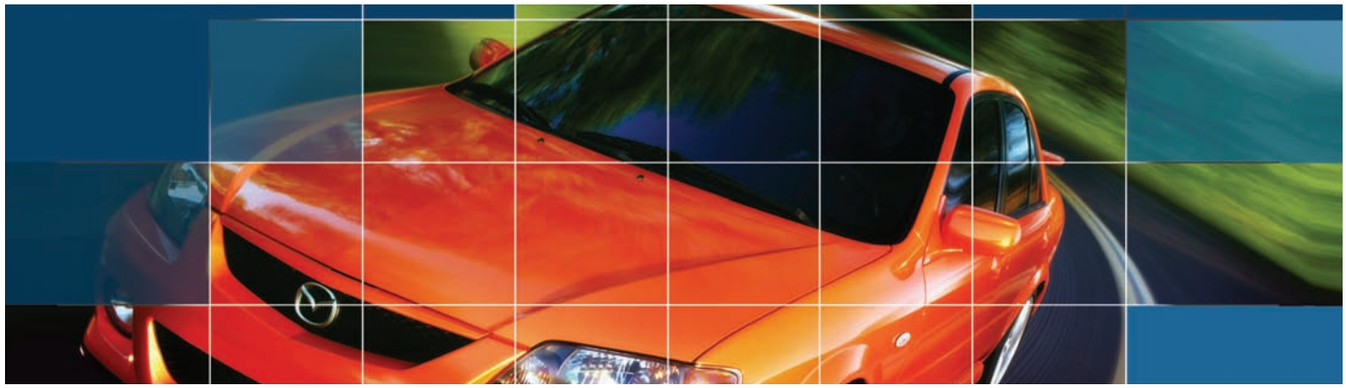

AUTOMOTIVE SERVICE

• Inspection • Maintenance • Repair

Fourth Edition

Tim Gilles
Professor
Santa Barbara City College
ASE Master Automotive Technician,
ASE Master Automotive Machinist

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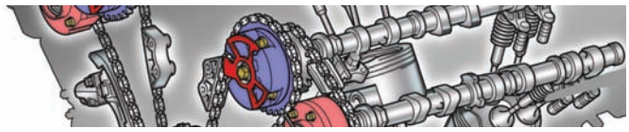

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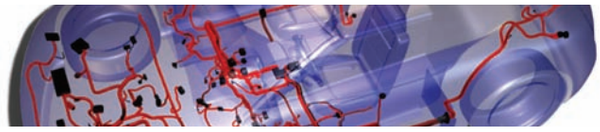

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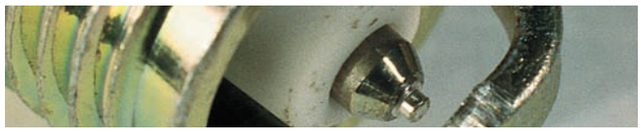

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NOTE TO STUDENT: *Learn to use the index. It has been constantly updated and will help you find what you need in the book.*

PREFACE

Automotive Service: Inspection, Maintenance, Repair, 4th edition evolved in part from my participation in a successful articulation program between local high schools and the community college where I have been a teacher for over 37 years. The text and art manuscripts of this best-selling book have once again been updated and improved in this fourth edition revision. An array of excellent technical reviews by a dedicated group of professional teachers and technicians ensures that this is the most technically accurate and up-to-date comprehensive automotive textbook available in the marketplace. The text has been written from a carefully detailed outline to allow each chapter to follow a logical, easy-to-understand path. Many new original color photographs and sketches have been added to update and supplement earlier material.

The transportation industry in North America is vast, with one in every six people contributing to it in some way. These include people of many levels of understanding and ability. With that in mind, the introductory fundamentals chapters are written at a lower level for all the students, whereas the service chapters are for those who have mastered the introductory material.

As a teacher, my philosophy is to challenge the best students in anticipation that the rest will be brought to a higher level: "A rising tide raises all boats."

The text can be used for a variety of educational purposes, including:

- As a basic text in any automotive repair class
- To educate entry-level or apprentice technicians
- To prepare more experienced technicians for ASE certification

Automotive Service: Inspection, Maintenance, Repair, 4th edition is divided into 79 chapters that cover the NATEF Auto General Service Technician Program Standards and A1–A8 (the eight ASE automotive specialty areas). Advanced engine performance and emission controls are also covered in detail. In addition to coverage of the usual repairs performed in almost any automotive repair facility, the reader is introduced to the most frequently performed inspection and service procedures—from safety inspections to tire and wheel service.

The automotive repair industry of today continues to evolve into more of a maintenance industry as vehicles last longer and require fewer repairs. Long-term customer relationships, ethics, and professionalism have become even more important to the success of a business. There are also environmental concerns today that were not a part of the industry of the past. The text includes chapters on safety, hand tools, and vehicle maintenance and lubrication that are more comprehensive than those found in most comparable texts. An accompanying lab manual emphasizes the NATEF Auto General Service Technician Program Standards, those jobs done in service stations, fast-lube outlets, or mass merchandisers (such as Sears, Goodyear, Firestone, or Kmart). An additional lab workbook, *Automotive Service Job Sheets for NATEF Task Mastery*, covers the eight main ASE system areas.

Automobiles have become so complex in the last 30 years that to remain competent many of today's technicians specialize in one or more systems of the car. Basic theory of all automotive and light truck systems is covered so that service personnel will understand the function of the parts being serviced. When working in the industry, there is often no time for basic theory. Therefore, automotive class work could be the one and only chance students have to learn how systems operate so they can become better diagnosticians in the future.

This book is comprehensive in that it deals with the entire car and aims to teach theory of vehicle systems at an introductory student level, followed by service, diagnosis, and light repairs at a more advanced student level.

Most of the systems used in automobiles today are strikingly similar. Repair techniques universal to all automobiles are discussed and procedures or conditions unique to only one specific automobile make are purposely avoided. The reader is encouraged to refer to the service and repair information for the specific vehicle in question.

A major challenge for me as an automotive author is to keep the scope of the book from growing out of control by expanding into areas of in-service training best covered by manufacturers and aftermarket educators. My objective is to take an abundance of sometimes complicated information and condense and simplify that information so it can be understood by a student preparing for *job-entry level*. Following the completion of this text, better students will be at a high job-entry level, at a skill level suitable for entry as an apprentice in one or more of the specialty areas of automotive repair in a new car dealership or an independent repair shop.

A primary objective of this book is to help the reader develop confidence in both thinking skills and problem-solving ability. One unique aspect of automotive education is that many automotive graduates venture into other professions and skilled trades, such as engineering or construction. They will find much of the material learned in automotive classes to be very valuable and useful in their chosen fields. This aspect of the student's education is especially valuable when one considers how middle school and high school industrial arts programs have been scaled back in recent

years. Dealing with such things as tools, soldering, basic electrical repairs, and repairing broken fasteners helps to provide some measure of practical education.

The tremendous decline in the number of corner gasoline service stations has resulted in a loss of those jobs formerly available in abundance to students. Successful service personnel who possess necessary basic automotive skills must continually learn new things in order to progress into other (higher-paying) specialty areas. The *Lab Manual to Accompany Automotive Service* contains service jobs that students should be able to perform before enrolling in an advanced automotive specialty area class.

UPDATES AND ENHANCEMENTS TO THE FOURTH EDITION

- New and updated information on hybrid vehicles and alternative fuels.
- New coverage on the latest information on engine oils and coolants.
- Vehicle electronics coverage has been improved and increased throughout.
- New and updated engine performance and electronics coverage includes technology advances in onboard diagnostics, misfire detection, variable valve timing, displacement on demand, adaptive strategies, the latest CAN systems, drive-by-wire, and wide-band oxygen sensors.
- Chassis and powertrain coverage includes updated information on stability control and traction control systems, electronic suspension systems, electric steering, and electronic transmission and all-wheel drive.
- Updated comfort and safety topics include the newest developments in air conditioning, supplemental restraints, lighting, entertainment systems, and adaptive cruise control.
- New science, math, and history notes have been added.
- The Instructor Resources DVD and and other new and greatly enhanced supplements are designed to improve the organization and quality of time spent in the classroom and shop (see the Supplements page for more detail).
- All automotive terms, abbreviations, and acronyms used in this text comply with the SAE Technical Standards Board Publication *SAE J1930*.

ACKNOWLEDGMENTS

I would like to extend special thanks to the following individuals, organizations, and companies:

- Delmar, Cengage Learning Senior Product Manager Matt Thouin for his helpful, positive attitude. Matt's dedication to excellence and his efficiency and organizational skills were very important to the overall improvement of this fourth edition.
- Denise Denisoff and Chris Shortt, developmental editors in earlier editions of the text.
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- Friends and colleagues Bob Stockero and Dave Brainerd of Santa Barbara City College and Chuck Rockwood of Ventura College for their continuous input and support. All three provided in-depth reviews and excellent suggestions to this edition of the text.
- Members of the North American Council of Automotive Teachers (NACAT) and California Automotive Teachers (CAT), who provided a vast amount of input.
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- Staff at all of the campuses of Universal Technical Institute, who provided helpful reviews of the manuscript.
- Tom Butera has volunteered in my class since he retired after 31 years as the owner of a NAPA store, preceded by many years as an owner of four Texaco service stations. Parts people know lots of things about the automotive industry and Tom brings many things to class to share with me and my students.

From Tim Gilles

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DEDICATION

The completion of this book was made possible with help from a great many individuals. *Automotive Service: Inspection, Maintenance, Repair, 4th edition* is dedicated to them and to my wife, Joy. Her organizational skills and able assistance have been invaluable. Writing a 1,500-page comprehensive textbook with many thousands of photos and sketches is a daunting task. I would not be able to concentrate as much of my time on the important upgrading and editorial work if I did not have Joy organizing the art package and submitting final manuscript changes to the publisher. She retired from her full-time job to help with this project and has been especially helpful.

ABOUT THE AUTHOR

Tim Gilles has authored and coauthored several textbooks. He has been an automotive teacher since 1973 and is a professor in the Automotive Technology Department at Santa Barbara City College. He earned a Bachelor of Arts degree from Long Beach State University and a Master of Arts degree in Occupational Education from Chicago State University. He holds the industry certifications of ASE Master Engine Machinist and ASE Master Automotive Technician.

Tim has been active in professional associations for many years, as president and board member of the California Automotive Teachers (CAT) and as a board member and election committee chair of the North American Council of Automotive Teachers (NACAT). He is a frequent seminar presenter at association conferences. Tim has been a longtime member of the California Community College Chancellor's Trade and Industry Advisory Committee. He is active in industry associations, including AERA, ARC, and IATN, and has served several terms as education representative on the board of the Santa Barbara Chapter of the Independent Automotive Professionals Association (IAPA).

FEATURES

OF THE TEXT

OBJECTIVES

Each chapter begins with a list of the most important points discussed in the chapter. This list of objectives is intended to provide the student with a general idea of what he or she will be studying.

KEY TERMS

Each chapter contains a list of new terms to know. These terms are **highlighted in bold** in the text. Definitions of these terms can be found in the glossary.

CAUTIONS

Cautions are urgent warnings that personal injury or property damage could occur if careful preventive steps are not taken.

SHOP TIPS

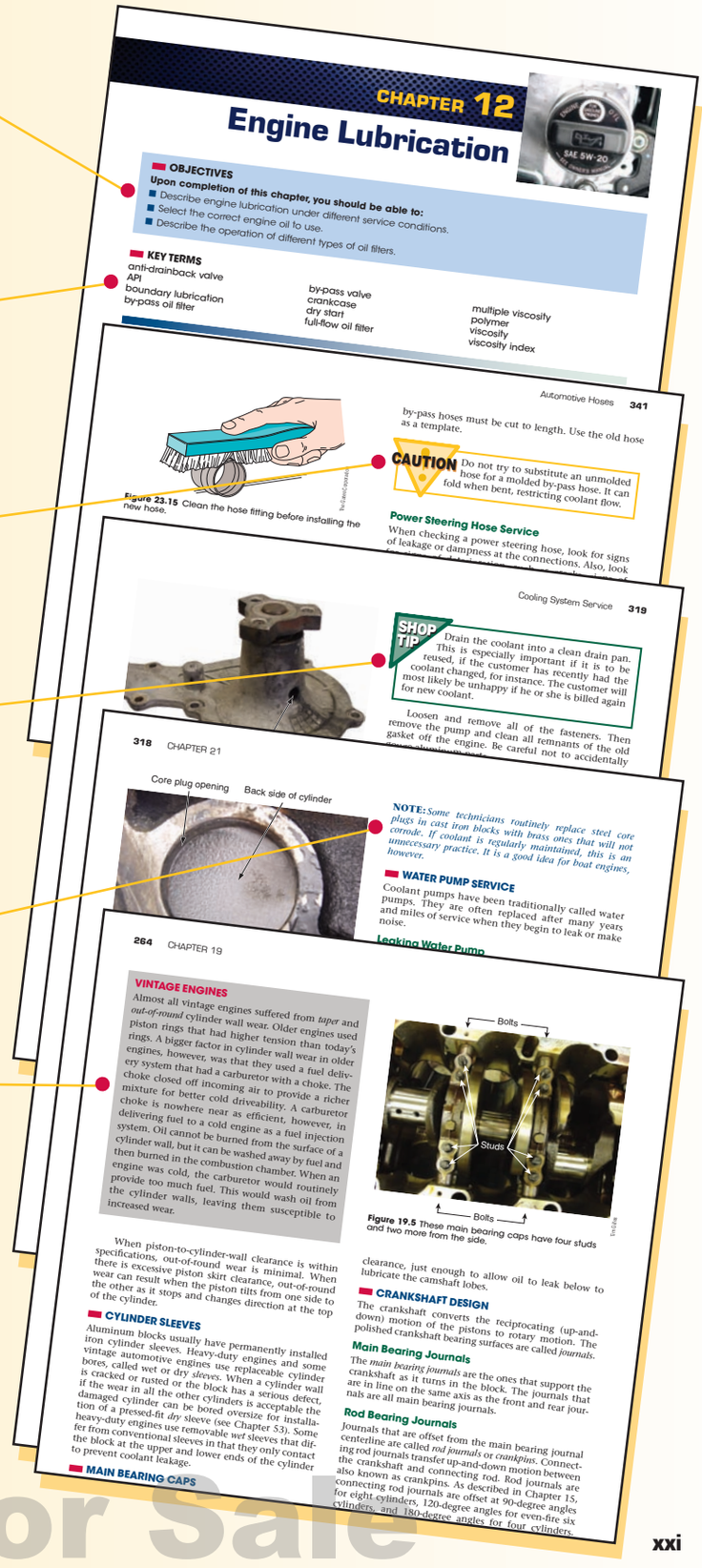
Appropriate shop tips are described throughout the text. These tips provide shortcuts and emphasize fine-tuning procedures to shop practices commonly performed by experienced technicians.

NOTES

Notes are used throughout the text to highlight especially important topics.

VINTAGE SYSTEM NOTES

Boxed information on vintage systems (and related parts) puts today's newer technologies in historical perspective and offers insights into the development of the automobile. Vintage notes are not only interesting but may even help the reader repair or restore vintage cars. This has become an important part of many automotive businesses.



SAFETY NOTES

Safety is the number-one priority in an automotive shop. There are numerous safety notes placed throughout the text. Most of the safety notes have been taken from real-world experiences and many are accompanied by actual case histories.

CASE HISTORIES

Case histories are presented throughout the text. These true stories recount actual automotive situations encountered by the author in over 30 years in automotive service. Case histories present the reader with examples of the pattern of critical thinking skills required to diagnose automotive problems.

SCIENCE, HISTORY, COMPUTER SYSTEM, AND MATH NOTES

These notes are included when interesting topics relating to them are covered in the text. The objective of these features is to pique the student's interest and show a correlation between his or her automotive studies and these areas of learning.

REVIEW QUESTIONS

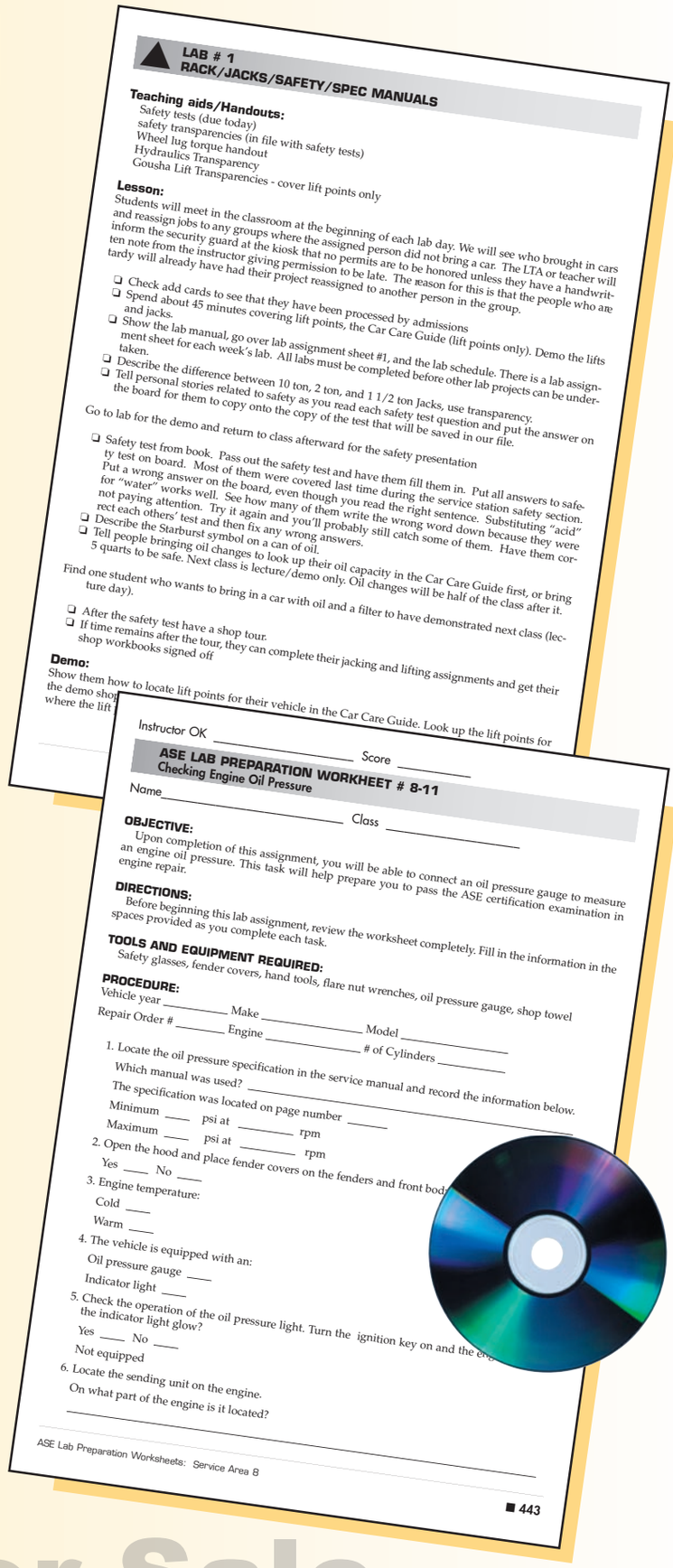
These questions guide the student to the most important points in the chapter and act as a check for understanding of the material. Each chapter's review questions are presented in the same order in which they appear in the chapter. This provides an instructor with the flexibility to assign portions of the chapter to read and then follow up with a few of the study questions.

ASE-STYLE REVIEW QUESTIONS

These questions are designed to provide preparation for the certification examinations administered by the *National Institute for Automotive Service Excellence* (*ASE*). The ASE test is a task-oriented test (the test taker is supposed to be able to relate to shop-oriented questions), so the practice tests should help the student in becoming familiar with accepted trade procedures.

SUPPLEMENTS

- **Instructor Resources**—The fourth edition Instructor Resources DVD includes an Instructor's Guide in Microsoft Word, a Computerized Test Bank in ExamView with hundreds of modifiable questions (true/false, fill-in-the-blank, and ASE-style multiple choice), chapter presentations in PowerPoint with full-color images, video clips and animations, a searchable Image Library of hundreds of full-color photos and line art from the core text, and Correlation Grids to the NATEF Automobile Program Standards.
- **CourseMate**—The all new CourseMate for *Automotive Service, 4th edition,* offers students and instructors access to important tools and resources, all in an online environment. The CourseMate includes an Interactive eBook for Automotive Service, Fourth Edition, nearly 300 videos and animations, interactive quizzes, flashcards, an interactive glossary, and an Engagement Tracker tool for monitoring students' progress in the CourseMate product.
- **WebTutor Advantage**—Newly available for *Automotive Service* is the WebTutor Advantage for the Blackboard online course management system. The WebTutor includes chapter presentations in PowerPoint, end-of-chapter review questions, pretests and posttests, discussion springboard topics, and more, all designed to enhance the classroom and shop experience.
- **Lab Manual**—The Lab Manual includes Worksheets that define each lab procedure, presented in increasing levels of difficulty. Each project or lab assignment is built upon the next in a logical sequence in much the same manner as science instructional programs are constructed, and the reader completes one task before progressing to the next one. In addition, a variety of illustrations support the Worksheets and help visual learners better understand the jobs. The Worksheets are keyed to the NATEF Auto General Service Technician Programs Standards where applicable.
- **Automotive Service Job Sheets for NATEF Task Mastery**—The Job Sheets in this manual cover all P-1, P-2, and most P-3 procedures as identified by the most recent NATEF Automobile Program Standards. Full-color illustrations offer visual support to the Job Sheets, and the sequence of topics follows that of the core text. Each Job Sheet includes a simple and clear rating rubric for instructor evaluation of student performance on the task, and a supplemental CD-ROM includes NATEF task-tracking software for easy recording of students' mastery of the procedures.



LAB # 1
RACK/JACKS/SAFETY/SPEC MANUALS

Teaching aids/Handouts:
Safety tests (due today)
safety transparencies (in file with safety tests)
Wheel lug torque handout
Hydraulics Transparency
Gousha Lift Transparencies - cover lift points only

Lesson:
Students will meet in the classroom at the beginning of each lab day. We will see who brought in cars and reassign jobs to any groups where the assigned person did not bring a car. The LTA or teacher will inform the security guard at the kiosk that no permits are to be honored unless they have a handwritten note from the instructor giving permission to be late. The reason for this is that the people who are tardy will already have had their project reassigned to another person in the group.

- ❑ Check add cards to see that they have been processed by admissions
- ❑ Spend about 45 minutes covering lift points, the Car Care Guide (lift points only). Demo the lifts and jacks.
- ❑ Show the lab manual, go over lab assignment sheet #1, and the lab schedule. There is a lab assignment sheet for each week's lab. All labs must be completed before other lab projects can be undertaken.
- ❑ Describe the difference between 10 ton, 2 ton, and 1 1/2 ton Jacks, use transparency.
- ❑ Tell personal stories related to safety as you read each safety test question and put the answer on the board for them to copy onto the copy of the test that will be saved in our file.

Go to lab for the demo and return to class afterward for the safety presentation

- ❑ Safety test from book. Pass out the safety test and have them fill them in. Put all answers to safety test on board. Most of them were covered last time during the service station safety section. Put a wrong answer on the board, even though you read the right sentence. Substituting "acid" for "water" works well. See how many of them write the wrong word down because they were not paying attention. Try it again and you'll probably still catch some of them. Have them correct each others' test and then fix any wrong answers.
- ❑ Describe the Starburst symbol on a can of oil.
- ❑ Tell people bringing oil changes to look up their oil capacity in the Car Care Guide first, or bring 5 quarts to be safe. Next class is lecture/demo only. Oil changes will be half of the class after it.

Find one student who wants to bring in a car with oil and a filter to have demonstrated next class (lecture day).

- ❑ After the safety test have a shop tour.
- ❑ If time remains after the tour, they can complete their jacking and lifting assignments and get their shop workbooks signed off

Demo:
Show them how to locate lift points for their vehicle in the Car Care Guide. Look up the lift points for the demo sho
where the lift

Instructor OK _____ Score _____

ASE LAB PREPARATION WORKHEET # 8-11
Checking Engine Oil Pressure

Name _____ Class _____

OBJECTIVE:
Upon completion of this assignment, you will be able to connect an oil pressure gauge to measure an engine oil pressure. This task will help prepare you to pass the ASE certification examination in engine repair.

DIRECTIONS:
Before beginning this lab assignment, review the worksheet completely. Fill in the information in the spaces provided as you complete each task.

TOOLS AND EQUIPMENT REQUIRED:
Safety glasses, fender covers, hand tools, flare nut wrenches, oil pressure gauge, shop towel

PROCEDURE:
Vehicle year _____ Make _____ Model _____
Repair Order # _____ Engine _____ # of Cylinders _____

1. Locate the oil pressure specification in the service manual and record the information below.
   Which manual was used? _____
   The specification was located on page number _____
   Minimum ____ psi at _____ rpm
   Maximum ____ psi at _____ rpm
2. Open the hood and place fender covers on the fenders and front bod
   Yes ____ No ____
3. Engine temperature:
   Cold ____
   Warm ____
4. The vehicle is equipped with an:
   Oil pressure gauge ____
   Indicator light ____
5. Check the operation of the oil pressure light. Turn the ignition key on and the en
   the indicator light glow?
   Yes ____ No ____
   Not equipped
6. Locate the sending unit on the engine.
   On what part of the engine is it located?
   _____

ASE Lab Preparation Worksheets: Service Area 8 ■ 443