BOOKS

An Introductory Physics Text That Conveys the Author's Enthusiasm

Physics: Calculus

Eugene Hecht
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Reviewed by Amy J. Kolan and Amy E. Larsen

We teach introductory physics at St. Olaf College and have four goals for our students: We want them to enjoy physics, to develop a good conceptual understanding of the fundamental ideas, to understand the relationship among the major ideas via mathematics and to be able to solve basic problems. When examining a text, we try to see how that text will help us meet these goals. In reviewing Eugene Hecht's *Physics*, we have chosen to focus on the mechanics section because one of us (Amy Larsen) used the text last semester in the first half of a calculus-based course. Hecht's text meets most of our goals admirably.

In the preface to his book, Hecht says, "It has been a privilege and an unending joy to have spent much of my life studying physics." The sense of unending joy permeates his book. We found something intriguing on every page. In discussing projectile motion, Hecht cites the distance record for a champagne cork. He also mentions that, because of air friction, corks should be launched at 40° instead of the familiar no-friction figure of 45°. In discussing free fall, he tells about a Soviet pilot who bailed out of his plane at 22 000 feet. In discussing rockets, Hecht presents a 1920 *New York Times* article vilifying Robert Goddard's knowledge of Newton's third law—and a 1969 retraction. These examples are the rule rather than the exception; there are wonderful applications and examples everywhere.

Complementing these examples are apt historical anecdotes. Hecht tells of Apollo astronaut David Scott dropping a hammer and a feather simultaneously on the Moon in order to verify Galileo Galilei's statement on falling bodies. There are wonderful quotes in the margins by Galileo, Leonardo da Vinci and Richard Feynman, to name a few. Many topics start with a historical introduction; Hecht's discussion of the development of the idea of linear momentum is superb. The illustrations are out of this world. Our favorite is of Isaac Newton's death mask. There are pictures of squids ejecting water, planes blasting exhaust and firefighters falling back with a spraying hose—all to illustrate Newton's third law.

Hecht's ability to deal with students' conceptual difficulties is impressive in places and less impressive in others. We find that students have great difficulty in distinguishing between momentum and energy. They need to see a series of examples in which one is conserved and the other is not. These examples are not present in Hecht's text, nor are there conceptual questions to lead students to make distinctions between these two quantities. Our students also forget that accelerations are associated with changing both direction and speed. Here, as in most texts, linear acceleration is treated in one section, circular motion in another, and never the twain shall meet.

Hecht, commendably, always uses the same notation for force, such as $\mathbf{F}_N$ for the normal force, $\mathbf{F}_T$ for tension. $\mathbf{F}_W$ for weight is not confused with W for work. However, he also introduces the centripetal force ($\mathbf{F}_c$) which, we find, our students don't identify as having a gravitational or electromagnetic origin. They seem to think it is a magical new force also acting on the object. The text doesn't help them. But these faults are minor and can all be ameliorated by a skillful teacher. Most of Hecht's physical explanations are wonderful. His description of airfoils is one of the best we've seen in a text at the introductory level. His introduction to force is just as good as his introduction to linear momentum. The discussion problems, which probe the students' conceptual understanding, are quite extensive.

Our students had some difficulty with the formulas in the text. In the section on projectile motion, there are formulas for total flight time, peak height and range of a projectile whose starting and ending points are at the same height. These formulas are smack in the main body of the text; it was not clear to our students that the formulas referred to a specific case. Overall, it was hard for the students to discern which formulas they "needed to know" and which could be derived easily.

Hecht does a good job in helping the students to develop their problem-solving abilities. There are numerous worked examples throughout the text as the concepts and equations are introduced. Each example ends with a check to ensure that the answers obtained are reasonable. At the end of each chapter is a section presenting several tips on problem-solving techniques. Many common pitfalls are addressed; students are warned about mixing up units and reminded to start each problem with a sketch.

There is a nice variety of problems at the end of each chapter, and many of them are grounded in everyday life. Students are asked to calculate the force of an orthodontal wire on a tooth, analyze the forces involved in automobile accidents and determine the trajectory of a dried pea shot out of a drinking straw. The problems cover a wide range of difficulty levels. In addition to the standard list of answers to the odd-numbered problems at the end of the text, a handful of problems from each chapter are actually worked out step by step.

All in all, this is a very good text. Its shortcomings are relatively minor and its strengths more than compensate. The love of physics that permeates this book and the exciting examples that it contains are reason enough to use it. After all, how can you resist a book with a picture of Newton's death mask in it?

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