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Book Review

A Review of Some Updates in the 13th Edition of "Sears and Zemansky's University Physics with Modern Physics" (Authors: Hugh D. Young and Roger A. Freedman; contributing author, A. Lewis Ford; 2012)

Young, H.D.; and Freedman, R.A.; Ford, A.L. (contributing author). 2012. Sears and Zemansky's University Physics with Modern Physics. 13th ed. Pearson Education, Inc., Addison-Wesley, San Francisco, CA, USA.

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The book entitled "Sears and Zemansky's University Physics with Modern Physics", thirteenth edition, by Hugh D. Young and Roger A. Freedman with contributing author A. Lewis Ford (2012) was published by Pearson Education, Inc., Addison-Wesley, San Francisco, CA, USA.

It was released on 8 January 2011, ©2012, international standard book number ISBN-13: 978-0-321-69686-1, ISBN-10: 0-321-69686-7.

The book was written by: Hugh David Young (1930-2013), Carnegie Mellon University, Pittsburgh, PA, USA; and Roger A. Freedman, University of California, Santa Barbara, CA, USA; with contributing author Albert Lewis Ford, Texas A&M University, College Station, TX, USA.

The total number of pages in the book is 1,600 pages including initial pages (24 pages), 10 chapters (1,522 pages), six appendices A-F and answers to odd-numbered problems (22 pages), photo credits (4 pages) and index (22 pages). A blank even page is added at the end of the last Chapter 44 (page 1,522) and the photo credits (page C4) to have an even number of pages. Blank pages at the end of the book are included due to even working with a binding signature having a group of 16 consecutive pages.

The previous twelfth edition of the book was released on 19 March 2007, ©2008, ISBN-13: 978-0-321-50121-9, ISBN-10: 0-321-50121-7.

The first edition of "University Physics" written by Francis Weston Sears (1898-1975) and Mark Waldo Zemansky (1900-1981) was published by Addison-Wesley in 1949 with "an emphasis on the fundamental principles of physics and how to apply them". The intention to concentrate on the basic physical phenomena persists in all editions. Physics is thoroughly considered as a natural science even though the provided illustrations and problems are most often based on practical technical examples. Therefore, there are certain limitations in providing specific technical details related to engineering physics and engineering applications. The book is composed of three volumes. Volume 1 includes Chapters 1-20 and covers mechanics, waves/acoustics and thermo-dynamics. Volume 2 includes Chapters 21-36 and considers electromagnetism and optics. Volume 3 includes Chapters 37-44 dealing with modern physics: relativity, photons: light waves behaving as particles, particles behaving as waves, quantum mechanics, atomic structure, molecules and condensed matter, nuclear physics, and particle physics and cosmology. Volumes 1 and 2 form the standard edition and the inclusion of Volume 3 is considered as an extended edition. Volume 3 was first introduced in 1992 in the eighth edition.

The previous chapter structure is preserved in the thirteenth edition with the exception of Chapter 12 on fluid mechanics which is placed before Chapter 13 on gravitation and Chapter 14 on periodic motion. Therefore, the information about oscillations and simple harmonic motion immediately precedes Chapter 15 on mechanical waves.

A list of updates is given in the Preface starting with the notion of a Bridging Problem which replaces the Key Terms and also the answers to the Chapter Opening Question and Test Your Understanding Questions between the summary and the problem set of each chapter. The Bridging Problem has a solution guide with Identify and Set Up, Execute, and Evaluate parts which include a series of steps to help students in solving multi-concept problems in preparation for dealing with the Challenge Problems. The reader is also redirected to the MasteringPhysics® study area provided by Pearson Education, Inc. at <www.masteringphysics.com> for a full Video Tutor solution.

Apparently, the Key Terms are now totally omitted. However, they could prove useful to English-as-a-second-language (ESL) students who are unfamiliar with technical English. The enhancement of the conciseness and clarity of all chapters, examples and problems can help alleviate this issue to a certain extent. Nevertheless, from the perspective of an ESL student with minimal technical background, reading the book would be a challenging task. Therefore, the access to the MasteringPhysics® study area and the use of Video Tutor materials is a timely improvement.

The answers to the Chapter Opening Question, Test Your Understanding Questions and the newly included Bridging Problem are now placed at the end of each chapter after the Challenge Problems.

In addition to the ActivPhysics Online™ applets from the previous edition, over 70 PhET simulations (University of Colorado Boulder, Boulder, CO, USA) are also available in the Pearson eText and in the Study Area of MasteringPhysics® to stimulate the process of learning by doing using electronic media.

Responses from instructors resulted in the inclusion of more problems so that 15%-20% of the problems are new. Many problems are classified as: problems of increasing difficulty (•, ••, and •••); cumulative problems incorporating material from earlier chapters (CP); problems requiring calculus (CALC); and biosciences problems (BIO). Some problems have a double or triple classification such as • CALC, •• CP BIO, etc. The access to MasteringPhysics® allows an increase of the number of CALC problems, an inclusion of five to seven BIO problems in most chapters, and an increase of the number of cumulative problems which are linked to earlier chapters. The variety of available end-of-chapter materials would help the instructors to select problems which match the level of understanding of the students.

All modern physics chapters in Volume 3 have been substantially revised, especially the core Chapters 38-41. The authors of the book support "a more idea-centered, less historical approach to the material". This approach is justified from a scientific viewpoint because the historical path of scientific discovery is often complicated. However, the historical events have to be correctly interpreted even though the logical presentation of the material may result in a scrambled chronology. Otherwise, a quasi-history replaces the historical account and one such example is the discovery of the Rayleigh-Jeans and Planck radiation formulae (Whitaker 1979a,b). A detailed evolution of quasi-history related to said formulae in different editions of the book can be found in Persson (2013). Therefore revisions for clarity and consistency have to be balanced with historical correctness.

The names of famous physicists who are credited with the discovery of the laws of physics are mentioned on multiple occasions. Consider, for example, the following sentences:

"These principles were clearly stated for the first time by Sir Isaac Newton (1642-1727); today we call them Newton's laws of motion."

"Einstein explained the photoelectric effect in 1905 by assuming that the energy of electromagnetic waves is quantized; that is, it comes in little bundles called *photons*…"

Apparently, there are no references in the book to show the source of information for such sentences. Usually, physics books used for teaching purposes do not provide exact citations for every statement or formula. However, it is desirable to have a bibliography which contains most of the books and journal papers the material is based on. The students would rarely check the references in the bibliography but it is very useful for the instructors. One may reason that a book containing so much information will need an exhaustive number of references which are omitted because of space limitations. It can be said in response that typically a binding signature of 16 pages leaves a sufficient number of unused blank pages at the end of the book. On a more serious note, the lack of bibliography can be considered in relation to the idea-centered approach in teaching materials and the vague notion that references on the origins of scientific discovery should be listed in other books about the history of physics. In this respect, the dynamically changing content of Wikipedia appears more verifiable than a book without bibliography because every article there has a list of references which are cited. Peculiarly, the initial page iv of the book contains the following statement: "Includes bibliographical references and index." Actually, the book includes credits and index.

The provision of more bioscience applications and problems would benefit students choosing to major in biophysics or related fields of study. However, the book content may appear less attractive to students majoring in computer science, information technology, communication and computer network technology, nanotechnology, etc., due to the limited number of suitable examples. Also, bioscience is so closely linked to biotechnology that the two terms tend to be used interchangeably. Biotechnology includes the scientific study of genetic materials but this technological frontier is only briefly mentioned when explaining the effect of X-ray radiation on a genetic material. On the one hand, it is to be expected that a physics book would consider mostly natural phenomena. On the other hand, the scientific method relies on engineering and technology for the creation of advanced measuring devices to probe the physical properties of the observable universe. The global role of engineering and technology in scientific exploration and all aspects of human life shifts the student's attention toward practical applications. Therefore, the thirteenth edition of the book with the inclusion of bioscience applications should be considered as transitional.

There are numerous applications, which could possibly be included in prospective future editions, related to the following physical phenomena:

- basics of non-linear physics, especially non-linear optics, optical solitons, meta-materials and invisible cloaks;
- quantum entanglement, quantum bits (qubits) and teleportation;
- high-temperature superconductivity, etc.

Parts of advanced physics, which are better understood and can be explained clearly to university students, are pending to be included in existing or new chapters on modern physics.

The announcement of the discovery of the Higgs boson at the European Organization for Nuclear Research, known as CERN, on 4 July 2012 is an example how quickly the following information in Volume 3 became outdated:

"A remaining difficulty in the electroweak theory is that photons are massless but the weak bosons are very massive. To account for the broken symmetry among these interaction mediators, a particle called the Higgs boson has been proposed. Its mass is expected to be less than 1 TeV/c^2, but to produce it in the laboratory may require a much greater available energy. The search for the Higgs boson is an important mission of the Large Hadron Collider at CERN."

Peter Ware Higgs and François Baron Englert were awarded the 2013 Nobel Prize in Physics for their work and prediction of the Higgs boson. It is now known that the particle exists and has a mass between 125 and 127 GeV/c^2 which is lower than expected and raises new questions about the limitations of the Standard Model.

Table 1. Fundamental physical constants.

Reference	Value
Speed of light in vacuum, c [m/s]	
12th ed. (2008)	2.997 924 58 × 10^{8}
13th ed. (2012)	
CODATA (2010)	
Magnitude of charge of electron, e [C]	
12th ed. (2008)	1.602 176 53(14) × 10^{-19}
13th ed. (2012)	1.602 176 487(40) × 10^{-19}
CODATA (2010)	1.602 176 565(35) × 10^{-19}
Gravitational constant, G [N · m^2/kg^2]	
12th ed. (2008)	6.674 2(10) × 10^{-11}
13th ed. (2012)	6.674 28(67) × 10^{-11}
CODATA (2010)	6.673 84(80) × 10^{-11}
Planck's constant, h [J · s]	
12th ed. (2008)	6.626 069 3(11) × 10^{-34}
13th ed. (2012)	6.626 068 96(33) × 10^{-34}
CODATA (2010)	6.626 069 57(29) × 10^{-34}
Boltzmann constant, k [J/K]	
12th ed. (2008)	1.380 6505(24) × 10^{-23}
13th ed. (2012)	1.380 6504(24) × 10^{-23}
CODATA (2010)	1.380 6488(13) × 10^{-23}
Avogadro's number, N_A [molecules/mol]	
12th ed. (2008)	6.022 141 5(10) × 10^{23}
13th ed. (2012)	6.022 141 79(30) × 10^{23}
CODATA (2010)	6.022 141 29(27) × 10^{23}
Gas constant, R [J/mol · K]	
12th ed. (2008)	8.314 472(15)
13th ed. (2012)	
CODATA (2010)	8.314 4621(75)
Mass of electron, m_e [kg]	
12th ed. (2008)	9.109 382 6(16) × 10^{-31}
13th ed. (2012)	9.109 382 15(45) × 10^{-31}
CODATA (2010)	9.109 382 91(40) × 10^{-31}
Mass of proton, m_p [kg]	
12th ed. (2008)	1.672 621 71(29) × 10^{-27}
13th ed. (2012)	1.672 621 637(83) × 10^{-27}
CODATA (2010)	1.672 621 777(74) × 10^{-27}
Mass of neutron, m_n [kg]	
12th ed. (2008)	1.674 927 28(29) × 10^{-27}
13th ed. (2012)	1.674 927 211(84) × 10^{-27}
CODATA (2010)	1.674 927 351(74) × 10^{-27}
Permeability of free space, μ_0 [Wb/A · m]	
12th ed. (2008)	$4\pi \times 10^{-7}$
13th ed. (2012)	
CODATA (2010)	
Permittivity of free space, $\epsilon_0 = 1/\mu_0 c^2$ [C^2/N · m^2], $1/4\pi\epsilon_0$ [N · m^2/C^2]	
12th ed. (2008)	8.854 187 817… × 10^{-12}, 8.987 551 787… × 10^{9}
13th ed. (2012)	
CODATA (2010)	

Table 2. Other useful constants.

Reference	Value
Mechanical equivalent of heat [J/cal (15º calorie)]	
12th ed. (2008)	4.186
13th ed. (2012)	
CODATA (2010)	
Standard atmospheric pressure, 1 atm [Pa]	
12th ed. (2008)	1.013 25 × 10^{5}
13th ed. (2012)	
CODATA (2010)	
Absolute zero, 0 K [ºC]	
12th ed. (2008)	-273.15
13th ed. (2012)	
CODATA (2010)	
Electron volt, 1 eV [J]	
12th ed. (2008)	1.602 176 53(14) × 10^{-19}
13th ed. (2012)	1.602 176 487(40) × 10^{-19}
CODATA (2010)	1.602 176 565(35) × 10^{-19}
Atomic mass unit, 1 u [kg]	
12th ed. (2008)	1.660 538 86(28) × 10^{-27}
13th ed. (2012)	1.660 538 782(83) × 10^{-27}
CODATA (2010)	1.660 538 921(73) × 10^{-27}
Electron rest energy, $m_e c^2$ [MeV]	
12th ed. (2008)	0.510 998 918(44)
13th ed. (2012)	0.510 998 910(13)
CODATA (2010)	0.510 998 927(25)
Volume of ideal gas (0ºC and 1 atm) [liter/mol]	
12th ed. (2008)	22.413 996(39)
13th ed. (2012)	
CODATA (2010)	22.413 968(20)
Acceleration due to gravity (standard), g [m/s^2]	
12th ed. (2008)	9.806 65
13th ed. (2012)	
CODATA (2010)	

Another example with the values of the physical constants should be mentioned. Tables 1 and 2 show the values of fundamental and other useful constants which are listed in the 12th edition (2008) and the 13th edition (2012) of the book as compared to the latest values in CODATA (2010). The 13th edition (2012) was released earlier on 8 January 2011 and CODATA (2010) became available after 2 June 2011. The highlighted decimal digits show the observed differences.

In the presence of a steady accumulation of new results by the scientific community, a particular strength of the book is that additional materials (like the bioscience applications) can be linked nicely to the existing content.

References

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