Automotive Brake Systems

Seventh Edition

James D. Halderman

AUTOMOTIVE BRAKE SYSTEMS

SEVENTH EDITION

James D. Halderman

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Composition: Integra Software Services Private Limited
Printer/Binder: R. R. Donnelley/Menasha
Cover Printer: Phoenix Color
Text Font: 9/13, Helvetica Neue LT Pro-Roman

Library of Congress Cataloging-in-Publication Data
Halderman, James D.,
Automotive brake systems/James D. Halderman.—Seventh edition.
pages cm
ISBN 978-0-13-406312-6 (alk. paper)—ISBN 0-13-406312-0 (alk. paper) 1. Automobiles—Brakes. I. Title.
TL269.H35 2017
629.2'46—dc23

2015036929

10 9 8 7 6 5 4 3 2 1

PEARSON

ISBN 10: 0-13-406312-0
ISBN 13: 978-0-13-406312-6

PREFACE

PROFESSIONAL TECHNICIAN SERIES Part of Pearson Automotive's Professional Technician Series, the seventh edition of *Automotive Brake 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.

The series is also peer reviewed for technical accuracy.

NEW TO THIS SEVENTH EDITION As a result of comments and suggestions from reviewers and automotive instructors, the following changes have been made to the seventh edition:

- Over 40 new full-color photos and line drawings have been added to help bring the subject to life.
- All of the content throughout has been updated to meet the latest NATEF and ASE standards.
- The chapter on brake principles (Chapter 4) has been expanded and now includes the details on brake friction materials which are now in one location instead of being repeated in the drum and disc brake chapters.
- Qualifying a brake lathe information has been added to Chapter 15
- The three chapters on antilock brake systems (ABS) have been condensed and updated to two new chapters (Chapters 17 and 18) to make this topic more concise, which makes it easier to teach or learn this technical content.
- The chapter on regenerative brakes (Chapter 20) has been moved to the end of the book as suggested by automotive instructors.
- Many new review and chapter quiz questions were changed to match the new and updated content in each chapter.

Examples of what was changed and updated include:

1. The GM regular production code (RPO) information has been added to Chapter 3 (Braking System Components and Performance Standards)
2. Content related to ceramic brake pads and environmental concerns of copper in brake friction materials has been added to Chapter 4 (Brake Principles and Friction Materials).
3. Case studies have been updated to include the "three Cs" (complaint, cause, and correction).
4. The BCM control of the red brake warning light (RBWL) has been added to Chapter 6 (Hydraulic Valves and Switches).
5. Brake line corrosion reduction coating has been added to Chapter 7(Brake Fluid and Lines).
6. New disc brake photo sequence has been added to Chapter 13 (Disc Brake Diagnosis and Service)

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:

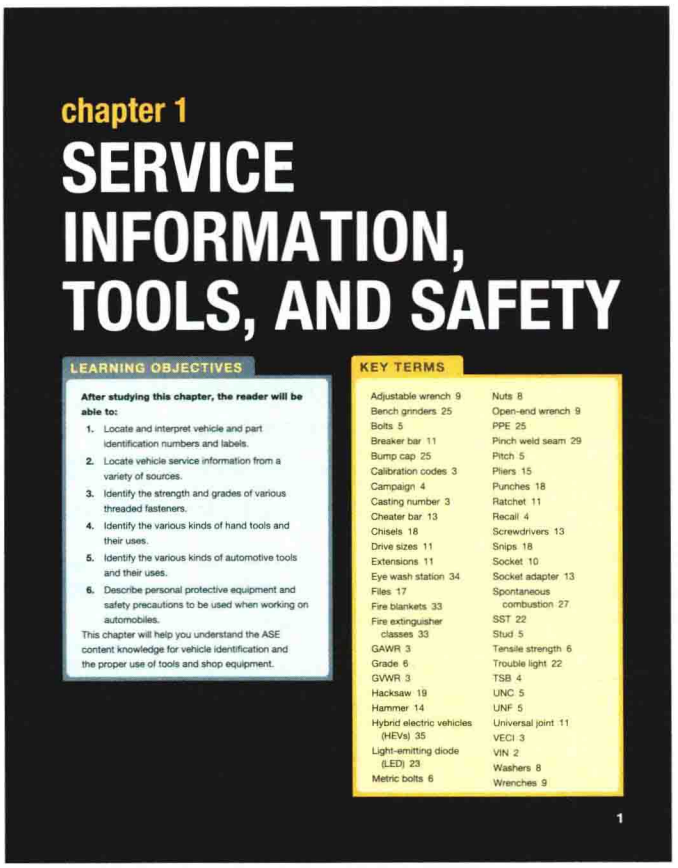
- As an appendix to each book
- At the beginning of each chapter in the Instructor's Manual

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
Bench grinders 25
Bolts 5
Breaker bar 11
Bump cap 25
Calibration codes 3
Campaign 4
Casting number 3
Cheater bar 13
Chisels 18
Drive sizes 11
Extensions 11
Eye wash station 34
Files 17
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GAWR 3
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Metric bolts 6
Nuts 8
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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.

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 Sinking Brake Pedal

This author has experienced what happens when brake fluid is not changed regularly. Just as many technicians will tell you, we do not always do what we know should be done to our own vehicles. While driving a four-year-old vehicle on vacation in very hot weather in a mountainous country, the brake pedal sank to the floor. When the vehicle was cold, the brakes were fine. But after several brake applications, the pedal became soft and spongy and sank slowly to the floor if pressure was maintained on the brake pedal. Because the brakes were okay when cold, I knew it had to be boiling brake fluid. Old brake fluid (four years old) often has a boiling point under 300°F (150°C). With the air temperature near 100°F (38°C), it does not take much more heat to start boiling the brake fluid. After bleeding over a quart (1 liter) of new brake fluid through the system, the brakes worked normally. I'll never again forget to replace the brake fluid as recommended by the vehicle manufacturer.

Summary:

- **Complaint**—Brake pedal would sink to the floor when driving in mountainous country.
- **Cause**—The brake fluid was boiling causing the loss of brakes.

Correction—The brake fluid was replaced and the system bled.

CASE STUDIES present students with actual automotive scenarios and show how these common (and sometimes uncommon) problems were diagnosed and repaired. Summary includes new elements called the "three Cs."

? 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.

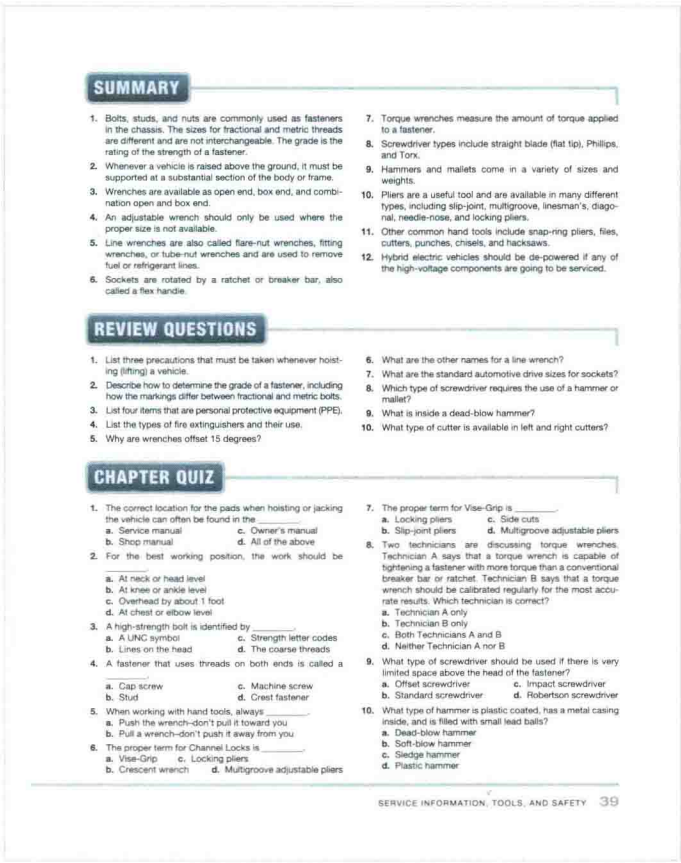
CAUTION: Never use hardware store (nongraded) bolts, studs, or nuts on any vehicle steering, suspension, or brake component. Always use the exact size and grade of hardware that is specified and used by the vehicle manufacturer.

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

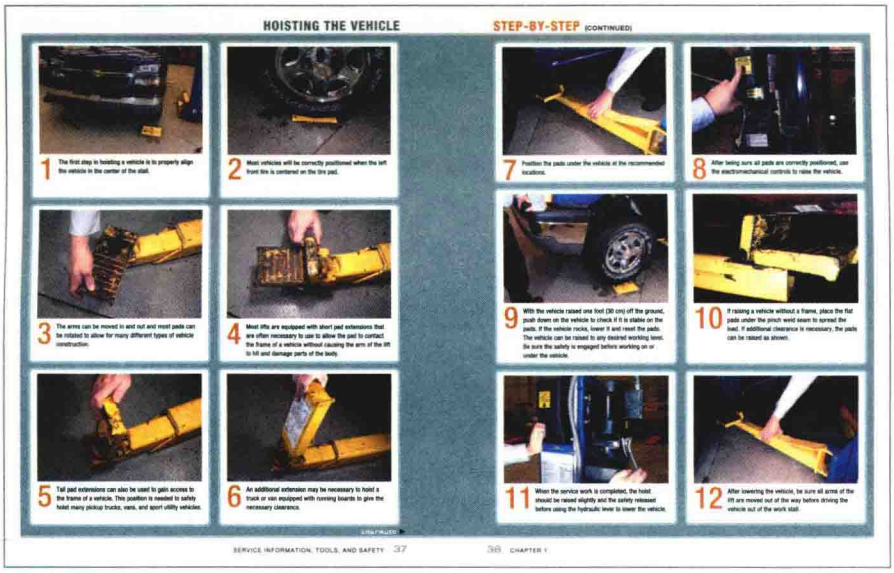
1. List three precautions that must be taken whenever hoisting (lifting) a vehicle.
2. Describe how to determine the grade of a fastener, including how the markings differ between fractional and metric bolts.
3. List four items that are personal protective equipment (PPE).
4. List the types of fire extinguishers and their use.
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 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

SERVICE INFORMATION, TOOLS, AND SAFETY 39

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
Automotive Brake Systems

Name of Supplement	*Print*	*Online*	*Audience*	*Description*
Instructor Resource Manual 0134072383		✔	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 0134071298		✔	Instructors	Test generation software and test bank for the text.
PowerPoint Presentation 0134072561		✔	Instructors	Slides include chapter learning objectives, lecture outline of the text, and graphics from the book.
Image Bank 0134072529		✔	Instructors	All of the images and graphs from the textbook to create customized lecture slides.
NATEF Correlated Task Sheets - for Instructors 0134072847		✔	Instructors	Downloadable NATEF task sheets for easy customization and development of unique task sheets.
NATEF Correlated Task Sheets— for Students 0134072421	✔		Students	Study activity manual that correlates NATEF Automobile Standards to chapters and pages 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**

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 organizations for their special contributions:

ASE
Automotion, Inc.
Automotive Parts Rebuilders Association (APRA)
Bendix
British Petroleum (BP)
Cooper Automotive Company
CR Services
Dana Corporation
Fluke Corporation
FMC Corporation
Ford Motor Company
Hennessy Industries
Hunter Engineering Company
Lee Manufacturing Company
MOOG Automotive Inc.
Perfect Hofmann-USA
SKF USA, Inc.
Society of Automotive Engineers (SAE)
Specialty Products Company
Tire and Rim Association, Inc.
Toyota Motor Sales, USA, Inc.
TRW Inc.
Wurth USA, 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

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

John Fowler
Iowa Central Community College

Steve Semon
Gateway Technical College

Donald Vath
Waubonsee Community College

Special thanks to instructional designer
Alexis Skriloff James.

PHOTO SEQUENCES The author wishes to thank Blaine Heeter, Mike Garblik, and Chuck Taylor of Sinclair Community College in Dayton, Ohio, 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 Masters 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 a member of the advisory broad for Technological Studies department at Ohio Northern University.

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

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BRIEF CONTENTS

CONTENTS

chapter 1

SERVICE INFORMATION, TOOLS, AND SAFETY

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KEY TERMS

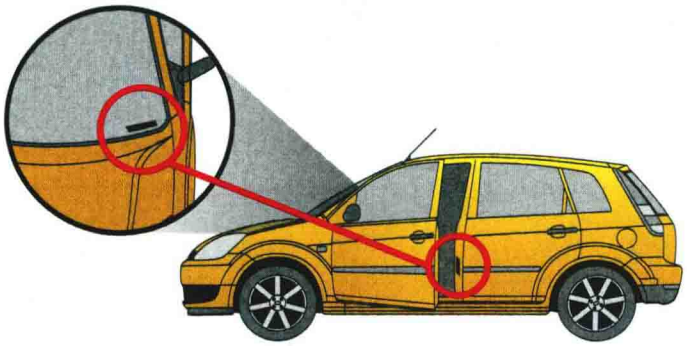

FIGURE 1–1 The vehicle identification number (VIN) is visible through the base of the windshield and on a decal inside the driver's door.

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.