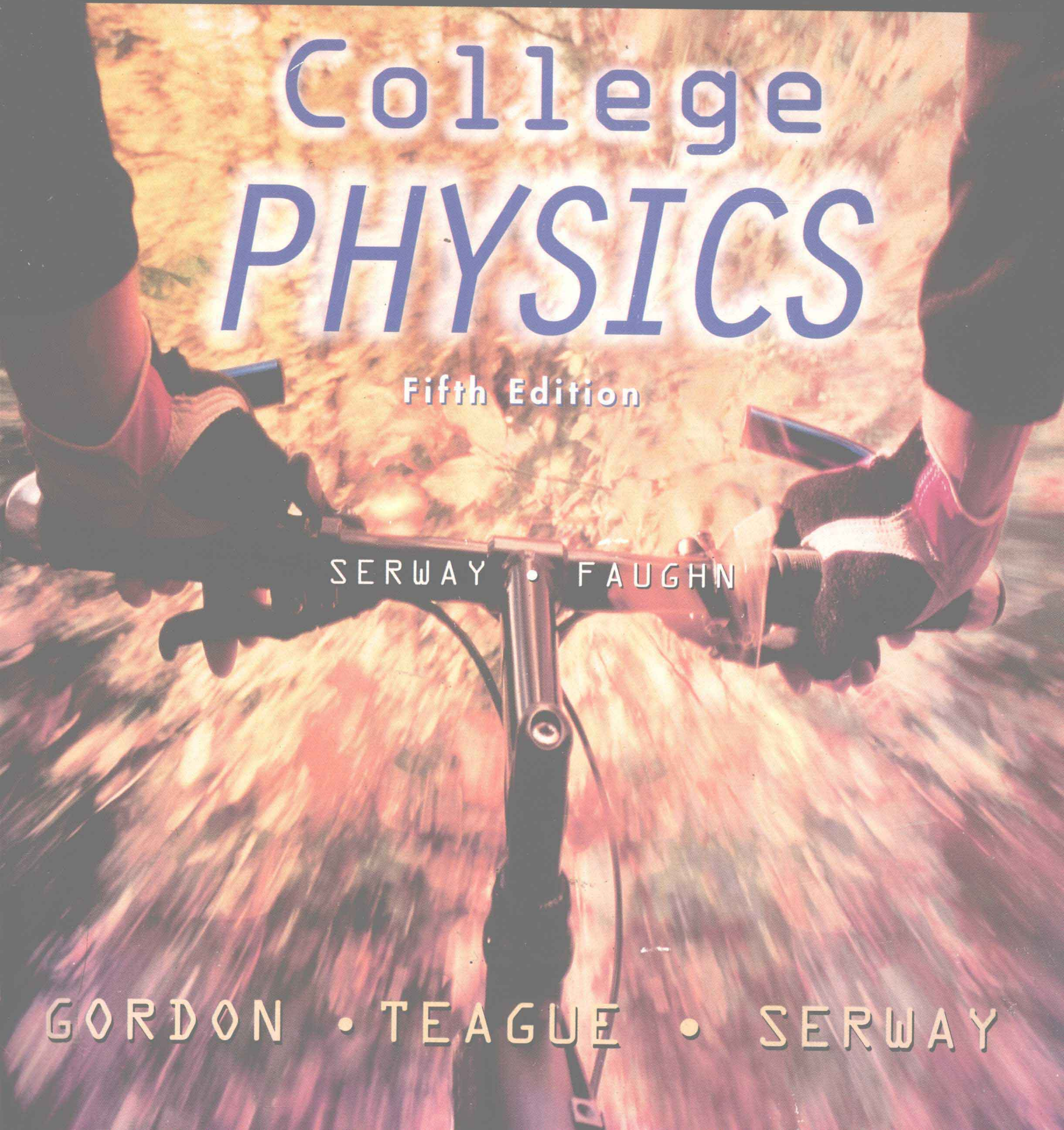
STUDY GUIDE and
STUDENT SOLUTIONS MANUAL

College PHYSICS

Fifth Edition

SERWAY • FAUGHN



GORDON • TEAGUE • SERWAY

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Preface

This Student Solutions Manual and Study Guide has been written to accompany the textbook **College Physics**, Fifth Edition, by Raymond A. Serway and Jerry S. Faughn. The purpose of this Study Guide is to provide the students with a convenient review of the basic concepts and applications presented in the textbook, together with solutions to selected end-of-chapter problems from the textbook. The Study Guide is not an attempt to rewrite the textbook in a condensed fashion. Rather, emphasis is placed upon clarifying typical troublesome points, and providing further drill in methods of problem solving.

Each chapter of the Study Guide is divided into several parts, and every textbook chapter has a matching chapter in the Study Guide. Very often, reference is made to specific equations or figures in the textbook. Every feature of the Study Guide has been included to insure that it serves as a useful supplement to the textbook. Most chapters contain the following sections:

- **Notes From Selected Chapter Sections:** This is a summary of important concepts, newly defined physical quantities, and rules governing their behavior.

- **Equations and Concepts:** This represents a review of the chapter, with emphasis on highlighting important concepts and describing important equations and formalisms.

- **Suggestions, Skills, and Strategies:** This offers hints and strategies for solving typical problems that you will often encounter in the course. In some sections, suggestions are made concerning mathematical skills that are necessary in the analysis of problems.

- **Review Checklist:** This is a list of topics and techniques that you should master after reading the chapter and working the assigned problems.

- **Solutions to Selected End-of-Chapter Problems:** Solutions are shown for approximately twenty percent of the problems from each chapter of the text. Problems were selected to illustrate important concepts in each chapter.

- **Chapter Self-Quiz:** This is a set of a twelve multiple-choice questions at the end of each chapter. They can be used to assess your understanding of the concepts presented in the chapter. Answers to the chapter self-quiz questions are given following the Self-Quiz for Chapter 30

We sincerely hope that this Study Guide will be useful to you in reviewing the material presented in the text, and in improving your ability to solve problems and score well on exams. We welcome any comments or suggestions which could help improve the content of this study guide in future editions; and we wish you success in your study.

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Special thanks go to Senior Developmental Editor, Susan Dust Pashos and Ancillary Editor, Alexandra Buczek of Saunders College Publishing for managing all phases of this project. Finally, we express our appreciation to our families for their inspiration, patience, and encouragement.

Suggestions for Study

Very often we are asked "How should I study this subject, and prepare for examinations?" There is no simple answer to this question; however, we would like to offer some suggestions which may be useful to you.

1. It is essential that you understand the basic concepts and principles before attempting to solve assigned problems. This is best accomplished through a careful reading of the textbook before attending your lecture on that material, jotting down certain points which are not clear to you, taking careful notes in class, and asking questions. You should reduce memorization of material to a minimum. Memorizing sections of a text, equations, and derivations does not necessarily mean you understand the material. Perhaps the best test of your understanding of the material will be your ability to solve the problems in the text, or those given on exams.

2. Try to solve as many problems at the end of the chapter as possible. You will be able to check the accuracy of your calculations to the odd-numbered problems, since the answers to these are given at the back of the text. Furthermore, detailed solutions to approximately twenty percent of the problems from the text are provided in this Study Guide. Many of the worked examples in the text will serve as a basis for your study.

3. The method of solving problems should be carefully planned. First, read the problem several times until you are confident you understand what is being asked. Look for key words which will help simplify the problem, and perhaps allow you to make certain assumptions. You should also pay special attention to the information provided in the problem.

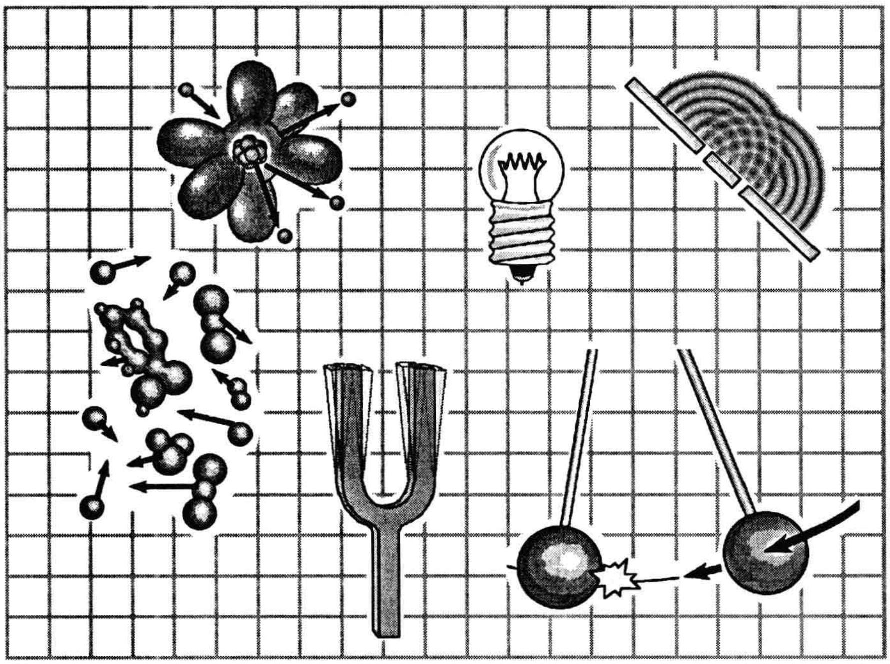
It is a good idea to write down the given information before proceeding with a solution. (For example, $a = -3.00 \text{ m/s}^2$ and $v_0 = 5.00$ m/s are given. Find the velocity v, and the displacement Δx after $\Delta t = 2.00$ s.) After you have decided on the method you feel is appropriate for the problem, proceed with your solution. If you are having difficulty in working problems, we suggest that you again read the text and your lecture notes. It may take several readings before you are ready to solve certain problems. The solved problems in this Study Guide should be of value to you in this regard.

4. After reading a chapter, you should be able to define any new quantities that were introduced, and discuss the first principles that were used to derive fundamental formulas. A review is provided in each chapter of the Study Guide for this purpose, and the marginal notes in the textbook (or the index) will help you locate these topics. You should be able to correctly associate with each physical quantity the symbol used to represent that quantity (including vector notation, if appropriate) and the SI unit in which the quantity is specified. Furthermore, you should be able to express each important formula or equation in a concise and accurate prose statement.

5. We suggest that you use this Study Guide to review the material covered in the text, and as a guide in preparing for exams. You should also use the **Chapter Review, Notes From Selected Chapter Sections,** and **Equations and Concepts** to focus in on any points which require further study. Remember that the main purpose of this Study Guide is to improve upon the efficiency and effectiveness of your study hours and your overall understanding of physical concepts. However, it should not be regarded as a substitute for your textbook or individual study and practice in problem solving.

Contents

Chapter 1



INTRODUCTION

Chapter 1

INTRODUCTION

The goal of physics is to provide an understanding of nature by developing theories based on experiments. The theories are usually expressed in mathematical form. Fortunately, it is possible to explain the behavior of a variety of physical systems with a limited number of fundamental laws.

Since following chapters will be concerned with the laws of physics, we must begin by clearly defining the basic quantities involved in these laws. For example, such physical quantities as force, velocity, volume, and acceleration can be described in terms of more fundamental quantities. In the next several chapters we shall encounter three basic quantities: length (L), mass (M), and time (T). In later chapters we will need to add two other standard units to our list, for temperature (the kelvin) and for electric current (the ampere). In our study of mechanics, however, we shall be concerned only with the units of length, mass and time.

NOTES FROM SELECTED CHAPTER SECTIONS

1.1 Standards of Length, Mass, and Time

Until recently, the meter was defined as 1,650,763.73 wavelengths of orange-red light emitted from a krypton-86 lamp. However, in October 1983, the **meter** was redefined to be **the distance traveled by light in a vacuum during a time of 1/299,792,458 second.**

The SI unit of mass, the **kilogram**, is defined as **the mass of a specific platinum-iridium alloy cylinder kept at the International Bureau of Weights and Measures at Sèvres, France.**

The **second** is now defined as 9,192,631,770 **times the period of one oscillation of radiation from the cesium atom.**

Systems of units commonly used are the **SI system,** in which the units of mass, length, and time are the kilogram (kg), meter (m), and second (s), respectively; the **cgs** or **gaussian system,** in which the units of mass, length, and time are the gram (g), centimeter (cm), and second, respectively; and the **British engineering system** (sometimes called the conventional system), in which the units of mass, length, and time are the slug, foot (ft), and second, respectively.

1.2 The Building Blocks of Matter

It is useful to view the atom as a miniature Solar System with a dense, positively charged nucleus occupying the position of the Sun and negatively charged electrons orbiting like the planets. Occupying the nucleus are two basic entities, protons and neutrons. The **proton** is nature's fundamental carrier of positive charge; the **neutron** has no charge and a mass about equal to that of a proton. We shall find in Chapter 30 that even more elementary building blocks than protons and neutrons exist. Protons and neutrons are each now thought to consist of three particles called **quarks**.

1.3 Dimensional Analysis

Dimensional analysis makes use of the fact that **dimensions can be treated as algebraic quantities**. That is, quantities can be added or subtracted only if they have the same dimensions. Furthermore, the quantities on each side of an equation must have the same dimensions.

1.4 Significant Figures

When multiplying several quantities, the number of significant figures in the final answer is the same as the number of significant figures in the **least** accurate of the quantities being multiplied, where "least accurate" means "having the lowest number of significant figures." The same rule applies to division. When numbers are added (or subtracted), the number of decimal places in the result should equal the smallest number of decimal places of any term in the sum. Most of the numerical examples and end-of-chapter problems will yield answers having either two or three significant figures.

1.5 Conversion of Units

Sometimes it is necessary to convert units from one system to another. An extensive list of conversion factors can be found on the inside of the back cover of the **Student Solution Manual**.

1.6 Order-of-Magnitude Calculations

Often it is useful to estimate an answer to a problem in which little information is given. In such a case we refer to the **order of magnitude** of a quantity, by which we mean the power of ten that is closest to the actual value of the quantity. Usually, when an order-of-magnitude calculation is made, the results are reliable to within a factor of 10.

1.7 Mathematical Notation

Many mathematical symbols will be used throughout this book. Some important examples are:

$\propto$		denotes	a proportionality
$<$		means	"is less than"
$>$		means	"is greater than"
$<<$		means	"is much less than"
$>>$		means	"is much greater than"
$\approx$		indicates	approximate equality
$=$		indicates	equality
Δx	("delta x")	indicates	the change in a quantity x
$\lvert x \rvert$		means	the absolute value of x, such that the sign of $\lvert x \rvert$ is always positive, regardless of the sign of x.
Σ	(capital sigma)	represents	a sum. For example, $x_1 + x_2 + x_3 + x_4 + x_5 = \sum_{i=1}^{5} x_i$

1.8 Coordinate Systems and Frames of Reference

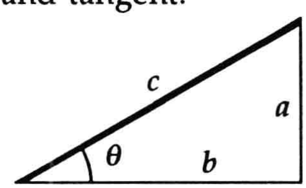
A coordinate system used to specify locations in space consists of:
1. A fixed reference point, called the origin
2. A set of specified axes or directions
3. Instructions that tell us how to label a point in space relative to the origin and axes

1.9 Trigonometry

The portion of mathematics that is based on the special properties of a right triangle is called trigonometry. You should review the basic trigonometric functions given by Equations 1.1 and 1.2.

EQUATIONS AND CONCEPTS

The three most basic trigonometric functions of one of the acute angles of a right triangle are the sine, cosine, and tangent.



$$\sin\theta = \frac{\text{side opposite to }\theta}{\text{hypotenuse}} = \frac{a}{c}$$

$$\cos\theta = \frac{\text{side adjacent to }\theta}{\text{hypotenuse}} = \frac{b}{c} \qquad (1.1)$$

$$\tan\theta = \frac{\text{side opposite to }\theta}{\text{side adjacent to }\theta} = \frac{a}{b}$$

The Pythagorean theorem is an important relationship among the lengths of the sides of a right triangle. In this equation, c represents the hypotenuse.

$$c^2 = a^2 + b^2 \qquad (1.2)$$

SUGGESTIONS, SKILLS, AND STRATEGIES

In developing problem-solving strategies, six basic steps are commonly used:

1. Read the problem carefully at least twice. Be sure you understand the nature of the problem before proceeding further.

2. Draw a suitable diagram with appropriate labels and coordinate axes, if needed.

3. As you examine what is being asked in the problem, identify the basic physical principle (or principles) that are involved, listing the knowns and unknowns.

4. Select a basic relationship or derive an equation that can be used to find the unknown, and symbolically solve the equation for the unknown.

5. Substitute the given values with the appropriate units into the equation.

6. Obtain a numerical value for the unknown. The problem is verified and receives a check mark if the following questions can be properly answered: Do the units match? Is the answer reasonable? Is the plus or minus sign proper or meaningful?

REVIEW CHECKLIST

▷ Discuss the units of length, mass and time and the standards for these quantities in SI units. (Section 1.1). Derive the quantities **force, velocity, volume, acceleration,** etc. from the three basic quantities.

▷ Perform a **dimensional analysis** of an equation containing physical quantities whose individual units are known. (Section 1.3)

▷ **Convert units** from one system to another. (Section 1.5)

▷ Carry out **order-of-magnitude calculations** or guesstimates. (Section 1.6)

▷ Describe the coordinates of a point in space using a Cartesian coordinate system. (Section 1.8)

SOLUTIONS TO SELECTED END-OF-CHAPTER PROBLEMS

3. The period of a simple pendulum, defined as the time for one complete oscillation, is measured in time units and is given by

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

where ℓ is the length of the pendulum and g is the acceleration due to gravity, in units of length divided by time squared. Show that this equation is dimensionally consistent.

Solution The length of the pendulum has units of length (L) and the acceleration due to gravity, g, is a length divided by the square of a time (L/T^2). The period, T, of the pendulum is a time (T) and $2p$ is a dimensionless constant. Substituting these dimensions into the equation for the period gives

$$(T) = \sqrt{\frac{(L)}{(L/T^2)}} = \sqrt{(L)\frac{(T^2)}{(L)}} = \sqrt{(T^2)} = (T) \qquad \Diamond$$

Thus, both sides of the equation have the same units or the equation is dimensionally consistent.

7. How many significant figures are there in (a) 78.9 ± 0.2, (b) 3.788×10^9, (c) 2.46×10^{-6}, (d) 0.0032?

Solution

(a) The notation ± 0.2 indicates an uncertainty of 2 units in the first decimal place. Thus, the number 78.9 contains 2 digits with no uncertainty and one digit with some uncertainty. Therefore, it has three significant figures. ◊

(b) In scientific notation, the first part of the number (3.788 in this case) contains all of the significant figures. The number of significant figures contained in 3.788×10^9 is therefore four. ◊

(c) As discussed in (b) above, the number of significant figures contained in 2.46×10^{-6} is three. ◊

(d) Expressing 0.0032 in scientific notation (i.e., as a number between 1 and 10 multiplied by a power of ten) gives 3.2×10^{-3}. Then, as discussed in part (b), observe that this number contains two significant figures. ◊

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11. A farmer measures the distance around a rectangular field. The length of each long side of the rectangle is found to be 38.44 m, and the length of each short side is found to be 19.5 m. What is the total distance around the field?

Solution The total distance around the field is given by:

Perimeter = length + width + length + width

= 38.44 m + 19.5 m + 38.44 m + 19.5 m = 115.88 m ◊