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# Physics I

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## Physics I: 501 Practice Problems For Dummies®

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# Contents at a Glance

# Table of Contents

# Introduction

Whether you want some extra practice for your college or high school physics class, you want to refresh your memory about a course you took long ago, or you're simply curious about the way the universe works, you've found the right book. After all, the best way to learn physics is to do physics, and the hundreds of problems in this book give you plenty of opportunity to do physics. You can practice as much as you like and become a pro at figuring out the right way to start out all sorts of problems that you'd expect to see in the first semester of a one-year physics course.

Why doesn't the moon crash into the earth? How is it possible to sleep on a bed of nails? Why does the water level in your glass stay the same when the ice melts? By working through the many problems in this book, you'll be better able to explain these and other mysteries of the universe to your friends.

## What You'll Find

The Physics I practice problems in this book are divided into 15 chapters, beginning with foundational practice (such as calculating displacement and working with vectors); moving on to forces, energy, and momentum; and wrapping up with thermodynamics. Some of the questions require you to reference a diagram, but that instruction is always clear within the questions.

Chapter 16 contains the solutions to all of the practice problems, as well as detailed explanations that help you understand how to come up with the correct answer. If you get a particular question wrong, though, don't just read the answer explanation and move on. Instead, try solving the question again because you know that now you won't make the same mistake that got you to the original wrong answer in the first place. (After all, sometimes knowing what *not* to do is a great start in discovering what *to* do.)

Whatever you do, stay positive. The harder questions in this book aren't meant to discourage you. Rather, they're meant to prove to you just how well you can understand the many challenging concepts presented in a typical Physics I class.

## How This Workbook Is Organized

This workbook is divided into two main parts: the questions and the answers.

## Part 1: The Questions

The questions in this book cover the following topics:

- **Math basics:** To learn physics, you need to know a little bit of math. (Just a little!) Chapter 1 checks your knowledge of basic algebra, trigonometry, units, and significant digits.
- **Kinematics:** The basic quantities you use to describe motion are displacement, velocity, and acceleration. In Chapter 2 you practice one-dimensional motion problems. Chapter 3 deals with the two-dimensional case.
- **Forces:** Newton's laws relate forces and motion. Chapter 4 has you applying Newton's laws; Chapter 5 questions you on friction and gravitational force.
- **Angular motion:** The linear quantities you use to describe motion and forces have angular analogues. Chapter 6 checks your knowledge of angular velocity and angular acceleration. In Chapter 7 you practice solving circular motion problems. Chapter 11 deals with torque, angular momentum, and rotational kinetic energy.
- **Energy and momentum:** You can discover a lot about the world around you by studying conserved quantities such as energy and momentum. Chapter 9 features work- and energy-related problems; Chapter 10 focuses on momentum and collisions.
- **Simple harmonic motion:** Periodic motion occurs repeatedly in nature, which is why Chapter 12 has you practice working with springs and pendula.
- **Liquids, gases, and thermodynamics:** Dealing with macroscopic properties is often easier than keeping track of the motion of each molecule. Chapter 8 focuses on density, pressure, and flow rates of liquids and gases. In Chapter 13 you examine temperature, heat, and heat transfer. Chapter 14 questions you on the ideal gas law, and Chapter 15 gets you applying the laws of thermodynamics to heat engines, heat pumps, and other situations.

## Part 2: The Answers

Here's where you can find detailed answer explanations for every question in this book. Find out how to set up and work through all the problems so that you arrive at the correct solution.

# Beyond the Book

In addition to what you're reading right now, this book comes with a free, access-anywhere Cheat Sheet that includes tips and other goodies you may want to have at your fingertips. To get this Cheat Sheet, simply go to `www.dummies.com` and type **Physics I Practice Problems For Dummies Cheat Sheet** into the Search box.

The online practice that comes free with this book offers you an addition 501 questions and answers, presented in a multiple-choice format. The beauty of the online problems is that you can customize your online practice to focus on the topic areas that give you trouble. If you're short on time and want to maximize your study, you can specify the quantity of problems you want to practice, pick your topics, and go. You can practice a few hundred problems in one sitting or just a couple dozen, and whether you can focus on a few types of problems or a mix of several types. Regardless of the combination you create, the online program keeps track of the questions you get right and wrong so you can monitor your progress and spend time studying exactly what you need.

To gain access to the online practice, you simply have to register. Just follow these steps:

1. Register your book or ebook at Dummies.com to get your PIN. Go to `www.dummies.com/go/getaccess`.
2. Select your product from the dropdown list on that page.
3. Follow the prompts to validate your product, and then check your email for a confirmation message that includes your PIN and instructions for logging in.

If you don't receive this email within two hours, please check your spam folder before contacting us through our Technical Support website at `http://support.wiley.com` or by phone at 877-762-2974.

Now you're ready to go! You can come back to the practice material as often as you want — simply log in with the username and password you created during your initial login. No need to enter the access code a second time.

Your registration is good for one year from the day you activate your PIN.

# Where to Go for Additional Help

The solutions to the practice problems in this book are meant to walk you through how to get the right answers; they're not meant to teach the material. If certain physics concepts are unfamiliar to you, you can find help at `www.dummies.com`. Just type **physics** I into the Search box to turn up a wealth of physics-related articles.

If you need more detailed instruction, check out *Physics I For Dummies,* 3rd Edition; *Physics I Workbook For Dummies,* 3rd Edition; and *Physics Essentials For Dummies,* all published by John Wiley & Sons.

# 1 The Questions

**IN THIS PART . . .**

Review math basics (Chapter 1)

Solve one-dimensional (Chapter 2) and two-dimensional (Chapter 3) motion problems

Work with forces (Chapters 4 and 5)

Focus on energy and momentum (Chapters 9 and 10)

Understand angular motion (Chapters 6, 7, and 11) and periodic motion (Chapter 12)

Deal with liquids (Chapter 8), gases (Chapter 14), and thermodynamics (Chapters 13 and 15)

Chapter 1

# Reviewing Math Fundamentals and Physics Measurements

Physics explains how the world works. You can use physics to predict how objects move and interact. This process often involves some basic algebra and trigonometry. To check these predictions, you can make a measurement. Sometimes you need to convert units to compare different measurements.

## The Problems You'll Work On

Here are some of the things you'll do in this chapter:

- Solving for an unknown variable with basic algebra
- Using basic trigonometry to determine side lengths and angles
- Converting between different types of units
- Writing numbers in scientific notation
- Understanding unit prefixes in the metric system
- Rounding to the correct number of significant digits

## What to Watch Out For

Be sure to remember the following:

- Making sure your answer has the right units
- Using conversion factors correctly
- Checking that your answers make sense physically

# Equipping Yourself with Basic Algebra

*1–3*

**1.** Solve the equation $y = 2m + 3$ for $m$.

**2.** You are given that $I = \frac{1}{2}mr^2$ and $m = m_0 + m_1$. Solve this expression for $m_0 + m_1$.

**3.** Solve the equation $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$ for $v$.

# Tackling a Little Trigonometry

*4–5*

**4.** If $\cos\theta = 0.8$ and the hypotenuse of a right triangle is 8 meters long, how long is the adjacent side of the right triangle?

**5.** A pool is 2.0 meters deep. You dive in at an angle of 35 degrees to the surface of the water. If you continue in this direction, how far from the edge of the pool will you hit the bottom?

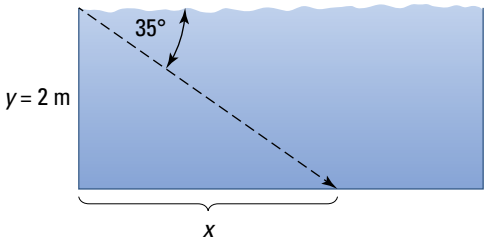


*Illustration by Thomson Digital*

# Converting between Units

*6–10*

**6.** A jet plane flies at about 10,000 meters. If 1 meter is 3.3 feet, how high does the plane fly in feet?

**7.** When you drive into Canada, the speed limit sign says 100 kilometers per hour. What is the speed limit in miles per hour? One mile consists of 1.6 kilometers.

**8.** You hire 5 painters to paint your house, which has a surface of 200 square meters. If each painter can paint 10 square meters per hour, how long does it take for them to paint the entire house?

**9.** Your dog eats a quarter pound of dog food each day. How often (in days) do you have to buy a 10-pound bag of dog food?

**10.** Your grandmother can knit a sweater in 3 days if she works 8 hours per day. She uses one bobbin of yarn every 2 hours, and each bobbin has 10 yards of yarn. How long is all the yarn in the sweater?

## Practicing Scientific Notation

*11–14*

**11.** The speed of light is about 300,000,000 meters per second. Write this speed in scientific notation.

**12.** A femtosecond is 1 millionth of 1 billionth of a second. What is a femtosecond in scientific notation?

**13.** The radius of the sun is $r = 6.955 \times 10^8$. Using the formula $V = \frac{4}{3}\pi r^3$ for the volume of a sphere of radius $r$, what is the volume of the sun in scientific notation?

**14.** Assume there are 7 billion people on Earth. If each person has a mass of 70 kilograms and the Earth has a mass of $6 \times 10^{24}$ kilograms, what fraction of the mass of Earth is due to humans?

## Understanding Unit Prefixes

*15–16*

**15.** A recipe calls for 500 milligrams of salt. You're serving a large group, so you want to triple the portions of the recipe. How many grams of salt are required?

**16.** How many milliwatts are in 1 megawatt? Give the answer in scientific notation.

## Spotting the Number of Significant Digits

*17–20*

**17.** How many significant digits are in the number 303.4?

**18.** Calculate the sum $21.21 + 4.8 + 2.33$ to the correct number of significant digits.

**19.** How many significant digits are in the number 5,003?

**20.** How many significant digits can you retain for $\sqrt{45.365 + 29.821}$?

## Rounding to the Correct Number of Digits

*21–25*

**21.** Calculate the sum 98.374 + 28.56 to the correct number of significant digits.

**22.** A physicist adds 0.25 gallons of paint to a container that already holds 10 gallons of paint. Given the significant digits of the quantities added, how much paint can the physicist say is in the container?

**23.** Evaluate the equation $t = (5.01 \times 4.4) + (3.2 \times 18)$ to the correct number of significant digits, and express the answer using the appropriate notation.

**24.** You measure the height of your apartment to be 2.6 meters high. If the apartment building has 8 floors, what is the height of the apartment building?

**25.** What is the result of $63.005 \times \left(18.54 + \frac{65}{4}\right)$ to the correct number of significant digits?

Chapter 2

# Moving along with Kinematics

To describe motion, you can use terms like displacement, speed, velocity, and acceleration. *Displacement* is a distance in a particular direction. *Speed* is the distance traveled in a certain amount of time. If you combine speed with a direction, you get *velocity. Acceleration* measures how quickly velocity changes.

## The Problems You'll Work On

In this chapter you'll move through the following topics:

- Finding the displacement in one and two dimensions
- Using velocity to determine the displacement
- Taking the average of the instantaneous speed
- Determining the change in velocity using acceleration
- Relating displacement, velocity, acceleration, and time

## What to Watch Out For

You'll speed through these questions if you keep the following in mind:

- Using the distance traveled, not the displacement, to determine average speed
- Remembering that velocity is the change in displacement in a certain amount of time
- Remembering that acceleration is the change in velocity in a certain amount of time

## Determining Displacement Using Positions in One Dimension

*26–29*

**26.** You leave your apartment and walk 2 blocks north, only to realize that you forgot your keys. You turn around and walk back 2 blocks south to get them. What is your total displacement?

**27.** A car is driven north for 5 miles, then south for 3 miles, and then north again for 2 miles. What is its displacement?

**28.** A pair of figure skaters skates together for 10 meters. Then skater A launches their partner, skater B, through the air. Skater B lands 15 meters ahead of where the pair began skating. What is skater B's displacement with respect to the launching point after landing?

**29.** An elevator is at the ground floor. It goes once to the first floor, twice to the second floor, three times to the third floor, and then four times to the fourth floor. What is the displacement of the elevator when Ms. Smith gets on at the third floor?

## Getting Displacement in Two Dimensions with Axes

*30–35*

**30.** You move a marker on a board from one point (2 centimeters, 4 centimeters) to another point (5 centimeters, 8 centimeters). What is the magnitude of the displacement of the marker?

**31.** To get to your friend's house, you walk 4 blocks north and 1 block east. What is the direction of your displacement with respect to the direction east?

**32.** A basketball player shoots the ball, releasing it at 8 feet above the floor and 5 feet from the basket. The ball goes straight through the basket, which is 10 feet above the floor. What is the magnitude of the displacement of the ball from the point at which it is released and the point at which it passes through the hoop?

**33.** A chess board is 8 squares by 8 squares. You move your bishop from one square $(3,1)$ to another square $(7,5)$. What is the magnitude (in squares) and angle of the displacement?

**34.** A child is scooting around on a toy truck. The child scoots 5 meters down the hall, then turns 90 degrees to the right and scoots 3 meters, then turns again 90 degrees to the right and scoots 2 more meters. What is the child's displacement over this trip?

**35.** You want to shoot a laser beam from the edge of a stage to a disco ball hanging from the ceiling. The stage is 1 meter above the floor, the disco ball is 1 meter below the ceiling, and the height of the ceiling is 4 meters. The horizontal distance from the edge of the stage where the laser is mounted to the point directly under the disco ball is 5 meters. At what angle above the horizontal should you aim the laser?

## Traveling with Average Speed and at Instantaneous Speed

*36–40*

**36.** You run from your house to the grocery store in 1.0 minute, and the store is 300 meters from your house. What is your average speed in meters per second for the trip?

**37.** In a traffic jam, you drive at 10 miles per hour for 10 minutes, at 20 miles per hour for 1 minute, at 15 miles per hour for 5 minutes, at 30 miles per hour for 2 minutes, and at 5 miles per hour for 15 minutes. What is your maximum instantaneous speed?

**38.** A ball is dropped from the top floor of your five-floor apartment building. You're on the bottom floor and see the ball go past your small window. If you measure the ball's speed at this point, is it the average speed, the instantaneous speed, both the average and the instantaneous speed, or neither the average nor the instantaneous speed?

**39.** The average speed of a car being driven in London is 11 miles per hour. If you have to drive 15 miles from your home to work in London, how long do you expect it to take?

**40.** The average speed of runner A is 10 percent greater than that of runner B. If runner B is given a 10-meter head start in a 100-meter dash, which runner will finish first?

## Distinguishing between Average Speed and Average Velocity

*41–45*

**41.** You travel north for 80 miles and then east for 30 miles. What is the magnitude of your average velocity if the entire trip takes 4 hours?

**42.** You travel north for 80 miles and then east for 30 miles. What is your average speed if the entire trip takes 4 hours?

**43.** You travel 35 miles north and 20 miles east. If the trip takes 30 minutes, what is the magnitude (in miles per hour) and direction of your average velocity?

**44.** A mail carrier walks 10 blocks north, then 3 blocks east, and then south for an unknown number of blocks. The time for the trip is 1.0 hour, and each block is 100 meters long. If the mail carrier's average speed is 1.0 meter per second, what is the magnitude of the average velocity in meters per second?

**45.** You travel 40 miles north, then 30 miles east, then 20 miles north, and then 10 miles south. If your trip takes 2 hours, what is your average speed?

## Speeding Up and Down with Acceleration

*46–50*

**46.** It takes you 2.0 seconds to accelerate from a standstill to a running speed of 7.0 meters per second. What is the magnitude of your acceleration?

**47.** The acceleration due to gravity at the surface of Earth is about 9.8 meters per second per second. If you drop a small heavy ball from the fourth floor of a building, how fast is the ball moving after 0.5 seconds?

**48.** Your infant daughter has a maximum crawling velocity of 0.3 meters per second. If she accelerates at 2 meters per second per second, how long does it take her to reach her maximum velocity when she starts from rest?

**49.** A plane's takeoff speed is 300 kilometers per hour. If it accelerates at 2.9 meters per second per second, how long is it on the runway after starting its takeoff roll?

**50.** You ride your bicycle at 10 meters per second and accelerate at –2.3 meters per second per second for 10 seconds. What is your final velocity?

## Finding Displacement with Acceleration and Time

*51–54*

**51.** Starting from rest, you accelerate at 2 meters per second per second for 2 seconds to get up to full speed on your bicycle. How far do you travel during this time?