

INTERNATIONAL EDITION

TODAY'S TECHNICIAN™

AUTOMOTIVE ENGINE REPAIR & REBUILDING

4TH EDITION

SHOP MANUAL



We Support
ASE Program Certification
Through



CHRISTOPHER HADFIELD

Not for Sale in the
United States

CONTENTS

Photo Sequence Contents	viii
Job Sheets Contents	ix
Preface	xii
CHAPTER 1 Safety and Shop Practices	1
• Personal Safety 2 • Lifting and Carrying 4 • Hand Tool Safety 6 • Power Tool Safety 6	
• Compressed Air Equipment Safety 8 • Lift Safety 8 • Jack and Jack Stand Safety 11	
• Engine Lift Safety 12 • Cleaning Equipment Safety 12 • Hazardous Waste 16	
• Vehicle Operation 17 • Work Area Safety 18 • Case Study 19 • Terms to Know 18	
• ASE-Style Review Questions 20 • ASE Challenge Questions 21 • Job Sheets 23	
CHAPTER 2 Basic Testing, Initial Inspection, and Service Writing	31
• Identifying the Area of Concern 31 • Test-Driving for Engine Concerns 33	
• Writing a Service Repair Order 35 • Case Study 36 • Terms to Know 36	
• ASE-Style Review Questions 37 • ASE Challenge Questions 38 • Job Sheets 39	
CHAPTER 3 Engine Rebuilding Tools and Skills	45
• Units of Measure 46 • Engine Diagnostic Tools 48 • Exhaust Gas Analyzers 58	
• Engine Analyzer 58 • Engine Measuring Tools 60 • Special Hand Tools 74	
• Special Reconditioning Tools and Equipment 77 • Working as a Professional Technician 90 • Service Information 98 • Case Study 101 • Terms to Know 101	
• ASE-Style Review Questions 104 • Job Sheets 105	
CHAPTER 4 Diagnosing and Servicing Engine Operating Systems ...	121
• Battery Testing 122 • Battery Testing Series 124 • Starting System Tests and Service 127	
• Lubrication System Testing and Service 134 • Cooling System Testing and Service 141	
• Gallery and Casting Plugs 151 • Leak Diagnosis 153 • Warning Systems Diagnosis 161	
• Case Study 163 • Terms to Know 163 • ASE-Style Review Questions 165	
• ASE Challenge Questions 166 • Job Sheets 167	
CHAPTER 5 Repair and Replacement of Engine Fasteners, Gaskets, and Seals	196
• Thread Repair 196 • Gasket Installation 204 • Cylinder Head Gasket Installation 204	
• Oil Pan Gasket Installation 205 • Valve Cover Gasket Replacement 205	
• Seal Installation 205 • Using Sealants 207 • Case Study 208 • Terms to Know 208	
• ASE-Style Review Questions 209 • ASE Challenge Questions 210 • Job Sheets 211	
CHAPTER 6 Intake and Exhaust System Diagnosis and Service	218
• Air Cleaner Service 218 • Vacuum System Diagnosis and Troubleshooting 221	
• Vacuum Tests 222 • Intake Manifold Service 224 • Exhaust System Service 229	
• Turbocharger Diagnosis 235 • Supercharger Diagnosis and Service 242 • Case Study 245	
• Terms to Know 245 • ASE-Style Review Questions 245 • ASE Challenge Questions 246	
• Job Sheets 247	

CONTENTS

CHAPTER 7 Diagnosing Engine Performance Concerns	259
• Introduction 259 • Spark Plug Evaluation and Power Balance Testing 259	
• Spark Plugs 260 • Power Balance Testing 263 • Engine Smoking 266	
• Improper Combustion 272 • Compression Testing 273 • Wet Compression Test 276	
• Running Compression Test 277 • Cylinder Leakage Testing 279 • Engine Noise	
Diagnosis 282 • Case Study 285 • Terms to Know 285 • ASE-Style Review Questions 286	
• ASE Challenge Questions 287 • Job Sheets 289	
CHAPTER 8 Engine Removal, Engine Swap, and Engine Installation	303
• Preparing the Engine for Removal 303 • Removing the Engine 308 • Mounting the Engine on a Stand (Photo Sequence 16) 312 • Installing a Remanufactured Engine 315 • Installing the Engine 322 • Engine Start-Up and Break-In 325 • Case Study 329 • Terms to Know 329	
• ASE-Style Review Questions 329 • ASE Challenge Questions 330 • Job Sheets 331	
CHAPTER 9 Cylinder Head Disassembly, Inspection, and Service	337
• Disassembling the Cylinder Head 342 • Valve Inspection 349 • Cylinder Head Inspection 353 • Machine Shop Services 358 • Straightening Aluminum Cylinder Heads 359 • Valve Guide Repair 360 • Replacing Valve Seats 363 • Refinishing Valves and Valve Seats 365 • Case Study 372 • Terms to Know 372 • ASE-Style Review Questions 375	
• ASE Challenge Questions 376 • Job Sheets 377	
CHAPTER 10 Valvetrain Service	397
• Inspecting and Servicing the Valvetrain 397 • Inspecting and Servicing Valvetrain Components, OHV Engine 403 • Replacing Rocker Arms Studs 406 • Cylinder Head Reassembly 413 • Valve Adjustment 418 • Adjusting Mechanical Followers with Shims 421	
• Adjusting Valves Using Adjustable Rocker Arms 422 • On-Car Service 424 • Valve Spring Replacement 429 • Case Study 430 • Terms to Know 430 • ASE-Style Review Questions 430	
• ASE Challenge Questions 431 • Job Sheets 433	
CHAPTER 11 Timing Mechanism Service	451
• Introduction 451 • Symptoms of a Worn Timing Mechanism 452 • Symptoms of a Jumped or Broken Timing Mechanism 452 • Timing Chain Inspection 454 • Timing Belt Inspection 455 • Timing Gear Inspection 456 • Sprocket Inspection 456 • Tensioner Inspection 457	
• Timing Chain Guide Inspection 457 • Reuse Versus Replacement Decisions 458	
• Timing Mechanism Replacement 458 • Timing Chain Replacement on OHC Engines 458	
• Timing Belt Replacement 462 • Timing Chain or Gear Replacement on Camshaft-in-the-Block Engines 464 • Timing Chain Replacement on Engines with OHC and Balance Shafts 467 • Timing Chain Replacement on Engines with VVT Systems 469	
• Case Study 471 • Terms to Know 471 • ASE-Style Review Questions 471 • ASE Challenge Questions 472 • Job Sheets 473	

CONTENTS

CHAPTER 12 <i>Inspecting, Disassembling, and Servicing the Cylinder Block Assembly</i>	481
• Engine Disassembly 481 • Engine Preparation 481 • Cylinder Head Removal 482	
• Timing Mechanism Disassembly 484 • Engine Block Disassembly 487	
• Inspecting the Cylinder Block 492 • Inspecting the Crankshaft 498	
• Inspecting the Harmonic Balancer and Flywheel 501 • Servicing the Cylinder Block Assembly 501 • Camshaft and Balance Shaft Bearing Service 510 • Reconditioning Crankshafts 513 • Installing Oil Gallery Plugs and Core Plugs 515 • Case Study 516	
• Terms to Know 516 • ASE-Style Review Questions 517 • ASE Challenge Questions 518	
• Job Sheets 519	
CHAPTER 13 <i>Short Block Component Service and Engine Assembly</i>	533
• Inspecting Crankshaft Bearings 533 • Inspecting the Pistons and Connecting Rods 537	
• Piston Assembly Service 549 • Engine Block Preparation 557 • Installing the Main Bearings and Crankshaft 561 • Installing the Pistons and Connecting Rods 567	
• Completing the Block Assembly 568 • Valve Timing and Installing Valvetrain Components 572 • Checking and Adjusting Valve Clearance 574 • Completing the Engine Assembly 574 • Case Study 580 • Terms to Know 580 • ASE-Style Review Questions 580	
• ASE Challenge Questions 582 • Job Sheets 583	
CHAPTER 14 <i>Alternative Fuel and Advanced Technology Vehicle Service</i>	600
• Introduction 600 • Servicing Propane Fueled Engines 600 • Servicing CNG Vehicles 601	
• Servicing Hybrid Electric Vehicles 603 • Servicing The Toyota Prius 605	
• Servicing The Honda Civic Hybrid 606 • HEV Warranties 608 • Case Study 608	
• Terms to Know 608 • ASE-Style Review Questions 608 • ASE Challenge Questions 609	
• Job Sheets 611	
APPENDIX A <i>ASE Practice Exam</i>	619
APPENDIX B <i>Special Tools Suppliers</i>	624
APPENDIX C <i>Manufacturer's Service Information Centers</i>	625
APPENDIX D <i>Metric Conversion Charts</i>	626
APPENDIX E <i>Engine Specifications Chart</i>	627
Glossary	630
Index	639