

## ***Preface to the Definitive Edition***

More than forty years have passed since Richard Feynman taught the introductory physics course that gave rise to these three volumes, *The Feynman Lectures on Physics*. In those forty years our understanding of the physical world has changed greatly, but *The Feynman Lectures* have endured. They are as powerful today as when first published, thanks to Feynman's unique physics insights and pedagogy. *The Lectures* have been studied worldwide by novices and mature physicists alike; they have been translated into at least a dozen languages with more than 1.5 millions copies printed in the English language alone. Perhaps no other set of physics books has had such wide impact, for so long.

This new *Definitive Edition* of *The Feynman Lectures on Physics* differs from previous editions in two ways: all known errata have been corrected, and it is being published in concert with a new fourth volume, *Feynman's Tips on Physics: A Problem-Solving Supplement to The Feynman Lectures on Physics*. This *Supplement* contains additional materials from Feynman's course: three lectures by Feynman on problem solving and one on inertial guidance, plus exercises and answers prepared by Feynman's colleagues Robert B. Leighton and Rochus Vogt.

## ***How this Edition Came to Be***

The three original volumes of *The Feynman Lectures* were produced very quickly by Feynman and his co-authors, Robert B. Leighton and Matthew Sands, working from and expanding on tape recordings and blackboard photos of Feynman's 1961–63 course lectures.<sup>1</sup> Inevitably, errors crept in. Feynman accumulated long lists of claimed errata over the subsequent years—errata found by students and faculty at Caltech and by readers around the world. In the 1960's and early 70's, Feynman made time in his intense life to check most of the claimed errata for Volumes I and II, and insert corrections into subsequent printings. However, Feynman's sense of duty never rose high enough above the excitement of discovering new things to make him deal with the errata in Volume III.<sup>2</sup> After his untimely death in 1988, lists of unchecked errata were deposited in the Caltech Archives, and there they lay forgotten.

In 2002 Ralph Leighton (son of the late Robert Leighton and compatriot of Feynman) informed me of the old errata and a new long list compiled by Ralph's friend Michael Gottlieb. Leighton proposed that Caltech produce this new *Definitive Edition* of *The Feynman Lectures* with all errata corrected, and publish it alongside the *Supplement* volume that he and Gottlieb were preparing. Leighton also sought my help in making sure that physics errors had not crept into Gottlieb's edited transcription of the *Supplement's* four lectures, and in obtaining Caltech's agreement for the *Supplement* to be published officially in concert with this *Definitive Edition* of the three original volumes.

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<sup>1</sup> For descriptions of the genesis of Feynman's lectures and these volumes, see the Special Preface, Feynman's Preface, and the Foreword—all in this volume and its companions—and also Matt Sands' Memoir in the new *Supplement*.

<sup>2</sup> In 1975, he started checking errata for Volume III but got distracted by other things and never finished the task, so no corrections were made.

Feynman was my hero and a close personal friend. When I saw the lists of errata and the content of the *Supplement*, I quickly agreed to help. Fortunately, I knew the ideal person to vet the errata and the *Supplement's* physics: Dr. Michael Hartl.

Hartl had recently completed his PhD in physics at Caltech, and had been granted the only “lifetime achievement award for excellence in teaching” ever given to a Caltech graduate student by our undergraduates. Hartl understands physics deeply, he is among the most meticulous physicists I have known, and like Feynman he is an outstanding pedagogue.

And so we struck a deal: Ralph Leighton and Michael Gottlieb prepared the *Supplement* (and did so superbly well), with authorization from Feynman’s children Carl and Michelle who own the *Supplement's* four lectures, and from Rochus Vogt and Leighton himself for the *Supplement's* exercises and answers. Leighton, Gottlieb, and the Feynmans gave me final authority over the *Supplement's* contents. Caltech (i.e., Tom Tombrello, Chair of Physics, Mathematics and Astronomy) gave me authority to oversee the new *Definitive Edition* of the original three volumes and agreed to the *Supplement* being published in concert with the *Definitive Edition*. And everyone agreed that Michael Hartl would act in my behalf, vetting the errata for the *Definitive Edition*, and editing the physics content and physics style of the *Supplement*. I would spot check Hartl’s work and approve the final version of all four volumes, and Addison-Wesley, the Publisher, would bring the project to conclusion.

To my delight, this has all come to fruition smoothly! Feynman would be pleased and proud of the product, I do believe.

## **The Errata**

The errata corrected in this edition come from three sources: about 80 percent are from Michael Gottlieb; most of the rest are from a long list by an anonymous reader, submitted to Feynman in the early 1970s via the publisher; and the remainder are from scattered short lists provided to Feynman or us by various readers.

The corrected errata are mainly of three types: (i) typographical errors in the prose; (ii) roughly 150 typographical and mathematical errors in equations, tables, and figures—sign errors, incorrect numbers (e.g., a 5 that should be a 4), and missing subscripts, summation signs, parentheses and terms in equations; (iii) roughly 50 incorrect cross references to chapters, tables, and figures. These kinds of errors, though not terribly serious to a mature physicist, can be frustrating and confusing to students, the audience Feynman was trying to reach.

It is remarkable that the errata included only two inadvertent errors in physics: Volume I, page 45-4 now says “When a rubber band is stretched its temperature rises,” not “falls” as claimed in previous editions; and Volume II, page 5-9 now says “. . . no static distribution of charges inside a closed *grounded* conductor can produce any [electric] fields outside” (the word *grounded* was omitted in previous editions). This second error was pointed out to Feynman by a number of readers, including Beulah Elizabeth Cox, a student at The College of William and Mary, who had relied on Feynman’s erroneous passage in an exam. To Ms. Cox, Feynman wrote in 1975,<sup>3</sup> “Your instructor was right not to give you any points, for your answer was wrong, as he demonstrated using Gauss’s law. You should, in science, believe logic and arguments, carefully drawn, and not authorities. You also read the book correctly and understood it. I made a mistake, so the book is wrong. I probably was thinking of a grounded conducting sphere, or else of the fact that moving the charges around in different places inside does not affect things on the

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<sup>3</sup> Pages 288–289 of *Perfectly Reasonable Deviations from the Beaten Track, The Letters of Richard P. Feynman*, ed. Michelle Feynman (Basic Books, New York, 2005).

outside. I am not sure how I did it, but I goofed. And you goofed, too, for believing me.”

Feynman was uncomfortably aware of this error, and of others. In correspondence with the publisher in 1975, he refers to “errors of physics in Volumes II and III that are more than just typographical.” I do not know the other errors. Finding them is a challenge for future readers! To this end, Michael Gottlieb is creating a web site, [www.feynmanlectures.info](http://www.feynmanlectures.info), on which all errata corrected in this Edition will be listed, along with any new errata found by future readers.

## **The Supplement**

*Feynman's Tips on Physics: A Problem Solving Supplement to the Feynman Lectures on Physics* is a fascinating fourth volume. Its highlight is four lectures mentioned by Feynman in his Preface to the original volumes: “Although I did put in three lectures in the first year on how to solve problems, they are not included here,” he wrote. “Also there was a lecture on inertial guidance which certainly belongs after the lecture on rotating systems, but which was, unfortunately, omitted.”

Michael Gottlieb has prepared the *Supplement's* written version of these four lectures working with Ralph Leighton from tape recordings of Feynman's presentations and from photographs of his blackboards, in much the same way that Ralph's father and Matthew Sands prepared the original three volumes 40 years ago, but without the pressure of time. The only thing missing was Feynman, to vet the written manuscript. Matthew Sands played Feynman's role, giving Gottlieb feedback and advice, and then Hartl and I provided the final vetting. Fortunately, Gottlieb did such an excellent job of capturing Feynman's four lectures onto the written page that our task was easy. These four “new” lectures are a delight to read, especially passages where Feynman advises the students about how to deal with being in the bottom half of the class.

The “new” lectures are accompanied, in the *Supplement*, by an equally delightful Memoir by Matthew Sands—reminiscences, 43 years later, about the genesis and creation of *The Feynman Lectures on Physics*, and by a selected set of instructive problems and answers prepared in the mid 1960's by Robert Leighton and Rochus Vogt for use with *The Feynman Lectures*. Several of my physicist colleagues, who worked through these problems as Caltech students, tell me how well crafted and useful they are.

## **The Structure of this Edition**

This *Definitive Edition* begins with front matter, paginated in Roman numerals, that was created in “modern times”, long after the First Edition: this Preface, a brief Biography of Feynman, and a Special Preface written in 1989 by Gerry Neugebauer (who participated in preparation of the original three volumes) and David Goodstein (creator of *The Mechanical Universe* course and films). The subsequent material, paginated with Arabic numerals 1, 2, 3, . . . , is identical to the original First Edition, except for the correction of errata.

## **Memories of Feynman's Lectures**

These three volumes are a self-contained pedagogical treatise. They are also a historical record of Feynman's 1961–63 lectures, a course required for all Caltech freshmen and sophomores regardless of their majors.

Readers may wonder, as have I, how Feynman's lectures impacted the students. Feynman, in his Preface to these volumes, offers a somewhat negative view. “I don't think I did very well by the students,” he writes. Goodstein and Neugebauer,

in their 1989 Special Preface, express a mixed view, while Sands, in his memoir in the new *Supplement*, expresses a far more positive view. Out of curiosity, in spring 2005 I emailed or talked to a quasi-random set of 17 students (out of about 150) from that 1961–63 class—some who had great difficulty with the class, and some who mastered it with ease; majors in biology, chemistry, engineering, geology, mathematics and astronomy, as well as in physics.

The intervening years might have glazed their memories with a euphoric tint, but about 80 percent recall Feynman's lectures as highlights of their college years. "It was like going to church." The lectures were "a transformational experience," "the experience of a lifetime, probably the most important thing I got from Caltech." "I was a biology major but Feynman's lectures stand out as a high point in my undergraduate experience . . . though I must admit I couldn't do the homework at the time and I hardly turned any of it in." "I was among the least promising of students in this course, and I never missed a lecture. . . . I remember and can still feel Feynman's joy of discovery. . . . His lectures had an . . . emotional impact that was probably lost in the printed Lectures."

By contrast, several of the students have negative memories due largely to two issues: (i) "You couldn't learn to work the homework problems by attending the lectures. Feynman was too slick—he knew tricks and what approximations could be made, and had intuition based on experience and genius that a beginning student does not possess." Feynman and colleagues, aware of this flaw in the course, addressed it in part with materials now incorporated into the *Supplement*: the Leighton-Vogt problems and answers, and Feynman's problem-solving lectures. (ii) "The insecurity of not knowing what was likely to be discussed in the next lecture, the lack of a text book or reference with any connection to the lecture material, and consequent inability for us to read ahead, were very frustrating. . . . I found the lectures exciting and understandable in the hall, but they were Sanskrit outside [when I tried to reconstruct the details]." This problem, of course, was solved by these three volumes, the written version of *The Feynman Lectures on Physics*. They became the textbook from which Caltech students studied for many years thereafter, and they live on today as one of Feynman's greatest legacies.

## Acknowledgments

This *Definitive Edition* of *The Feynman Lectures on Physics* would not have been possible without the original impetus from Ralph Leighton and Michael Gottlieb and the outstanding hands-on work with the errata by Michael Hartl. I thank Gottlieb and anonymous readers for the lists of errata on which the corrections were based, and I thank Tom Tombrello, Rochus Vogt, Gerry Neugebauer, James Hartle, Carl and Michelle Feynman, and Adam Black for their support, sage advice, and contributions to this endeavor.

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