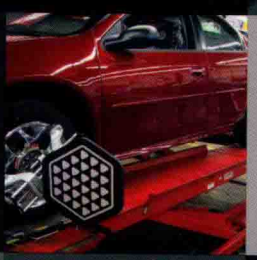
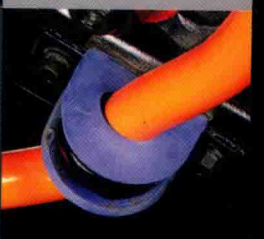
SIXTH EDITION

AUTOMOTIVE STEERING, SUSPENSION, AND ALIGNMENT

JAMES D. HALDERMAN





AUTOMOTIVE STEERING, SUSPENSION, AND ALIGNMENT

SIXTH EDITION

James D. Halderman

PEARSON

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto
Delhi Mexico City São Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

Editor in Chief: Vernon Anthony
Acquisitions Editor: Lindsey Prudhomme Gill
Editorial Assistant: Amanda Cerreto
Director of Marketing: David Gesell
Marketing Manager: Harper Coles
Marketing Assistant: Crystal Gonzalez
Project Manager: Jessica H. Sykes
Production Manager: Holly Shufeldt
Cover Art Director: Jayne Conte
Cover Designer: Bruce Kenselaar
Editor, Digital Projects: Nichole Caldwell
Media Project Manager: Karen Bretz
Full-Service Project Management: Abinaya Rajendran, Integra Software Services, Inc.
Composition: Integra Software Services, Ltd.
Printer/Binder: R.R. Donnelley
Cover Printer: R.R. Donnelley
Text Font: Helvetica Neue

Library of Congress Control Number: 2012955704

10 9 8 7 6 5 4 3

PEARSON

ISBN-10: 0-13-274776-6
ISBN-13: 978-0-13-274776-9

PREFACE

PROFESSIONAL TECHNICIAN SERIES Part of Pearson Automotive's Professional Technician Series, the sixth edition of *Automotive Steering, Suspension, and Alignment* represents the future of automotive textbooks. The series is a full-color, media-integrated solution for today's students and instructors. The series includes textbooks that cover all eight areas of ASE certification, plus additional titles covering common courses.

The series is also peer reviewed for technical accuracy.

UPDATES TO THE SIXTH EDITION

- Dramatic new full-color design.
- Over 40 new color photos and line drawings have been added to this edition.
- Inductive heating tool use added to Chapter 12.
- Expanded coverage on electric power steering (Chapter 13).
- Additional material on CV joint boots (Chapter 15).
- New information on rolling compensation added to Chapter 18.
- New content on the use of "chassis ears" to diagnose noise and vibrations (Chapter 19).
- Content has been streamlined for easier reading and comprehension.
- Unlike other textbooks, this book is written so that the theory, construction, diagnosis, and service of a particular component or system are presented in one location. There is no need to search through the entire book for other references to the same topic.

ASE AND NATEF CORRELATED NATEF certified programs need to demonstrate that they use course material that covers NATEF and ASE tasks. All Professional Technician textbooks have been correlated to the appropriate ASE and NATEF task lists. These correlations can be found in two locations:

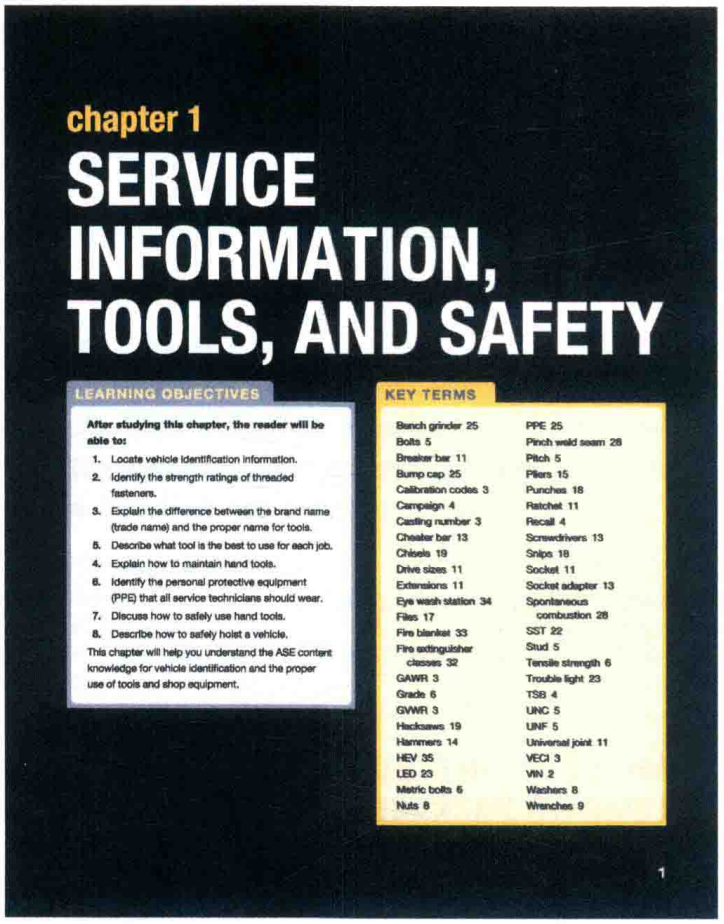
- As an appendix to each book.
- At the beginning of each chapter in the Annotated Instructor's Guide.

A COMPLETE INSTRUCTOR AND STUDENT SUPPLEMENTS PACKAGE All Professional Technician textbooks are accompanied by a full set of instructor and student supplements. Please see page vi for a detailed list of supplements.

A FOCUS ON DIAGNOSIS AND PROBLEM SOLVING The Professional Technician Series has been developed to satisfy the need for a greater emphasis on problem diagnosis. Automotive instructors and service managers agree that students and beginning technicians need more training in diagnostic procedures and skill development. To meet this need and demonstrate how real-world problems are solved, "Real World Fix" features are included throughout and highlight how real-life problems are diagnosed and repaired.

The following pages highlight the unique core features that set the Professional Technician Series book apart from other automotive textbooks.

IN-TEXT FEATURES



chapter 1

SERVICE INFORMATION, TOOLS, AND SAFETY

LEARNING OBJECTIVES

After studying this chapter, the reader will be able to:

1. Locate vehicle identification information.
2. Identify the strength ratings of threaded fasteners.
3. Explain the difference between the brand name (trade name) and the proper name for tools.
5. Describe what tool is the best to use for each job.
4. Explain how to maintain hand tools.
6. Identify the personal protective equipment (PPE) that all service technicians should wear.
7. Discuss how to safely use hand tools.
8. Describe how to safely hoist a vehicle.

This chapter will help you understand the ASE content knowledge for vehicle identification and the proper use of tools and shop equipment.

KEY TERMS

Bench grinder 25
Bolts 5
Breaker bar 11
Bump cap 25
Calibration codes 3
Campaign 4
Casting number 3
Cheater bar 13
Chisels 19
Drive sizes 11
Extensions 11
Eye wash station 34
Files 17
Fire blanket 33
Fire extinguisher classes 32
GAWR 3
Grade 6
GVWR 3
Hacksaws 19
Hammers 14
HEV 35
LED 23
Metric bolts 6
Nuts 8
PPE 25
Pinch weld seam 28
Pitch 5
Pliers 15
Punches 18
Ratchet 11
Recall 4
Screwdrivers 13
Snips 18
Socket 11
Socket adapter 13
Spontaneous combustion 28
SST 22
Stud 5
Tensile strength 6
Trouble light 23
TSB 4
UNC 5
UNF 5
Universal joint 11
VECI 3
VIN 2
Washers 8
Wrenches 9

1

LEARNING OBJECTIVES AND KEY TERMS appear at the beginning of each chapter to help students and instructors focus on the most important material in each chapter. The chapter objectives are based on specific ASE and NATEF tasks.

SAFETY TIP

Shop Cloth Disposal

Always dispose of oily shop cloths in an enclosed container to prevent a fire. ● **SEE FIGURE 1–69.** Whenever oily cloths are thrown together on the floor or workbench, a chemical reaction can occur, which can ignite the cloth even without an open flame. This process of ignition without an open flame is called **spontaneous combustion.**

SAFETY TIPS alert students to possible hazards on the job and how to avoid them.

REAL WORLD FIX

Three Brake Jobs in 40,000 Miles

A service technician was asked to replace the front disc brake pads on a Pontiac Grand Am because the sensors were touching the rotors and making a squealing sound. This was the third time that the front brakes needed to be replaced. Previous brake repairs had been limited to replacement of the front disc brake pads only.

When the caliper was removed and the pads inspected, it was discovered that a part of one pad had broken and a piece of the lining was missing. ● **SEE FIGURE 13–15.**

REAL WORLD FIXES present students with actual automotive scenarios and show how these common (and sometimes uncommon) problems were diagnosed and repaired.

TECH TIP

It Just Takes a Second

Whenever removing any automotive component, it is wise to screw the bolts back into the holes a couple of threads by hand. This ensures that the right bolt will be used in its original location when the component or part is put back on the vehicle.

TECH TIPS feature real-world advice and "tricks of the trade" from ASE-certified master technicians.

FREQUENTLY ASKED QUESTION

How Many Types of Screw Heads Are Used in Automotive Applications?

There are many, including Torx, hex (also called Allen), plus many others used in custom vans and motor homes. ● **SEE FIGURE 1–9.**

FREQUENTLY ASKED QUESTIONS are based on the author's own experience and provide answers to many of the most common questions asked by students and beginning service technicians.

NOTE: Most of these "locking nuts" are grouped together and are commonly referred to as *prevailing torque nuts*. This means that the nut will hold its tightness or torque and not loosen with movement or vibration.

NOTES provide students with additional technical information to give them a greater understanding of a specific task or procedure.

CAUTION: *Never* use hardware store (nongraded) bolts, studs, or nuts on any vehicle steering, suspension, or brake component. Always use the exact size and grade of hardware that is specified and used by the vehicle manufacturer.

CAUTIONS alert students about potential damage to the vehicle that can occur during a specific task or service procedure.

WARNING

Do not use incandescent trouble lights around gasoline or other flammable liquids. The liquids can cause the bulb to break and the hot filament can ignite the flammable liquid which can cause personal injury or even death.

WARNINGS alert students to potential dangers to themselves during a specific task or service procedure.

SUMMARY

1. Bolts, studs, and nuts are commonly used as fasteners in the chassis. The sizes for fractional and metric threads are different and are not interchangeable. The grade is the rating of the strength of a fastener.
2. Whenever a vehicle is raised above the ground, it must be supported at a substantial section of the body or frame.
3. Wrenches are available in open end, box end, and combination open and box end.
4. An adjustable wrench should only be used where the proper size is not available.
5. Line wrenches are also called flare-nut wrenches, fitting wrenches, or tube-nut wrenches and are used to remove fuel or refrigerant lines.
6. Sockets are rotated by a ratchet or breaker bar, also called a flex handle.
7. Torque wrenches measure the amount of torque applied to a fastener.
8. Screwdriver types include straight blade (flat tip) and Phillips.
9. Hammers and mallets come in a variety of sizes and weights.
10. Pliers are a useful tool and are available in many different types, including slip-joint, multigroove, lineman's, diagonal, needle-nose, and locking pliers.
11. Other common hand tools include snap-ring pliers, files, cutters, punches, chisels, and hacksaws.
12. Hybrid electric vehicles should be de-powered if any of the high-voltage components are going to be serviced.

REVIEW QUESTIONS

1. List three precautions that must be taken whenever hoisting (lifting) a vehicle.
2. Describe how to determine the grade of a fastener, including how the markings differ between fractional and metric bolts.
3. List four items that are personal protective equipment (PPE).
4. List the types of fire extinguishers and their usage.
5. Why are wrenches offset 15 degrees?
6. What are the other names for a line wrench?
7. What are the standard automotive drive sizes for sockets?
8. Which type of screwdriver requires the use of a hammer or mallet?
9. What is inside a dead-blow hammer?
10. What type of cutter is available in left and right cutters?

CHAPTER QUIZ

1. The correct location for the pads when hoisting or jacking the vehicle can often be found in the _____.
   a. Service manual c. Owner's manual
   b. Shop manual d. All of the above
2. For the best working position, the work should be _____.
   a. At neck or head level
   b. At knee or ankle level
   c. Overhead by about 1 foot
   d. At chest or elbow level
3. A high-strength bolt is identified by _____.
   a. A UNC symbol c. Strength letter codes
   b. Lines on the head d. The coarse threads
4. A fastener that uses threads on both ends is called a _____.
   a. Cap screw c. Machine screw
   b. Stud d. Crest fastener
5. When working with hand tools, always _____.
   a. Push the wrench—don't pull toward you
   b. Pull a wrench—don't push a wrench away from you
6. The proper term for Channel Locks is _____.
   a. Vise Grips c. Locking pliers
   b. Crescent wrench d. Multigroove adjustable pliers
7. The proper term for Vise Grips is _____.
   a. Locking pliers c. Side cuts
   b. Slip-joint pliers d. Multigroove adjustable pliers
8. Two technicians are discussing torque wrenches. Technician A says that a torque wrench is capable of tightening a fastener with more torque than a conventional breaker bar or ratchet. Technician B says that a torque wrench should be calibrated regularly for the most accurate results. Which technician is correct?
   a. Technician A only c. Both Technicians A and B
   b. Technician B only d. Neither Technician A nor B
9. What type of screwdriver should be used if there is very limited space above the head of the fastener?
   a. Offset screwdriver c. Impact screwdriver
   b. standard screwdriver d. Robertson screwdriver
10. What type of hammer is plastic coated, has a metal casing inside, and is filled with small lead balls?
    a. Dead-blow hammer c. Sledgehammer
    b. Soft-blow hammer d. Plastic hammer

THE SUMMARY, REVIEW QUESTIONS, AND CHAPTER QUIZ at the end of each chapter help students review the material presented in the chapter and test themselves to see how much they've learned.

STEP-BY-STEP photo sequences show in detail the steps involved in performing a specific task or service procedure.

SUPPLEMENTS

RESOURCES IN PRINT AND ONLINE

NAME OF SUPPLEMENT	PRINT	ONLINE	AUDIENCE	DESCRIPTION
Instructor Resource Manual 0132988089		✔	Instructors	NEW! The ultimate teaching aid: chapter summaries, key terms, chapter learning objectives, lecture resources discuss/ demonstrate classroom activities. MyAutomotiveLab correlation, and answers to the in-text review and quiz questions.
TestGen 013286116X		✔	Instructors	Test generation software and test bank for the text.
PowerPoint Presentation 0132861100		✔	Instructors	Slides include chapter learning objectives, lecture outline of the test, and graphics from the book.
Image Bank 0132865629		✔	Instructors	All of the images and graphs from the textbook to create customized lecture slides.
Instructors Resource CD-ROM 0132865637	✔			Take your instructor resources with you! This convenient CD houses the text PowerPoint presentation, Image Bank, instructors manual, and TestGen.
NATEF Correlated Task Sheets – for instructors		✔	Instructors	Downloadable NATEF task sheets for easy customization and development of unique task sheets.
NATEF Task Sheets – For Students 0132845245	✔		Students	Study activity manual that correlates NATEF Automobile Standards to chapters and page numbers in the text. Available to students at a discounted price when packaged with the text.
CourseSmart eText 0132861119		✔	Students	An alternative to purchasing the print text-book, students can subscribe to the same content online and save up to 50% off the suggested list price of the print text. Visit **www.coursesmart.com**

All online resources can be downloaded from the Instructor's Resource Center: **www.pearsonhighered.com/irc**

ACKNOWLEDGMENTS

A large number of people and organizations have cooperated in providing the reference material and technical information used in this text. The author wishes to express sincere thanks to the following individuals and organizations for their special contributions:

Richard Krieger, Lapeer County Vo-Tech Center
James (Mike) Watson, Watson Automotive LLC
Jim Morton, Automotive Training Center (ATC)
Jim Linder, Linder Technical Services, Inc.

TECHNICAL AND CONTENT REVIEWERS The following people reviewed the manuscript before production and checked it for technical accuracy and clarity of presentation. Their suggestions and recommendations were included in the final draft of the manuscript. Their input helped make this textbook clear and technically accurate while maintaining the easy-to-read style that has made other books from the same author so popular.

Jim Anderson
Greenville High School

Victor Bridges
Umpqua Community College

Dr. Roger Donovan
Illinois Central College

Steve Cartwright
Federal Mogul

A. C. Durdin
Moraine Park Technical College

Herbert Ellinger
Western Michigan University

Al Engledahl
College of Dupage

Larry Hagelberger
Upper Valley Joint Vocational School

Oldrick Hajzler
Red River College

Betsy Hoffman
Vermont Technical College

Steven T. Lee
Lincoln Technical Institute

Carlton H. Mabe, Sr.
Virginia Western Community College

Roy Marks
Owens Community College

Tony Martin
University of Alaska Southeast

Kerry Meier
San Juan College

Fritz Peacock
Indiana Vocational Technical College

Dennis Peter
NAIT (Canada)

Kenneth Redick
Hudson Valley Community College

Mitchell Walker
St. Louis Community College at Forest Park

Jennifer Wise

Sinclair Community College
Special thanks to instructional designer **Alexis I. Skriloff James.**

PHOTO SEQUENCES The author wishes to thank Blaine Heeter, Mike Garblik, and Chuck Taylor of Sinclair Community College in Dayton, Ohio, plus Steve Cartwright, Tony Martin, and James (Mike) Watson who helped with many of the photos.

Most of all, I wish to thank Michelle Halderman for her assistance in all phases of manuscript preparation.

—James D. Halderman

ABOUT THE AUTHOR

JIM HALDERMAN brings a world of experience, knowledge, and talent to his work. His automotive service experience includes working as a flat-rate technician, a business owner, and a professor of automotive technology at a leading U.S. community college for more than 20 years.

He has a Bachelor of Science Degree from Ohio Northern University and a Master's Degree in Education from Miami University in Oxford, Ohio. Jim also holds a U.S. Patent for an electronic transmission control device. He is an ASE certified Master Automotive Technician and Advanced Engine Performance (L1) ASE certified.

Jim is the author of many automotive textbooks all published by Prentice Hall.

Jim has presented numerous technical seminars to national audiences including the California Automotive Teachers (CAT) and the Illinois College Automotive Instructor Association (ICAIA). He is also a member and presenter at the North American Council of Automotive Teachers (NACAT). Jim was also named Regional Teacher of the Year by General Motors Corporation and an outstanding alumnus of Ohio Northern University.

Jim and his wife, Michelle, live in Dayton, Ohio. They have two children. You can reach Jim at

jim@jameshalderman.com

BRIEF CONTENTS

CONTENTS

chapter 1
SERVICE INFORMATION, TOOLS, AND SAFETY 1

chapter 2
ENVIRONMENTAL AND HAZARDOUS MATERIALS 40

chapter 3
TIRES AND WHEELS 54

chapter 4
TIRE-PRESSURE MONITORING SYSTEMS 85

chapter 5
TIRE AND WHEEL SERVICE 98

chapter 6
SUSPENSION SYSTEM COMPONENTS AND OPERATION 122

chapter 7
FRONT SUSPENSION AND SERVICE 153

chapter 8
REAR SUSPENSION AND SERVICE 185