

# Automotive Steering, Suspension, and Alignment

Seventh Edition

James D. Halderman



# **AUTOMOTIVE STEERING, SUSPENSION, AND ALIGNMENT**

SEVENTH EDITION

**James D. Halderman**

**PEARSON**

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# PREFACE

**PROFESSIONAL TECHNICIAN SERIES** Part of Pearson Automotive's Professional Technician Series, the seventh 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 SEVENTH EDITION** Based on requests and suggestions from reviewers and users of the sixth edition, the following have been updated for the new edition:

- The content has been updated throughout to reflect the changes in the industry and to meet the latest NATEF/ASE standards.
- Many new full-color photos and line drawings have been added to this edition.
- The chapter on power steering has been split into two separate chapters—"Hydraulic Power Steering Systems" (Chapter 13) and "Electric Power Steering Systems" (Chapter 14)—making teaching and learning these topics easier.
- New Case Study elements which include the "three Cs" (Complaint, Cause, and Correction) have been added to many chapters.
- New content on tire selection, chrome clad wheels, and using a pin plate to balance wheels has been added in Chapter 3.
- Additional content on snap-in and clamp-on TPMS sensors plus updated relearn procedures has been added in Chapter 4.
- Additional content on various wheel weight materials plus wheel flange information has been added to the totally updated Chapter 5.
- New information on "Hi Per strut" has been included in Chapter 7.
- Two new Case Studies have been added to Chapter 8.
- Discussion related to resetting the steering angle sensor after an alignment has been added to Chapter 18.
- 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, "Case Study" 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 and interpret vehicle and part identification numbers and labels.
2. Locate vehicle service information from a variety of sources.
3. Identify the strength and grades of various threaded fasteners.
4. Identify the various kinds of hand tools and their uses.
5. Identify the various kinds of automotive tools and their uses.
6. Describe personal protective equipment and safety precautions to be used when working on automobiles.

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

#### KEY TERMS

Adjustable wrench 9	Nuts 8
Bench grinders 25	Open-end wrench 9
Bolts 5	PPE 25
Breaker bar 11	Pinch weld seam 29
Bump cap 25	Pitch 5
Calibration codes 3	Pliers 15
Campaign 4	Punches 18
Casting number 3	Ratchet 11
Chester bar 13	Recall 4
Chisels 18	Screwdrivers 13
Drive sizes 11	Strips 18
Extensions 11	Socket 10
Eye wash station 34	Socket adapter 13
Files 17	Spontaneous combustion 27
Fire blankets 33	SST 22
Fire extinguisher classes 33	Stud 5
GAWR 3	Tensile strength 6
Grade 6	Trouble light 22
GVWR 3	TSB 4
Hacksaw 19	UNC 5
Hammer 14	UNF 5
Hybrid electric vehicles (HEVs) 35	Universal joint 11
Light-emitting diode (LED) 23	VECI 3
Metric bolts 6	VW 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.



#### 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.



#### 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.



#### CASE STUDY

##### The Rattle Story

A customer complained that a rattle was heard every time the vehicle hit a bump. The noise sounded as if it came from the rear. All parts of the exhaust system and suspension system were checked. Everything seemed okay until the vehicle was raised with a frame-type hoist instead of a drive-on type. Then, whenever the right rear wheel was lifted, the noise occurred. The problem was a worn (elongated) shock absorber mounting hole. A washer with the proper-size hole was welded over the worn lower frame mount and the shock absorber was bolted back into place.

##### Summary:

- **Complaint**—Vehicle owner complained of a rattle sound from the rear suspension at times.
- **Cause**—The lower shock mount was found to be worn (elongated) causing the noise.
- **Correction**—A steel washer was welded over the worn lower frame mount which restored the shock mount to the correct size and solved the noise issue.

**CASE STUDIES** present students with actual automotive scenarios and shows 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:** 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 as 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), 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, multigroove, 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 uses.
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 UNJ 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 put it toward you  
b. Pull a wrench—don't push it away from you
6. The proper term for Channel Locks is \_\_\_\_\_.  
a. Vise-Grip      c. Locking pliers  
b. Crescent wrench      d. Multigroove adjustable pliers
7. The proper term for Vise-Grip 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  
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      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  
b. Soft-blow hammer  
c. Sledge hammer  
d. Plastic hammer

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## 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.

# HOISTING THE VEHICLE

# STEP-BY-STEP (CONTINUED)



1 The first step in hoisting a vehicle is to properly align the vehicle in the center of the stand.



2 Most vehicles will be correctly positioned when the left front tire is centered on the lift pad.



3 The arms can be moved in and out and most pads can be rotated to allow for many different types of vehicle construction.



4 Most lifts are equipped with short pad extensions that are often necessary to use to allow the pad to contact the frame of a vehicle without causing the arm of the lift to hit and damage parts of the body.



5 Full 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.



6 An additional extension may be necessary to hoist a truck or van equipped with running boards to give the necessary clearance.



7 Position the pads under the vehicle at the recommended locations.



8 After lifting most all pads are correctly positioned, use the electromechanical controls to raise the vehicle.



9 With the vehicle raised one foot (30 cm) off the ground, push down on the vehicle to check if it is stable on the pads. If the vehicle rocks, lower it and reseat 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.



10 If raising a vehicle without a frame, place the full pads under the pinch welds to support the axle. If additional clearance is necessary, the pads can be raised as shown.



11 When the service work is completed, the hold should be released slightly and the safety released before using the hydraulic lever to lower the vehicle.



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 area.

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38 CHAPTER 1

**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 Automotive Steering, Suspension, and Alignment

NAME OF SUPPLEMENT	PRINT	ONLINE	AUDIENCE	DESCRIPTION
<b>Instructor Resource Manual</b> 0134074939		✓	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.
<b>TestGen</b> 0134075056		✓	Instructors	Test generation software and test bank for the text.
<b>PowerPoint Presentation</b> 0134074947		✓	Instructors	Slides include chapter learning objectives, lecture outline of the text, and graphics from the book.
<b>Image Bank</b> 0134074807		✓	Instructors	All of the images and graphs from the textbook to create customized lecture slides.
<b>NATEF Correlated Task Sheets – for instructors</b>		✓	Instructors	Downloadable NATEF task sheets for easy customization and development of unique task sheets.
<b>NATEF Correlated Task Sheets – For Students</b> 0134075072	✓		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.

All online resources can be downloaded from the Instructor's Resource Center: [www.pearsonhighered.com/irc](http://www.pearsonhighered.com/irc)



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—James D. Halderman



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## chapter 1

# SERVICE INFORMATION, TOOLS, AND SAFETY

### LEARNING OBJECTIVES

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

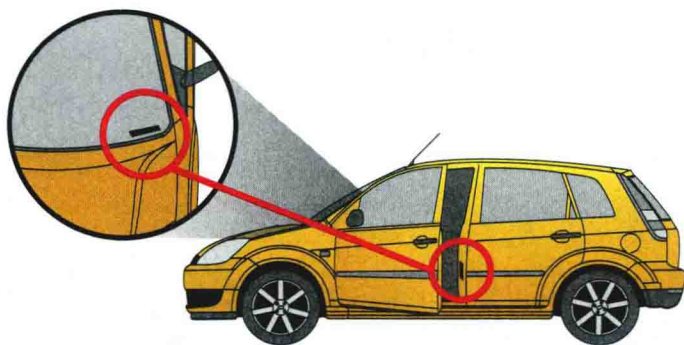
1. Locate and interpret vehicle and part identification numbers and labels.
2. Locate vehicle service information from a variety of sources.
3. Identify the strength and grades of various threaded fasteners.
4. Identify the various kinds of hand tools and their uses.
5. Identify the various kinds of automotive tools and their uses.
6. Describe personal protective equipment and safety precautions to be used when working on automobiles.

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

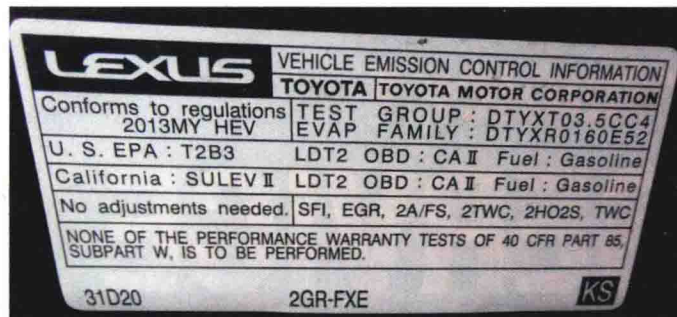
### KEY TERMS

Adjustable wrench 9	Nuts 8
Bench grinders 25	Open-end wrench 9
Bolts 5	PPE 25
Breaker bar 11	Pinch weld seam 29
Bump cap 25	Pitch 5
Calibration codes 3	Pliers 15
Campaign 4	Punch 18
Casting numbers 3	Ratchet 11
Cheater bar 13	Recall 4
Chisel 18	Screwdriver 13
Drive sizes 11	Snips 18
Extensions 11	Socket 10
Eye wash station 34	Socket adapter 13
Files 17	Spontaneous combustion 27
Fire blankets 33	SST 22
Fire extinguisher classes 33	Stud 5
GAWR 3	Tensile strength 6
Grade 6	Trouble light 22
GVWR 3	TSBS 4
Hacksaw 19	UNC 5
Hammers 14	UNF 5
Hybrid electric vehicles (HEVs) 35	Universal joints 11
Light-emitting diode (LED) 23	VECI 3
Metric bolt 6	VIN 2
	Washers 8
	Wrenches 9





**FIGURE 1-1** The vehicle identification number (VIN) is visible through the base of the windshield and on a decal inside the driver's door.



**FIGURE 1-2** The vehicle emissions control information (VECI) sticker is placed under the hood.

## 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 manufacture of the vehicle.

**Make:** e.g., Chevrolet

**Model:** e.g., Impala

**Year:** e.g., 2008

**VEHICLE IDENTIFICATION NUMBER** The 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 characters represent 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.**

1 = United States	J = Japan	T = Czechoslovakia
2 = Canada	K = Korea	U = Romania
3 = Mexico	L = China	V = France
4 = United States	M = India	W = Germany
5 = United States	N = Turkey	X = Russia
6 = Australia	P = Philippines	Y = Sweden
8 = Argentina	R = Taiwan	Z = Italy
9 = Brazil	S = England	

**CHART 1-1**

The first number or letter in the VIN identifies the country where the vehicle was made.

A = 1980/2010	L = 1990/2020	Y = 2000/2030
B = 1981/2011	M = 1991/2021	1 = 2001/2031
C = 1982/2012	N = 1992/2022	2 = 2002/2032
D = 1983/2013	P = 1993/2023	3 = 2003/2033
E = 1984/2014	R = 1994/2024	4 = 2004/2034
F = 1985/2015	S = 1995/2025	5 = 2005/2035
G = 1986/2016	T = 1996/2026	6 = 2006/2036
H = 1987/2017	V = 1997/2027	7 = 2007/2037
J = 1988/2018	W = 1998/2028	8 = 2008/2038
K = 1989/2019	X = 1999/2029	9 = 2009/2039

**CHART 1-2**

The pattern repeats every 30 years for the year of manufacture.