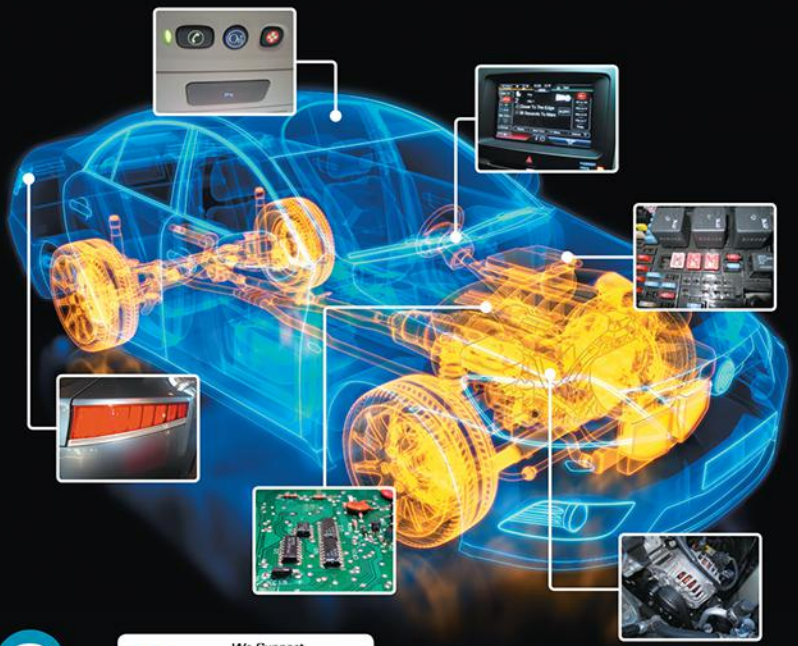
Automotive Electricity and Electronics

JAMES D. HALDERMAN



We Support ASE Education Foundation

SIXTH EDITION

AUTOMOTIVE ELECTRICITY AND ELECTRONICS

This page is intentionally left blank

AUTOMOTIVE ELECTRICITY AND ELECTRONICS

SIXTH EDITION

James D. Halderman

Pearson

Director of Product Management: Linea Rowe
Product Manager, Trades, Hospitality, & Careers: Derril Trakalo
Senior Analyst, HE Global Content, Trades & Hospitality: Tara Warrens
Analyst, HE Global Content, Careers & Professional: Bridget Daly
Manager Content HE, Careers & Professional: Jenifer Niles
Director, Digital Studio & Content Production: Brian Hyland
Managing Content Producer: Jennifer Sargunar
Managing Producer, Teacher Education & Careers: Autumn Benson
Content Producer (Team Lead): Faraz Sharique Ali
Permissions Editor: Jenell Forschler
Cover Design: Carie Keller, SPi
Cover Credit: Courtesy of ASE; Henrik5000/E+/Getty images
Full-Service Management and Composition: Integra Software Service Pvt. Ltd.
Printer/Binder: LSC Communications, Inc.
Cover Printer: LSC Communications, Inc.
Text Font: Helvetica Neue LT W1G

Library of Congress Cataloging-in-Publication Data

Names: Halderman, James D., author.
Title: Automotive electricity and electronics / James D. Halderman.
Description: Sixth edition. | Hoboken, New Jersey : Pearson, 2020. | Includes index.
Identifiers: LCCN 2019033309 | ISBN 9780135764428 (paperback) | ISBN 9780135764626 (epub)
Subjects: LCSH: Automobiles—Electric equipment. | Automobiles—Electronic equipment. | Automobiles—Electric equipment.—Maintenance and repair. | Automobiles—Electronic equipment—Maintenance and repair.
Classification: LCC TL272 .H22256 2020 | DDC 629.25/4—dc23
LC record available at https://lccn.loc.gov/2019033309

ScoutAutomatedPrintCode

ISBN-10: 0-13-576442-4
ISBN-13: 978-0-13-576442-8

BRIEF CONTENTS

chapter 1 Service Information, Work Orders, and Vehicle Identification 1
chapter 2 Tools and Safety 9
chapter 3 Environmental and Hazardous Materials 42
chapter 4 Electrical Fundamentals 53
chapter 5 Electrical Circuits and Ohm's Law 64
chapter 6 Series Circuits 72
chapter 7 Parallel Circuits 79
chapter 8 Series–Parallel Circuits 86
chapter 9 Circuit Testers and Digital Meters 93
chapter 10 Oscilloscopes and Graphing Multimeters 111
chapter 11 Automotive Wiring and Wire Repair 119
chapter 12 Wiring Schematics and Circuit Testing 134
chapter 13 Capacitance and Capacitors 152
chapter 14 Magnetism and Electromagnetism 158
chapter 15 Electronic Fundamentals 171
chapter 16 Computer Fundamentals 189
chapter 17 CAN and Network Communications 197
chapter 18 Batteries 214
chapter 19 Battery Testing and Service 223
chapter 20 Cranking System 238
chapter 21 Cranking System Diagnosis and Service 251
chapter 22 Charging System 266
chapter 23 Charging System Diagnosis and Service 279
chapter 24 Lighting and Signaling Circuits 301
chapter 25 Driver Information and Navigation Systems 321
chapter 26 Security and Anti-Theft Systems 338
chapter 27 Airbag and Pretensioner Circuits 347

chapter 28 Body Electrical Accessories 362

chapter 29 Advanced Driver Assist Systems (ADAS) 392

chapter 30 Audio System Operation and Diagnosis 404

APPENDIX 1

SAMPLE ELECTRICAL (A6) ASE-TYPE CERTIFICATION TEST WITH ANSWERS 419

APPENDIX 2

2017 ASE CORRELATION CHART 423

GLOSSARY 426

INDEX 438

CONTENTS

chapter 1

SERVICE INFORMATION, WORK ORDERS, AND VEHICLE IDENTIFICATION 1

- Learning Objectives 1
- Key Terms 1
- Owner's Manuals 1
- Service Information 2
- Technical Service Bulletins 2
- Recalls and Campaigns 2
- Work Order 3
- Service Records 3
- Additional Information 5
- Parts of a Vehicle 5
- Front-Wheel Drive Versus Rear-Wheel Drive 5
- Vehicle Identification 5
- Vehicle Safety Certification Label 7
- VECI Label 7

SUMMARY 7
REVIEW QUESTIONS 8
CHAPTER QUIZ 8

chapter 2

TOOLS AND SAFETY 9

- Learning Objectives 9
- Key Terms 9
- Threaded Fasteners 9
- Hand Tools 13
- Screwdrivers 16
- Torx 17
- Pliers 19
- Basic Hand Tool List 22
- Tool Sets and Accessories 23
- Electrical Hand Tools 23
- Hand Tool Maintenance 25
- Trouble Lights 25
- Air and Electrically Operated Tools 25
- Personal Protective Equipment 27
- Safety Precautions 28
- Vehicle Protection 29
- Safety Lifting (Hoisting) a Vehicle 29
- Jacks and Safety Stands 31
- Drive-on Ramps 31
- Electrical Cord Safety 32
- Jump Starting and Battery Safety 32
- Fire Extinguishers 33
- Fire Blankets 34
- First Aid and Eye Wash Stations 34
- Hybrid Electric Vehicle Safety Issues 35

SUMMARY 40
REVIEW QUESTIONS 40
CHAPTER QUIZ 40

chapter 3

ENVIRONMENTAL AND HAZARDOUS MATERIALS 42

- Learning Objectives 42
- Key Terms 42
- Hazardous Waste 42
- Federal and State Laws 42
- Asbestos Hazards 44
- Used Brake Fluid 45
- Used Oil 45
- Solvents 46
- Coolant Disposal 47
- Lead-Acid Battery Waste 48
- Fuel Safety and Storage 48
- Airbag Handling 49
- Used Tire Disposal 49
- Air-Conditioning Refrigerant Oil Disposal 50

SUMMARY 52
REVIEW QUESTIONS 52
CHAPTER QUIZ 52

chapter 4

ELECTRICAL FUNDAMENTALS 53

- Learning Objectives 53
- Key Terms 53
- Introduction 53
- Electricity 53
- How Electrons Move Through a Conductor 56
- Units of Electricity 57
- Sources of Electricity 59
- Conductors and Resistance 60
- Resistors 61

SUMMARY 62
REVIEW QUESTIONS 62
CHAPTER QUIZ 63

chapter 5
ELECTRICAL CIRCUITS AND OHM'S LAW 64

- Learning Objectives 64
- Key Terms 64
- Circuits 64
- Circuit Fault Types 65
- Ohm's Law 67
- Watt's Law 69

SUMMARY 70
REVIEW QUESTIONS 70
CHAPTER QUIZ 71

chapter 6
SERIES CIRCUITS 72

- Learning Objectives 72
- Key Terms 72
- Series Circuits 72
- Ohm's Law and Series Circuits 72
- Kirchhoff's Voltage Law 73
- Voltage Drops 74
- Series Circuit Laws 75
- Series Circuit Examples 76

SUMMARY 77
REVIEW QUESTIONS 77
CHAPTER QUIZ 78

chapter 7
PARALLEL CIRCUITS 79

- Learning Objectives 79
- Key Terms 79
- Parallel Circuits 79
- Kirchhoff's Current Law 79
- Parallel Circuit Laws 80
- Determining Total Resistance in a Parallel Circuit 80
- Parallel Circuit Calculation Examples 83

SUMMARY 84
REVIEW QUESTIONS 84
CHAPTER QUIZ 85

chapter 8
SERIES–PARALLEL CIRCUITS 86

- Learning Objectives 86
- Key Terms 86
- Series–Parallel Circuits 86
- Solving Series–Parallel Circuit Calculation Problems 87
- Series–Parallel Circuit Calculation Examples 87

SUMMARY 89
REVIEW QUESTIONS 89
CHAPTER QUIZ 89

chapter 9
CIRCUIT TESTERS AND DIGITAL METERS 93

- Learning Objectives 93
- Key Terms 93
- Fused Jumper Wire 93
- Test Lights 94
- Logic Probe 95
- Digital Multimeters 95
- Inductive Ammeters 99
- Diode Check, Duty Cycle, and Frequency 100
- Electrical Unit Prefixes 101
- How to Read Digital Meters 102

SUMMARY 110
REVIEW QUESTIONS 110
CHAPTER QUIZ 110

chapter 10
OSCILLOSCOPES AND GRAPHING MULTIMETERS 111

- Learning Objectives 111
- Key Terms 111
- Types of Oscilloscopes 111
- Scope Setup and Adjustments 112
- AC Voltage 113
- DC and AC Coupling 113
- Pulse Trains 114
- Number of Channels 114
- Triggers 114
- Using a Scope 115
- Graphing Multimeter 117
- Graphing Scan Tools 117

SUMMARY 118
REVIEW QUESTIONS 118
CHAPTER QUIZ 118

chapter 11
AUTOMOTIVE WIRING AND WIRE REPAIR 119

- Learning Objectives 119
- Key Terms 119
- Automotive Wiring 119
- Ground Wires 121
- Battery Cables 121
- Jumper Cables 122

- Fuses and Circuit Protection Devices 122
- Terminals and Connectors 128
- Wire Repair 129
- Electrical Conduit 131

SUMMARY 132
REVIEW QUESTIONS 133
CHAPTER QUIZ 133

chapter 12
WIRING SCHEMATICS AND CIRCUIT TESTING 134

- Learning Objectives 134
- Key Terms 134
- Wiring Schematics and Symbols 134
- Schematic Symbols 135
- Relay Terminal Identification 140
- Locating an Open Circuit 143
- Common Power or Ground 144
- Circuit Troubleshooting Procedure 145
- Locating a Short Circuit 145
- Electrical Troubleshooting Guide 148
- Step-by-Step Troubleshooting Procedure 149

SUMMARY 150
REVIEW QUESTIONS 150
CHAPTER QUIZ 150

chapter 13
CAPACITANCE AND CAPACITORS 152

- Learning Objectives 152
- Key Terms 152
- Capacitance 152
- Capacitor Construction and Operation 152
- Factors of Capacitance 155
- Uses for Capacitors 155
- Capacitors in Circuits 156

SUMMARY 157
REVIEW QUESTIONS 157
CHAPTER QUIZ 157

chapter 14
MAGNETISM AND ELECTROMAGNETISM 158

- Learning Objectives 158
- Key Terms 158
- Fundamentals of Magnetism 158
- Electromagnetism 160
- Uses of Electromagnetism 162
- Electromagnetic Induction 165
- Ignition Coils 166
- Electromagnetic Interference 168

SUMMARY 169
REVIEW QUESTIONS 169
CHAPTER QUIZ 169

chapter 15
ELECTRONIC FUNDAMENTALS 171

- Learning Objectives 171
- Key Terms 171
- Semiconductors 171
- Summary of Semiconductors 172
- Diodes 173
- Zener Diodes 174
- High-Voltage Spike Protection 174
- Diode Ratings 176
- Light-Emitting Diodes 176
- Photodiodes 177
- Photoresistors 177
- Silicon-Controlled Rectifiers 178
- Thermistors 178
- Rectifier Bridges 178
- Transistors 179
- Field-Effect Transistors 180
- Phototransistors 181
- Integrated Circuits 181
- Transistor Gates 182
- Operational Amplifiers 182
- Electronic Component Failure Causes 183
- How to Test Diodes and Transistors 184
- Converters and Inverters 185
- Electrostatic Discharge 186

SUMMARY 187
REVIEW QUESTIONS 187
CHAPTER QUIZ 187

chapter 16
COMPUTER FUNDAMENTALS 189

- Learning Objectives 189
- Key Terms 189
- Computer Fundamentals 189
- Computer Functions 189
- Digital Computers 191
- Computer Input Sensors 193
- Computer Outputs 193

SUMMARY 195
REVIEW QUESTIONS 196
CHAPTER QUIZ 196

chapter 17

CAN AND NETWORK COMMUNICATIONS 197

- Learning Objectives 197
- Key Terms 197
- Module Communications and Networks 197
- Network Fundamentals 197
- Module Communications Configuration 199
- Network Communications Classifications 199
- General Motors Communications Protocols 200
- Ford Network Communications Protocols 203
- Chrysler Communications Protocols 203
- Controller Area Network 205
- Honda/Toyota Communications 206
- European Bus Communications 207
- Network Communications Diagnosis 208
- OBD-II Data Link Connector 211

SUMMARY 212
REVIEW QUESTIONS 212
CHAPTER QUIZ 213

chapter 18

BATTERIES 214

- Learning Objectives 214
- Key Terms 214
- Introduction 214
- Battery Construction 214
- How a Battery Works 217
- Specific Gravity 217
- Battery Construction Types 218
- Causes and Types of Battery Failure 219
- Battery Ratings 220
- Battery Sizes 221

SUMMARY 221
REVIEW QUESTIONS 222
CHAPTER QUIZ 222

chapter 19

BATTERY TESTING AND SERVICE 223

- Learning Objectives 223
- Key Terms 223
- Battery Service Safety Considerations 223
- Symptoms of a Weak or Defective battery 223
- Battery Maintenance 224
- Battery Voltage Test 225
- Hydrometer Testing 226
- Battery Load Testing 226
- Electronic Conductance Testing 227
- Battery Charging 228
- Battery Charge Time 230
- Float-Type Battery Chargers 230
- Jump Starting 231
- Battery Electrical Drain Test 231
- Maintaining Electronic Memory Functions 233
- Battery Symptom Guide 235

SUMMARY 236
REVIEW QUESTIONS 236
CHAPTER QUIZ 236

chapter 20

CRANKING SYSTEM 238

- Learning Objectives 238
- Key Terms 238
- Cranking Circuit 238
- Computer-Controlled Starting 239
- Starter Motor Operation 240
- How the Starter Motor Works 242
- Gear-Reduction Starters 245
- Starter Drives 245
- Starter Solenoids 247
- Stop-Start Systems 248

SUMMARY 249
REVIEW QUESTIONS 249
CHAPTER QUIZ 250

chapter 21

CRANKING SYSTEM DIAGNOSIS AND SERVICE 251

- Learning Objectives 251
- Key Terms 251
- Starting System Troubleshooting Procedure 251
- Voltage Drop Testing 252
- Control Circuit Testing 254
- Starter Amperage Test 254
- Starter Removal 255
- Starter Motor Service 255
- Bench Testing 257
- Starter Installation 257
- Starter Drive-to-Flywheel Clearance 257
- Starting System Symptom Guide 259

SUMMARY 264
REVIEW QUESTIONS 264
CHAPTER QUIZ 264

chapter 22

CHARGING SYSTEM 266

- Learning Objectives 266
- Key Terms 266

- Principle of Alternator Operation 266
- Alternator Construction 266
- Alternator Overrunning Pulleys 267
- Alternator Components and Operation 269
- How an Alternator Works 271
- Alternator Output Factors 272
- Alternator Voltage Regulation 273
- Alternator Cooling 274
- Computer-Controlled Charging Systems 275

SUMMARY 277
REVIEW QUESTIONS 277
CHAPTER QUIZ 277

chapter 23

CHARGING SYSTEM DIAGNOSIS AND SERVICE 279

- Learning Objectives 279
- Key Terms 279
- Charging System Testing and Service 279
- Drive Belt Inspection and Adjustment 281
- AC Ripple Voltage Check 282
- Testing AC Ripple Current 284
- Charging System Voltage Drop Testing 285
- Alternator Output Test 286
- Minimum Required Alternator Output 286
- Alternator Removal 287
- Alternator Disassembly 288
- Testing the Rectifier 290
- Reassembling the Alternator 290
- Remanufactured Alternators 291
- Alternator Installation 291

SUMMARY 299
REVIEW QUESTIONS 299
CHAPTER QUIZ 299

chapter 24

LIGHTING AND SIGNALING CIRCUITS 301

- Learning Objectives 301
- Key Terms 301
- Lighting Systems 301
- LED Lighting 302
- Bulb Numbers 304
- Brake Lights 305
- Turn Signals 305
- Daytime Running Lights 308
- Headlights 308
- High-Intensity Discharge Headlights 309
- LED Headlights 312
- Adaptive Front Lighting System 312
- Automatic Headlights 313
- Headlight High/Low Beam Switch 314
- Auto Dimming Headlights 314
- Headlight Aiming 314
- Fog and Driving Lights 314
- Automatic Dimming Mirrors 314
- Courtesy Lights 316
- Illuminated Entry 316
- Headlight System Diagnosis 317
- Lighting System Diagnosis 317
- Lighting System Symptom Guide 318

SUMMARY 320
REVIEW QUESTIONS 320
CHAPTER QUIZ 320

chapter 25

DRIVER INFORMATION AND NAVIGATION SYSTEMS 321

- Learning Objectives 321
- Key Terms 321
- Dash Warning Symbols 321
- Steering Wheel Controls 322
- Voice Activation 322
- Maintenance Indicators 323
- Analog and Digital Displays 323
- Head-up Display 324
- Night Vision 325
- Electronic Displays 326
- Virtual Display 327
- Touch Screens 327
- Speedometers/Odometers 328
- Dash Gauges 330
- Navigation and GPS 331
- Telematics 333
- Backup Camera 335

SUMMARY 336
REVIEW QUESTIONS 336
CHAPTER QUIZ 336

chapter 26

SECURITY AND ANTI-THEFT SYSTEMS 338

- Learning Objectives 338
- Key Terms 338
- Vehicle Security Systems 338
- Immobilizer Systems 339
- Chrysler Immobilizer System 341

- Ford PATS System 341
- General Motors Antitheft System 342
- Testing Immobilizer Systems 343

SUMMARY 345
REVIEW QUESTIONS 345
CHAPTER QUIZ 345

chapter 27
AIRBAG AND PRETENSIONER CIRCUITS 347

- Learning Objectives 347
- Key Terms 347
- Safety Belts and Retractors 347
- Front Airbags 349
- Airbag Diagnosis Tools and Equipment 353
- Airbag System Service 355
- Driver Side Airbag Module Replacement 356
- Safety When Manually Deploying Airbags 356
- Occupant Detection Systems 357
- Seat and Side Curtain Airbags 359
- Event Data Recorders 359

SUMMARY 360
REVIEW QUESTIONS 360
CHAPTER QUIZ 360

chapter 28
BODY ELECTRICAL ACCESSORIES 362

- Learning Objectives 362
- Key Terms 362
- Horns 362
- Horn Diagnosis 363
- Windshield Wipers 364
- Windshield Washers 366
- Rain-Sense Wipers 369
- Blower Motor 370
- Cruise Control 372
- Heated Rear Window Defoggers 373
- Power Windows 375
- Electric Power Door Locks 377
- Trunk/Lift Gate Locks 380
- Power Sun Roof/Moon Roof 380
- Sun Shades 380
- Power Seats 381
- Electrically Heated Seats 383
- Heated and Cooled Seats 383
- Heated Steering Wheel 384
- Heated Mirrors 385
- Adjustable Pedals 385
- Folding Outside Mirrors 386
- Keyless Entry 386
- Garage Door Opener 388
- Remote Start 389

SUMMARY 390
REVIEW QUESTIONS 390
CHAPTER QUIZ 390

Chapter 29
ADVANCED DRIVER ASSIST SYSTEMS (ADAS) 392

- Learning Objectives 392
- Key Terms 392
- Advanced Driver Assist Systems 392
- Blind Spot Monitor 393
- Parking-Assist Systems 394
- Lane Departure Warning 395
- Lane Keep Assist 395
- Adaptive Cruise Control 396
- Rear Cross-Traffic Warning (RCTW) 398
- Automatic Emergency Braking 398
- Pre-Collision System 399
- Hill Start Assist 399
- ADAS Diagnosis 400
- Camera and Radar Sensor Calibration 400

SUMMARY 402
REVIEW QUESTIONS 403
CHAPTER QUIZ 403

chapter 30
AUDIO SYSTEM OPERATION AND DIAGNOSIS 404

- Learning Objectives 404
- Key Terms 404
- Audio Fundamentals 404
- Radios and Receivers 406
- Antennas 406
- Antenna Diagnosis 407
- Speakers 408
- Speaker Types 410
- Sound Levels 410
- Crossovers 411
- Aftermarket Sound System Upgrade 411
- Voice Recognition 413
- Bluetooth 413
- Satellite Radio 414
- Radio Interference 415

Summary 418
Review Questions 418
Chapter Quiz 418

appendix 1
Sample Electrical (A6) ASE-Type Certification Test with Answers 419

appendix 2
2017 ASE Correlation Chart 423

GLOSSARY 426

INDEX 438

This page is intentionally left blank

PREFACE

NEW TO THIS EDITION. Based on the suggestions and recommendations from automotive instructors and reviewers, the following changes have been made to the sixth edition:

1. The number of chapters has been increased from 28 to 30 making it easier to select the exact content to study or teach.
2. The content in each chapter has been updated and expanded with over 40 new full color photos and line drawings to make the subject come alive.
3. The beginning chapters are more concisely organized making learning electrical systems easier. For example, the first chapter has been expanded and then divided into two shorter chapters:
   - **Chapter 1**—Service Information, Work Orders, and Vehicle Identification
   - **Chapter 2**—Tools and Safety
4. All of the electrical accessory circuits have been expanded so that it meets all of the latest ASE tasks and then divided into three chapters including:
   - **Chapter 26**—Security and Anti-Theft Systems
   - **Chapter 28**—Body Electrical Accessories
   - **Chapter 29**—Advanced Driver Assist Systems
5. New Case Studies included in this edition covering the "three Cs" (Complaint, Cause, and Correction).
6. New OSHA hazardous chemical labeling requirements added to Chapter 3 (Environmental and Hazardous Materials).
7. Static electricity and lightning information added to Chapter 4 (Electrical Fundamentals)
8. New content on three-legged and low-profile fuses, plus smart junction boxes, added to Chapter 11 (Automotive Wiring and Wire Repair).
9. Enhanced lead–acid batteries (ELA) information added to Chapter 18 (Batteries).
10. New content on float-type battery charges and memory saver tool that uses a 12-volt battery to connect to the power (terminal 16) and ground (terminals 4 and 5) of the DLC added to chapter 19 (Battery Testing and Service).
11. Stop-start and push-button start system added to Chapter 20 (Cranking Systems).
12. Cloudy headlight restoration information added to Chapter 24 (Lighting and Signaling Circuits).
13. Dash warning symbols (122 of them) added to Chapter 25 (Driver Information and Navigation Systems).
14. Airbag inflator sequences of inflation added to Chapter 27 (Airbags and Pretensioners).

ASE CORRELATED ASE-certified programs need to demonstrate that they use course material that covers ASE tasks. All *Professional Technician* textbooks have been correlated to the appropriate ASE task lists.

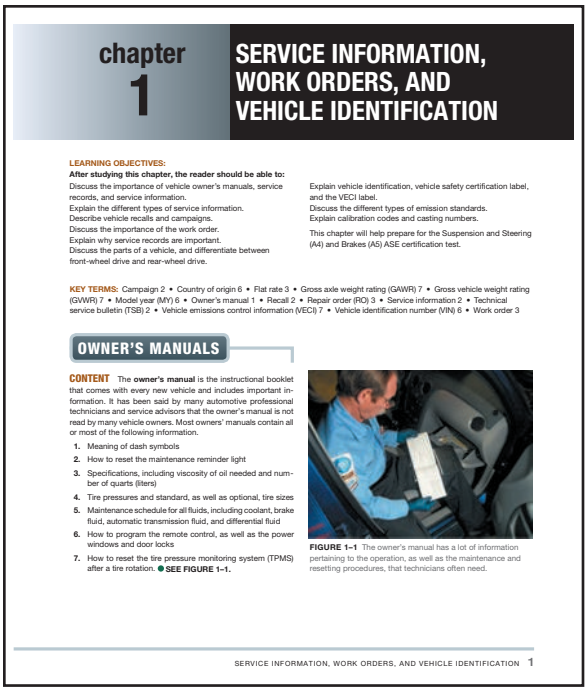
A COMPLETE INSTRUCTOR AND STUDENT SUPPLEMENTS PACKAGE All *Professional Technician* textbooks are accompanied by a full set of instructor and student supplements. Please see page xvi for a detailed list of supplements.

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, the 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, WORK ORDERS, AND VEHICLE IDENTIFICATION

LEARNING OBJECTIVES:
After studying this chapter, the reader should be able to:
Discuss the importance of vehicle owner's manuals, service records, and service information.
Explain the different types of service information.
Describe vehicle recalls and campaigns.
Discuss the importance of the work order.
Explain why service records are important.
Discuss the parts of a vehicle, and differentiate between front-wheel drive and rear-wheel drive.
Explain vehicle identification, vehicle safety certification label, and the VECI label.
Discuss the different types of emission standards.
Explain calibration codes and casting numbers.
This chapter will help prepare for the Suspension and Steering (A4) and Brakes (A5) ASE certification test.

KEY TERMS: Campaign 2 • Country of origin 6 • Flat rate 3 • Gross axle weight rating (GAWR) 7 • Gross vehicle weight rating (GVWR) 7 • Model year (MY) 6 • Owner's manual 1 • Recall 2 • Repair order (RO) 3 • Service information 2 • Technical service bulletin (TSB) 2 • Vehicle emissions control information (VECI) 7 • Vehicle identification number (VIN) 6 • Work order 3

OWNER'S MANUALS

CONTENT The **owner's manual** is the instructional booklet that comes with every new vehicle and includes important information. It has been said by many automotive professional technicians and service advisors that the owner's manual is not read by many vehicle owners. Most owners' manuals contain all or most of the following information.

1. Meaning of dash symbols
2. How to reset the maintenance reminder light
3. Specifications, including viscosity of oil needed and number of quarts (liters)
4. Tire pressures and standard, as well as optional, tire sizes
5. Maintenance schedule for all fluids, including coolant, brake fluid, automatic transmission fluid, and differential fluid
6. How to program the remote control, as well as the power windows and door locks
7. How to reset the tire pressure monitoring system (TPMS) after a tire rotation. ● SEE FIGURE 1–1.

FIGURE 1–1 The owner's manual has a lot of information pertaining to the operation, as well as the maintenance and resetting procedures, that technicians often need.

SERVICE INFORMATION, WORK ORDERS, AND VEHICLE IDENTIFICATION 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

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. Both the radio and the antenna were replaced to correct the problem. ● **SEE FIGURE 28–26.**

Summary:

- **Complaint**—Customer stated that the radio did not work.
- **Cause**—Visual inspection showed an antenna that had been stuck by lightning.
- **Correction**—Replacing the radio and the antenna restored proper operation.

CASE STUDY present students with actual automotive 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: Claw hammer has a claw used to remove nails; therefore, it is not for automotive service.

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

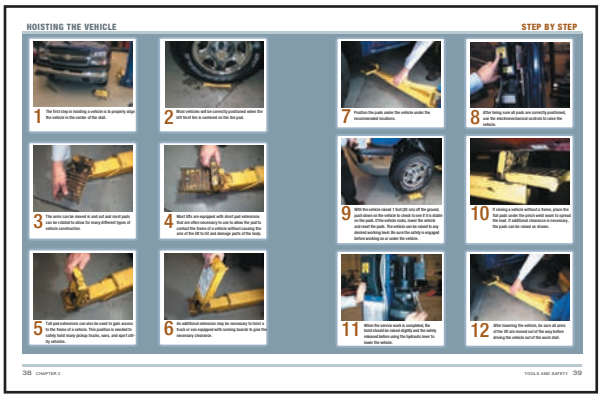
CAUTION: Do not use a screwdriver as a pry tool or chisel. Screwdrivers use hardened steel only at the tip and are not designed to be pounded on or used for prying because they could bend easily. Always use the proper tool for each application.

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



STEP-BY-STEP photo sequences show in detail the steps involved in performing 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, 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. Why are wrenches offset 15 degrees?
2. What are the other names for a line wrench?
3. What are the standard automotive drive sizes for sockets?
4. Which type of screwdriver requires the use of a hammer or mallet?
5. What is inside a dead-blow hammer?

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 UNC 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. Wrenches are made from _____.
   a. cast from nickel steel
   b. forged alloy steel
   c. machined from billet steel
   d. cast from chrome steel
6. The proper term for Channel Locks is _____.
   a. Vise Grips
   b. crescent wrench
   c. locking pliers
   d. multigroove adjustable pliers
7. The proper term for Vise Grips is _____.
   a. locking pliers
   b. slip-joint pliers
   c. side cuts
   d. multigroove adjustable pliers

40 CHAPTER 2

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.

SUPPLEMENTS

RESOURCES IN PRINT AND ONLINE
Automotive Electricity and Electronics

NAME OF SUPPLEMENT	PRINT	ONLINE	AUDIENCE	DESCRIPTION
Instructor Resource Manual 0135764394		✔	Instructors	NEW! The Ultimate teaching aid: Chapter summaries, key terms, chapter learning objectives, lecture resources, discuss/demonstrate classroom activities, and answers to the in-text review and quiz questions.
TestGen 0135764580		✔	Instructors	Test generation software and test bank for the text.
PowerPoint Presentation 0135764475		✔	Instructors	Slides include chapter learning objectives, lecture outline of the text, and graphics from the book.
Image Bank 0135764467		✔	Instructors	All of the images and graphs from the textbook to create customized lecture slides.
ASE Correlated Task Sheets—for Instructors 0135764602		✔	Instructors	Downloadable ASE task sheets for easy customization and development of unique task sheets.
ASE Correlated Task Sheets—for Students 0135764564	✔		Students	Study activity manual that correlates ASE Automobile Standards to chapters and pages numbers in the text. Available to students at a discounted price when packaged with the text.
VitalSource eText 0134074890		✔	Students	An alternative to purchasing the print textbook, students can subscribe to the same content online and save up to 50% off the suggested list price of the print text. Visit **www.vitalsource.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 for their special contributions:

ASE
Automotion, Inc.
Automotive Parts Rebuilders Association (APRA)
Dr. John Kershaw, Criterion Technical Education Consultants
Dave Scaler, Mechanics Education Association
Graphic Home
Jeff Trick, Wright State University
John Thornton, Autotrain Inc.
Mark Warren, Society of Automotive Engineers (SAE)
Tom Birch, Toyota Motor Sales, USA, Inc.
Wurth USA, Inc.

TECHNICAL AND CONTENT REVIEWERS The following people reviewed the past and current edition's manuscripts before production and checked them 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
Brett Baird
Salt Lake Community College
Tyler Boyles
Illinois Eastern Community College
Victor Bridges
Umpqua Community College
Dr. Roger Donovan
Illinois Central College
C. Durdin
Moraine Park Technical College
Gerry Egan
Wake Tech Community College
Al Engledahl
College of Dupage
Aaron Gregory
Merced College
Larry Hagelberger
Upper Valley Joint Vocational School
Oldrick Hajzler
Red River College
Paul Hidy
Solano Community College
Betsy Hoffman
Vermont Technical College
Richard Krieger
Michigan Institute of Technology
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
Jim Morton
Automotive Training Center (ATC)
Fritz Peacock
Indiana Vocational Technical College
Greg Pfahl
Miami-Jacobs Career College
Dennis Peter
NAIT (Canada)
Kenneth Redick
Hudson Valley Community College
Douglas Redman
College of the Desert
Jeff Rehkopf
Florida State College
Steve Scheuler
State Technical College of Missouri
John Skupien
Rock Valley College
Mark Spisak
Central Piedmont 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.

The author wishes to thank Chuck Taylor of Sinclair Community College in Dayton, Ohio, and Jeff Trick, who helped with many of the photos. A special thanks to Carl Borsani for his help with many of the new figures used in this edition. 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 (A1–A8), plus A9, F1, G1, L1 and L3).

Jim is the author of many automotive textbooks, all published by Pearson Education.

He 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 committee for the department of technology at Ohio Northern University and named MVP at the North American Council of Automotive Teachers (NACAT) conference in 2013.

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

jim@jameshalderman.com

AUTOMOTIVE ELECTRICITY AND ELECTRONICS

This page is intentionally left blank

chapter 1

SERVICE INFORMATION, WORK ORDERS, AND VEHICLE IDENTIFICATION

LEARNING OBJECTIVES:

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

Discuss the importance of vehicle owner's manuals, service records, and service information.
Explain the different types of service information.
Describe vehicle recalls and campaigns.
Discuss the importance of the work order.
Explain why service records are important.
Discuss the parts of a vehicle, and differentiate between front-wheel drive and rear-wheel drive.
Explain vehicle identification, vehicle safety certification label, and the VECI label.

This chapter will help prepare for the Suspension and Steering (A4) and Brakes (A5) ASE certification test.

KEY TERMS: Campaign 2 • Country of origin 6 • Flat rate 3 • Gross axle weight rating (GAWR) 7 • Gross vehicle weight rating (GVWR) 7 • Model year (MY) 6 • Owner's manual 1 • Recall 2 • Repair order (RO) 3 • Service information 2 • Technical service bulletin (TSB) 2 • Vehicle emissions control information (VECI) 7 • Vehicle identification number (VIN) 6 • Work order 3

OWNER'S MANUALS

CONTENT The **owner's manual** is the instructional booklet that comes with every new vehicle and includes important information. It has been said by many automotive professional technicians and service advisors that the owner's manual is not read by many vehicle owners. Most owners' manuals contain all or most of the following information.

1. Meaning of dash symbols
2. How to reset the maintenance reminder light
3. Specifications, including viscosity of oil needed and number of quarts (liters)
4. Tire pressures and standard, as well as optional, tire sizes
5. Maintenance schedule for all fluids, including coolant, brake fluid, automatic transmission fluid, and differential fluid
6. How to program the remote control, as well as the power windows and door locks
7. How to reset the tire pressure monitoring system (TPMS) after a tire rotation. ● **SEE FIGURE 1–1.**

FIGURE 1–1 The owner's manual has a lot of information pertaining to the operation, as well as the maintenance and resetting procedures, that technicians often need.

SERVICE INFORMATION

PURPOSE OF SERVICE INFORMATION **Service information** is needed to correctly service or repair vehicles because it contains all of the specifications, as well as the specified procedures to follow when servicing or repairing a vehicle.

FACTORY SERVICE INFORMATION Until the 1990s, most service information was found in paper manuals called *service manuals* or *shop manuals*. More recently, the manufacturer provides this information in a digital format. The most comprehensive and accurate service information is the service information from the vehicle manufacturer. This information is available for most, if not all, vehicles and can be purchased from their website. For the exact location for purchasing factory service information, visit National Automotive Service Task Force (NASTF) website for the websites for all vehicle manufacturers' service information and cost: www.NASTF.org.

AFTERMARKET SERVICE INFORMATION While factory service manuals cover just one year and one or more models of the same vehicle, most aftermarket service manuals cover multiple years and/or models in one manual. Originally, aftermarket service information was available in only paper manuals. Paper service manuals had the following disadvantages:

1. Required a lot of storage space
2. The pages would become dirty from handling
3. Difficult to use at the vehicle or to make copies from the thick manuals

Paper service manuals were replaced with electronic service information that came on CDs and then DVDs, before becoming available on the Internet. Most electronic service information has technical service bulletins (TSBs), wiring diagrams, and a main menu that includes the major components of the vehicle as a starting point. ALLDATA and Mitchell On-Demand are examples of commonly used subscription services that include service information for many vehicles. ● **SEE FIGURE 1–2.**

TECH TIP

Print It Out

It is often a benefit to have the written instructions or schematics (wiring diagrams) at the vehicle while diagnosing or performing a repair. The advantage of electronic service information is that the material can be printed out and taken to the vehicle for easy access. This also allows the service technician to write or draw on the printed copy, which can be a big help when performing tests, such as electrical system measurements. The schematic can be color-coded to show where there should be voltage and where a ground should be detected. These notes can then be used to document the test results on the work order.

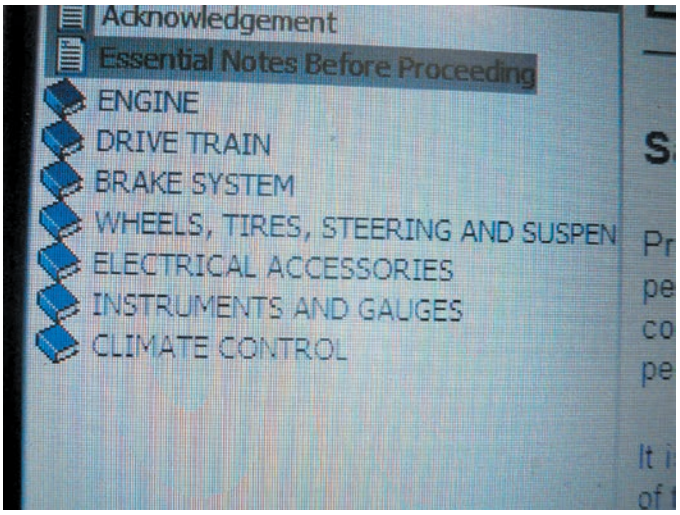


FIGURE 1–2 A main menu showing the major systems of the vehicle. Clicking on one of these major topics opens up another menu showing more detailed information.

TECHNICAL SERVICE BULLETINS

A **technical service bulletin (TSB)** is issued by the vehicle manufacturer to notify service technicians of a potential problem or other critical information. The TSB may include diagnostic procedures and the necessary corrective action. TSBs are not an authorization for repair or a guarantee to correct a concern. TSBs are designed for dealership technicians, but are republished by aftermarket companies and made available along with other service information to shops and vehicle repair facilities.

RECALLS AND CAMPAIGNS

A **campaign** is typically issued when a manufacturer wants to improve a product's performance or increase the customer's satisfaction. If the campaign involves a safety or emissions concern, it is considered a recall. A **recall** can occur when either the manufacturer or the National Highway Traffic Safety Administration (NHTSA) determines there is a concern. A recall or campaign is issued by a vehicle manufacturer and a notice is sent to all owners of record. While these faults may be repaired by independent shops, it is generally handled by a local dealer and treated as a warranty repair. Items that have created recalls in the past have included potential fuel system leakage problems, exhaust leakage, or electrical malfunctions that could cause a possible fire or the engine to stall. Unlike TSBs, whose cost is only covered when the vehicle is within the warranty period, a recall or campaign is always done at no cost to the vehicle owner regardless of the age or mileage on the vehicle. To check if a vehicle is subject to a recall, visit www.nhtsa.gov/recalls.