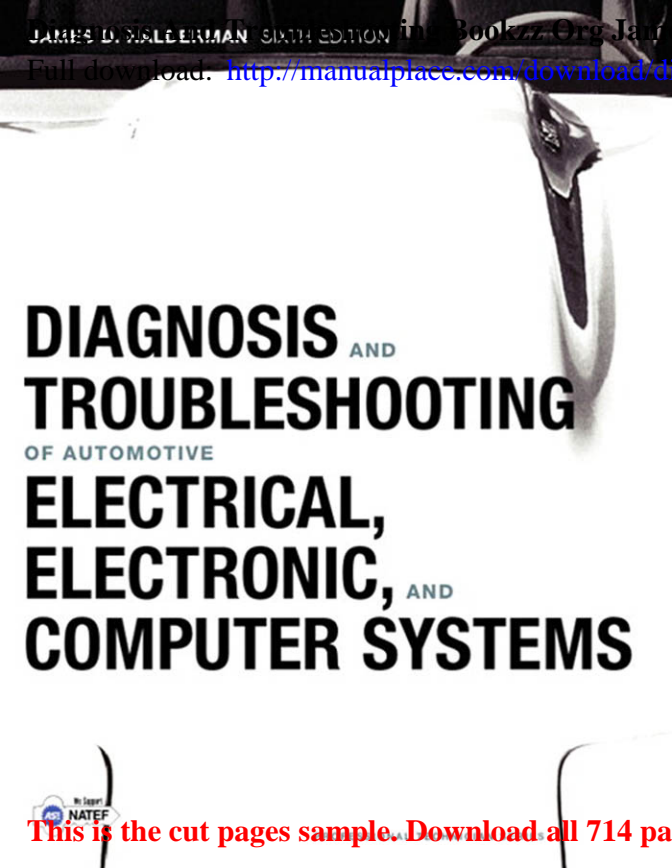


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OF AUTOMOTIVE
ELECTRICAL,
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DIAGNOSIS AND TROUBLESHOOTING OF AUTOMOTIVE ELECTRICAL, ELECTRONIC, AND COMPUTER SYSTEMS

SIXTH EDITION

James D. Halderman

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PREFACE

PROFESSIONAL TECHNICIAN SERIES Part of Pearson Automotive's Professional Technician Series, the sixth edition of *Diagnosis and Troubleshooting of Automotive Electrical, Electronic, and Computer Systems* 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 8 areas of ASE certification, plus additional titles covering common courses.

Current revisions are written by a team of very experienced writers and teachers. The series is also peer reviewed for technical accuracy.

UPDATES TO THE SIXTH EDITION

- All content is correlated to the latest NATEF tasks.
- A dramatic, new full-color design enhances the subject material.
- One entirely new chapter **Electronic Throttle Control Systems** (chapter 36).
- Greatly expanded coverage on circuit testers (chapter 6), lighting and signalling (chapter 21) and oxygen sensors (chapter 32).
- Over 40 new color photos and line drawings have been added to this edition.
- Content has been streamlined for easier reading and comprehension.
- This text is fully integrated with MyAutomotiveKit, an online supplement for homework, quizzing, testing, multimedia activities, and videos.
- Unlike other textbooks, this book is written so that the theory, construction, diagnosis, and service of a particular component or system is presented in one location. There is no need to search through the entire book for other references to the same topic.

NATEF CORRELATED NATEF certified programs need to demonstrate that they use course material that covers NATEF tasks. All Professional Technician textbooks have been correlated to the appropriate NATEF task lists. These correlations can be found in an appendix to each book.

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

OBJECTIVES: After studying Chapter 1, the reader will be able to:

- Understand the ASE knowledge content for vehicle identification and the proper use of tools and shop equipment.
- Retrieve vehicle service information.
- Identify the strength ratings of threaded fasteners.
- Describe how to safely hoist a vehicle.
- Discuss how to safely use hand tools.
- Identify the personal protective equipment (PPE) that all service technicians should wear.
- Describe what tool is the best to use for each job.
- Explain the difference between the brand name (trade name) and the proper name for tools.
- Explain how to maintain hand tools.
- Discuss how to safely use power tools.
- Identify the precautions that should be followed when working on hybrid electric vehicles.

KEY TERMS: Adjustable wrench 8 • Bench grinders 21 • Bolts 4 • Box-end wrench 8 • Breaker bar 9 • Bump cap 21 • Calibration codes 2 • Carriage 4 • Casting number 2 • Chatter bar 11 • Clutch 16 • Combination wrench 8 • Drive sizes 9 • Extensions 9 • Eye wash station 29 • Files 15 • Fire blanket 28 • Fire extinguisher classes 28 • GAWR 2 • Grade 5 • GVWR 2 • Hackaws 16 • Hammers 12 • Hybrid electric vehicles (HEVs) 30 • Light-emitting diode (LED) 19 • Line wrench 8 • Metric bolts 4 • Nuts 6 • Open-end wrench 7 • Personal protective equipment (PPE) 21 • Pinch weld seam 24 • Pitch 4 • Pliers 13 • Punches 15 • Ratchet 9 • Recall 4 • Screwdrivers 11 • Sings 15 • Socket 9 • Socket adapter 11 • Spontaneous combustion 22 • SST 19 • Stud 4 • Torque strength 6 • Trouble light 19 • YSB 3 • UNC 4 • UNF 4 • Universal joint 9 • VEC 2 • VIN 1 • Washers 7 • Wrenches 7

VEHICLE IDENTIFICATION

MAKE, MODEL, AND YEAR All service work requires that the vehicle and its components be properly identified. The most common identification is the make, model, and year of the vehicle.

Make: e.g., Chevrolet
Model: e.g., Impala
Year: e.g., 2008

VEHICLE IDENTIFICATION NUMBER The model year of the vehicle is often difficult to determine exactly. A model may be introduced as the next year's model as soon as January of the previous year. Typically, a new model year starts in September or October of the year prior to the actual new year, but not always. This is why the vehicle identification number, usually abbreviated VIN, is so important. ● SEE FIGURE 1-1.

Since 1981, all vehicle manufacturers have used a VIN that is 17 characters long. Although every vehicle manufacturer assigns various letters or numbers within these 17 characters, there are some constants, including:

- The first number or letter designates the country of origin. ● SEE CHART 1-1.
- The fourth and fifth character is the vehicle line/series.

- The sixth character is the body style.
- The seventh character is the restraint system.
- The eighth character is often the engine code. (Some engines cannot be determined by the VIN).
- The tenth character represents the year on all vehicles. ● SEE CHART 1-2.

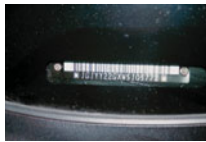


FIGURE 1-1 Typical vehicle identification number (VIN) as viewed through the windshield.

SERVICE INFORMATION, TOOLS, AND SAFETY 1

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.



TECH TIP

Hide Those from the Boss

An apprentice technician started working for a dealership and put his top tool box on a workbench. Another technician observed that, along with a complete set of good-quality tools, the box contained several adjustable wrenches. The more experienced technician said, “Hide those from the boss.” The boss does not want any service technician to use adjustable wrenches. If any adjustable wrench is used on a bolt or nut, the movable jaw often moves or loosens and starts to round the head of the fastener. If the head of the bolt or nut becomes rounded, it becomes that much more difficult to remove.

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



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

Lightning Damage

A radio failed to work in a vehicle that was outside during a thunderstorm. The technician checked the fuses and verified that power was reaching the radio. Then the technician noticed the antenna. It had been struck by lightning. Obviously, the high voltage from the lightning strike traveled to the radio receiver and damaged the circuits. Both the radio and the antenna were replaced to correct the problem.

● SEE FIGURE 26-26.

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



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: Before applying Ohm's law, be sure that each unit of electricity is converted into base units. For example, 10 K Ω should be converted to 10,000 ohms and 10 mA should be converted into 0.010 A.

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

CAUTION: Do not use a screwdriver as a pry tool or chisel. Screwdrivers use hardened steel only at the tip and are not designed to be pounded on or used for prying because they could bend easily. Always use the proper tool for each application.

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

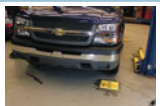











WARNING

Always use impact sockets with impact wrenches, and always wear eye protection in case the socket or fastener shatters. Input sockets are thicker walled and constructed with premium alloy steel. They are hardened with a black oxide finish to help prevent corrosion and distinguish them from regular sockets. ● SEE FIGURE 1-57.

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

HOISTING THE VEHICLE

STEP BY STEP

 <p>1 The first step in hoisting a vehicle is to properly align the vehicle in the center of the stall.</p>	 <p>2 Most vehicles will be correctly positioned when the hoist head fits in contact on the tire pad.</p>	 <p>7 Position the pads under the vehicle at the recommended location.</p>	 <p>8 After being sure of pads and correctly positioned, use the electromechanical controls to raise the vehicle.</p>
 <p>3 The arms can be moved in and out and most pads can be rotated to allow for many different types of vehicle construction.</p>	 <p>4 Most lifts are equipped with short pad extensions that are often necessary to use to align the pad to contact the frame of a vehicle without causing the arms of the lift to hit and damage parts of the body.</p>	 <p>9 With the vehicle raised one foot (30 cm) off the ground, push down on the vehicle's hood to see if it is stable on the pads. If the vehicle rocks, lower the vehicle and re-align the pads. The vehicle can be raised to any desired working level. Be sure the safety is engaged before working on or under the vehicle.</p>	 <p>10 If raising a vehicle without a frame, place the flat pads under the pinch weld area to support the load. If additional clearance is necessary, the pads can be raised or slanted.</p>
 <p>5 Tall pad extensions can also be used to gain access to the frame of a vehicle. This position is needed to safely hoist many pickup trucks, vans, and sport utility vehicles.</p>	 <p>6 An additional extension may be necessary to hold a truck or van equipped with running boards to give the necessary clearance.</p>	 <p>11 When the service work is completed, the hoist should be raised slightly and the safety released before using the hydraulic lever to lower the vehicle.</p>	 <p>12 After lowering the vehicle, be sure all arms of the lift are moved out of the way before driving the vehicle out of the work stall.</p>

32 CHAPTER 1
SERVICE INFORMATION, TOOLS, AND SAFETY 33

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 blades (flat tip), Phillips, and Torx.
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, multi-groove, linesman'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
 - b. Shop manual
 - c. Owner's 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 UNF symbol
 - b. Lines on the head
 - c. Strength letter codes
 - d. The coarse threads
4. A fastener that uses threads on both ends is called a
 - a. Cap screw
 - b. Stud
 - c. Machine screw
 - d. Crest fastener
5. When working with hand tools, always
 - a. Push the wrench—don't pull it toward you
 - b. Pull a wrench—don't push it away from you
 - c. Use Grip
 - d. The proper term for Channel Locks is _____
6. The proper term for Channel Locks is
 - a. Vise-Grip
 - b. Crescent wrench
 - c. Locking pliers
 - d. Multi-groove adjustable pliers
7. The proper term for Vise-Grip is
 - a. Locking pliers
 - b. Slip-joint pliers
 - c. Slide cuts
 - d. Multi-groove 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
 - b. Technician B only
 - c. Both Technicians A and B
 - 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
 - b. Stubby screwdriver
 - c. Impact 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
 - b. Soft-blow hammer
 - c. Sledge hammer
 - d. Plastic hammer

CHAPTER 1

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.

INSTRUCTOR SUPPLEMENTS The instructor supplement package has been completely revamped to reflect the needs of today's instructors. The all new **Online Instructor's Manual (ISBN: 0-13-255156-X)** is the cornerstone of the package.

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STUDENT SUPPLEMENTS

As a result of extensive student input, Pearson is no longer binding CDs into automotive students' textbooks. Today's student has more access to the Internet than ever, so all supplemental materials are downloadable at the following site for no additional charge:

www.pearsoned.com/autostudent

On the site, students will find:

- PowerPoint presentations
- Chapter review questions and quizzes
- English and Spanish Glossary
- A full Spanish translation of the text

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—James D. Halderman

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