechanical energy:

$$W_{nc} + (K_i + U_i) = (K_f + U_f) \qquad (6\text{-}25)$$

When the work done by nonconservative forces is zero, the mechanical energy does not change.

$$\text{If } W_{nc} = 0, \quad K_i + U_i = K_f + U_f \qquad (6\text{-}23)$$

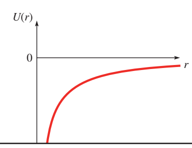
- The gravitational potential energy for an object of mass m in a *uniform* gravitational field is

$$U_{grav} = mgy \qquad (6\text{-}26)$$

where the $+y$-axis points up and we assign $U = 0$ at the point $y = 0$.
- The gravitational potential energy for two objects of masses m_1 and m_2 whose centers are separated by a distance r is

$$U = -\frac{Gm_1m_2}{r} \qquad (6\text{-}27)$$

where we assign $U = 0$ to infinite separation ($r = \infty$).



Problems

Combination conceptual/quantitative problem
Biomedical application
Challenging
Blue # Detailed solution in the Student Solutions Manual
[1, 2] Problems paired by concept

14.1 Internal Energy

1. A mass of 1.4 kg of water at 22°C is poured from a height of 2.5 m into a vessel containing 5.0 kg of water at 22°C. (a) How much does the internal energy of the 6.4 kg of water increase? (b) Is it likely that the water temperature increases? Explain.
2. The water passing over Victoria Falls, located along the Zambezi River on the border of Zimbabwe and Zambia, drops about 105 m. How much internal energy is produced per kilogram as a result of the fall?
3. How much internal energy is generated when a 20.0 g lead bullet, traveling at 7.00×10^2 m/s, comes to a stop as it strikes a metal plate?
4. Nolan threw a baseball, of mass 147.5 g, at a speed of 162 km/h to a catcher. How much internal energy was generated w

57. Doppler ultrasound is used to measure the speed of blood flow (see Problem 49). The reflected sound interferes with the emitted sound, producing beats. If the speed of red blood cells is 0.10 m/s, the ultrasound frequency used is 5.0 MHz, and the speed of sound in blood is 1570 m/s, what is the beat frequency?
58. (a) In Problem 49, find the beat frequency between the outgoing and reflected sound waves. (b) Show that the beat frequency is proportional to the speed of the blood cell if $v \ll u$. [*Hint*: Use the binomial ap-

Review and Synthesis

94. A green laser has a wavelength of 532 nm. A grating and a lens are used to split the beam into three parallel beams spaced 1.85 cm apart. (a) What range of slit spacings can the grating have to produce three and only three beams? (b) If the slit spacing is 1.0 μm, what focal length lens should be used?
95. A refracting telescope is 36.4 cm long and has a 6.0 cm diameter aperture. The magnifying power is 90.0. (a) What are the focal lengths of the lenses? (b) What is the diffraction limit on the minimum angular separation of objects that the telescope can resolve in 500 nm light?

- **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 ✦.
- indicates a combination **Conceptual and Quantitative** problem.
- indicates a problem with a biological or medical application.

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?

At the end of most chapters, you will find a **Review & Synthesis** section. This section will provide 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.

How to Study for an Exam

- At least 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.
- 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.

I hope these suggestions will help you get the most out of your physics course—not only to earn a good grade, but also to come away with a valuable set of skills and an enhanced understanding of and appreciation for the world around you. Have a great semester!

Alan Giambattista