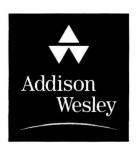
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PAUL G. HEWITT



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Assistant Editor: Liana Allday

Marketing Manager: Christy Lawerence Managing Editor: Diane Southworth Manufacturing Buyer: Stacey Weinberger

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The Conceptual Physics Photo Album

Conceptual Physics is a very personal book, reflected in the many photographs of family and friends that grace its pages. Closest to the writing of this edition is Ken Ford, former CEO of the American Institute of Physics, to whom the Eighth Edition was dedicated. Ken's hobby of gliding is appropriately shown in Figure 20.18, page 392, and his dedication to teaching in the opening photo of Chapter 35, page 686, with high school students at Germantown Academy in Pennsylvania. Also assisting in the production of this edition is Lillian Lee, to whom this book is dedicated. She is shown in the Chapter 1 opening photo on page 2, and in Figures 16.18 and 20.3, pages 316 and 383. Lillian holds her colorful pet conure on page 523.

The opening photo on page 1 is of Charlie Spiegel with his great granddaughter, Sarah Stafford. The First Edition of *Conceptual Physical Science* was dedicated to resourceful Charlie, who has since passed away. His personal touch to earlier editions carries over in this one. He is shown again on page 502.

Part openers with the cartoon style blurbs about physics are of family and close friends. Part 1 on page 19 shows Debbie and Natalie Limogan, children of my dear San Francisco friends, Hideko and Herman Limogan. The little boy in the middle is Genichiro Nakada. Part two on page 201 is Chucky Clement, grandson of dear and departed friend Mac Richardson, who was my teaching assistant with Lillian back in 1978. Part 3 opens on page 289 with Terrence Jones, son of my niece Corine Jones. Part 4, page 361, is my grandson Alexander Hewitt, and Part 5, page 411, is my granddaughter Megan, daughter of Leslie and Bob Abrams. Part 6, page 495, is Lillian's niece, Serena Sinn. Grandchildren Alexander and Grace Hewitt open Part 7 on page 623. Alexander alone opens Part 8 on page 623.

To celebrate this Ninth Edition, chapter-opening photographs are of teacher friends, mostly in their classrooms. Their names appear with their photos. In most cases they're demonstrating physics typical of the chapter material.

City College of San Francisco friends and colleagues open Chapters 3-6, 13, and 23. On page 96 we see Will Maynez with the air track he designed and built, and again burning a peanut on page 325. Dave Wall is shown next to my daughter on page 600. Dave's daughter, Ellender, who was featured as the little girl working with electronics in the Fourth Edition, now co-authors a physics text with her dad (that her "Uncle Paul" illustrated). The karate gal on page 90, is former CCSF student Cassy Cosme. This is a colorized black and white photo that graced three editions of this book before it went full color in the Seventh Edition.

University of Hawaii at Hilo friends and colleagues are featured in photo openers for Chapters 25, 30, 33, and 36.

High-school-physics-teachers include Chicago's finest, close friend Marshall Ellenstein, who walks barefoot on broken glass on page 263. Marshall, a long-time contributor to *Conceptual Physics*, edited the *Conceptual Physics Alive!* video series and has recently converted the tapes to DVDs. He is again seen opening Chapter 8 on page 125. Page 117 shows dear friend and dedicated San Mateo physics teacher, Pablo Robinson, who risks his body for science on

the bed of nails. Pablo, shown again on page 515, is the author of the lab manual that accompanies this book. His wife Ellyn opens Chapter 15 on page 290. An old black and white photo of Pablo's children, David and Kristin, is shown on page 152.

Family photos begin with the touching photo, Figure 5.15 on page 77, of son Paul and his daughter Grace. The prior touching photo in the Eighth Edition of my brother Steve with his daughter Gretchen at their coffee farm in Costa Rica is now on page 83. Son Paul is again shown on pages 308 and 345. His lovely wife, Ludmila, holds crossed Polaroids on page 579, and their dog Hanz pants on page 325. The endearing girl on page 204 is my daughter Leslie, now a mom, teacher, and earth-science co-author of our Conceptual Physical Science textbook. This photo of Leslie, now colorized, has been a trademark of Conceptual Physics since the Third Edition. A more recent photo of her, with husband Bob Abrams, is on page 600. Their children, Megan and Emily, make up the colorful set of photos on page 522. My late son James is shown on pages 144, 401, and 555. He left me my first grandson, Manuel, who is shown on pages 236, 389, and 709. Manuel helps his granddad with computer problems and lives in Hilo with me and my wife, Millie Hewitt, who bravely holds her hand above the active pressure cooker on page 308. Brother Dave (no, not a twin) and his wife Barbara demonstrate atmospheric pressure on page 272. Sister Marjorie Hewitt Suchocki (pronounced Su-hock'-ee, with silent c), an author and theologian at a graduate school in the Claremont Colleges, illustrates reflection on page 535. Marjorie's son, John Suchocki, my chemistry co-author of Conceptual Physical Science, Addison Wesley, 1999, walks fearlessly across hot coals on page 305 in the opener for Chapter 16 (for emphasis, David Willey does the same on page 336). Nephew John has recently written Conceptual Chemistry, Benjamin Cummings, © 2001. The group listening to music on page 406 are part of John's and Tracy's wedding party; from left to right, Butch Orr, my niece Cathy Candler, bride and groom, niece Joan Lucas, sister Marjorie, Tracy's parents Sharon and David Hopwood, teacher friends Kellie Dippel and Mark Werkmeister, and myself.

Personal friends begin with Tenny Lim, who draws her bow on page 108 as she has been doing since the Sixth Edition. Three dear friends from school days are Howie Brand on page 115, Bob Hulsman on page 458, and Dan Johnson on page 341. My buddy Tim Gardner demonstrates Bernoulli's principle on page 278. Lifelong friend Paul Ryan drags his finger through molten lead on page 336. My friend and mentor from sign painting days, Burl Grey, is shown on page 20. New friend Praful Shah is shown on page 154. Physics buddy John Hubisz is shown opening Chapter 12, page 226, and again in the entropy photo on page 356. Friends David Vasquez and Helen Yan demonstrate momentum conservation on page 116. David is a key player in the website that accompanies this edition. Helen, who now monitors satellite launches for Lockheed Martin, appears again on page 314, posing with the box she first posed with for the Fifth Edition when she was my teaching assistant. My talented physics editor, Suzanne Lyons, poses with her children Tristan and Simone on page 531. Simone is seen again on page 575. My

xvi Conceptual Physics Photo Album

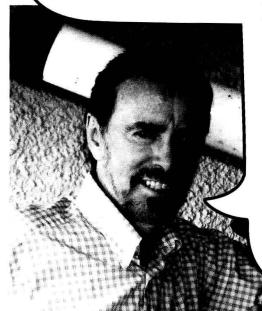
dear Hawaii friends, the Hu family of Honolulu, are seen in several figures, beginning with Meidor, pages 392 and 433, who took many photos for the previous two editions that carry over here. Mom Ping Hu is on page 133, with dad Wai Inn on page 432, brother Tin Hoy on page 461, sister Mei Tuck with husband Gabe Vitelli on page 352, and uncle Chiu Man Wu on page 325, and his daughter, Andrea, on page 123. Even the family rabbit, Beezes, is shown on page 517. San Francisco friend and former student Alexei Cogan demonstrates

center of gravity on page 139. On page 144 another San Francisco friend, Cliff Braun, is at the left in Figure 8.50, with nephew Robert Baruffaldi at the right. Lastly, on page 750 is a cartoon likeness of lifelong friend Ernie Brown, himself a cartoonist, who designed the physics logo.

The inclusion of these people who are so dear to me makes *Conceptual Physics* all the more my labor of love.

To the Student

You know you can't enjoy a game unless you know its rules; whether it's a ball game, a computer game, or simply a party game. Likewise, you can't fully appreciate your surroundings until you understand the rules of nature. Physics is a study of these rules, which will show you how everything in nature is beautifully connected. So the main reason to study physics is to enhance the way you see the physical world. You'll see the mathematical structure of physics in frequent equations, but more than being recipes for computation, you'll see the equations as guides to thinking.



I enjoy physics, and you will too
— because you'll understand it.

If you get hooked and take a
follow-up course, then you can
focus on mathematical problems.

Go for comprehension of
concepts now, and if
computation follows, it will be
with understanding.

Enjoy your physics!

PAUL G. HEWITT

To the Instructor

One of the small changes in this edition can lead to an enormous change in your physics course. It's the one-chapter delay to the study of kinematics. After the traditional opening chapter (About Science), I begin with the first of Newton's laws of motion instead of beginning mechanics with kinematics, as in previous editions. Kinematics all too often dominates a lion's share of an introductory physics course, sometimes being the "black hole" of physics instruction—taking too much time for too little gain. It is common for courses that begin in mid-August to still be treating kinematics well up to Halloween. For a course devoted to understanding concepts this is absurd, for the concepts *speed*, *velocity*, and *acceleration* are hardly the most exciting that your course has to offer. Furthermore, the kinematics equations appear to the student as the most intimidating in the book. Although the experienced eye doesn't see them as such, this is how students first see them:

$$\varsigma = \varsigma_0 + \delta \not\ni
\zeta = \varsigma_0 \not\ni + 1/2 \delta \not\ni^2
\varsigma^2 = \varsigma_0^2 + 2\delta \zeta
\varsigma\alpha = (\varsigma_0 + \varsigma)/2$$

If your goal is to reduce class size, display these on the first day and announce that class effort for the next couple of months will be making sense of these equations. Don't we do much the same with the standard symbols?

Whereas Newton's laws were covered in a single chapter in previous editions, here they each have their own chapter. Newton's first law starts with a brief historical overview from Aristotle to Galileo, and then progresses to the main feature of the chapter—the concept of *mechanical equilibrium*. This way your students meet mechanics via the concept of force, much more familiar and comprehensible than the concepts of velocity and acceleration. The vector combination of forces is also easier to grasp than the vector combination of velocities. So your students enter a comfortable part of physics before they meet the equations of kinematics.

They'll do that in the second mechanics chapter (Linear Motion), where the concept of acceleration is introduced, which is needed for Newton's second law. This chapter can serve as an interlude to the sequence of chapters on Newton's laws, and as such, merit less class time. Ask an educated person these two questions and you'll see where their education was concentrated when they took physics: First, ask for the acceleration of free fall. Second, ask what keeps the Earth's interior hot. Many more will correctly answer the first question than the second. The courses they took were likely top heavy in kinematics and low or nil in modern physics. Radioactive decay almost never gets the attention paid to falling bodies.

The third mechanics chapter picks up with Newton's second law, central to mechanics generally, and well deserving of its own separate chapter. Certainly more time can be allotted to this chapter if you sidestep getting bogged down with teaching the math of kinematics in the previous chapter. You'll note that the concepts of velocity, terminal velocity, and acceleration are featured at the end of this chapter, further justifying a lighter treatment earlier.

The fourth mechanics chapter continues with Newton's third law. Since coverage here is less than in previous chapters, the end of the chapter treats the parallelogram rule for combining vectors—both force and velocity vectors. It also introduces vector components.

The next mechanics chapter, as in previous editions, features momentum. Whereas many textbooks treat energy before momentum, I prefer that momentum directly follow Newton's third law mainly because the conservation of momentum is a logical extension. Momentum mv is also much simpler and easier to understand than kinetic energy $\frac{1}{2}mv^2$. And particularly for this edition, the treatment of vectors just learned in the previous chapter is employed with momentum but not with energy.

Whereas in the previous edition projectile motion was covered immediately following the chapter on linear motion, it is postponed to the last mechanics chapter and is combined with satellite motion. A chief benefit of this is postponing a subject that is difficult for many students. But mainly, projectile motion logically leads to satellite motion. Any projectile, moving fast enough, can become an earth satellite. Or moving faster, can become a satellite of the sun. Projectile motion and satellite motion belong together.

The chapters beyond mechanics follow the same sequence as previous editions. All are embellished, and all have selections of new exercises and, where appropriate, new problems.

On problems: I've always seen overemphasis on problem solving as the major folly in physics instruction. My war with this abuse began with absolutely no problems in the first editions of this book. To the nonscience student, physics is enormously interesting and central to a broad education. But when paired with problem solving, the price of admission is simply too high for too many. Hence the traditional lower enrollments in physics courses compared with other science courses. To me this has always been intolerable, for physics is the backbone of every other science discipline. If only one science were to be learned by any educated person, physics would be the logical choice.

By physics, I mean the study of the connections in nature. Shouldn't every welleducated person be knowledgeable about the connection between linear motion and satellite motion? Shouldn't they know about the connection between radioactive atoms and the power of volcanoes? Shouldn't they know that electricity and magnetism connect to become light? These concepts and their connections underlie the other sciences. But when the focus of a course is learning the techniques of solving algebraic problems, the allure of physics is degraded.

An important new feature of this edition is the inclusion of boxes with insightful material to complement the chapter. These include short essays on such topics as energy and technology, railroad train wheels, magnetic strips on credit cards, and maglev trains. Other boxes are devoted to some of the currently accepted fads of pseudoscience, including crystal power, the placebo effect, water dowsing, and magnetic therapy. There are also new boxes on the scare of electromagnetic waves surrounding power lines and the phobia about food irradiation and anything nuclear. To the person who works in the arena of science, who knows the care, checking, and crosschecking that go into understanding a thing, these fads and misconceptions are laughable. But to those who don't work in the science arena, including even your best students, pseudoscience can seem compelling when purveyors skillfully sidestep the tenants of science and masquerade their wares in the clothes of science. It is my hope that these boxes may help stem this rising tide.

Supporting this edition are the *Instructor's Manual* with suggested lectures and demonstrations, the *Next-Time Questions* book, the student *Practicing Physics* book (with answers to the odd-numbered exercises and problems herein), the *Laboratory Manual*, the set of *Transparencies* with an accompanying instruction guide, and the *Test Bank*. The newest feature of this ninth edition, and perhaps the most important, is the supporting web site, www.physicsplace.com.

For more information on the support ancillaries, check the Web site or contact me, Pghewitt@aol.com, or your Addison Wesley representative.

Acknowledgments

I am enormously grateful to Ken Ford for checking this edition for accuracy and for his many insightful suggestions. Many years ago I admired Ken's own books, one of which, *Basic Physics*, inspired me to first write *Conceptual Physics*. Today I am honored that he has given so much of his time and energy to help to make this edition my best ever. Errors invariably crop up after manuscript is submitted, so I take full responsibility for any errors that survive his scrutiny.

For valued suggestions I thank my friends Howie Brand, Marshall Ellenstein, John Hubisz, Bob and Lotte Hulsman, Burl Grey, Mike Kan, Dan Johnson, Jack and Marianne Ott, Nancy Shah, Kenn Sherey, Josip Slisko, Chuck Stone, and Pablo Robinson. Thanks to Jojo Kijamco for several novel suggestions. I thank my pen pal, Marylyn Hromatko, for her insightful ideas. Thanks to Vern Beardslee, Henry Kolm, and Paul Kinion for helping to correct errors in the previous edition that might otherwise carry over here. I am grateful to my Exploratorium friends and colleagues, Paul Doherty, Ron Hipschman, and Modesto Tamez. For photos I thank my brother Dave, my son Paul, Keith Bardin, Burl Grey, Will Maynez, Milo Patterson, Jay Pasachoff, and David Willey. I'm grateful to both my grandson, Manuel Hewitt, and nephew, John Suchocki, for their computer rendering of several photos. For help with the test bank I thank Robert Hudson.

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I am particularly grateful to Lillian Lee for her assistance in all phases of bookand-ancillary preparation. Thanks go to my life-long friend Ernie Brown for designing the physics logo.

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Paul G. Hewitt Hilo, Hawaii

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