1988

NATEF Certification curriculum for a course in automotive brakes

Manuel A. Rodriguez

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California State University
San Bernardino

NATEF Certification Curriculum

For A Course In

Automotive Brakes

A Project Submitted to the Faculty

of the School of Education In Partial Fulfillment

of the Requirements of the Degree of

Master of Arts in Education

Vocational Education Option

By

Manuel A. Rodriguez Jr.

Riverside, California

1988
NATEF Certification Curriculum

For A Course in

Automotive Brakes

By

Manuel A. Rodriguez Jr.

December, 1988

Approved By:

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ABSTRACT

Automotive Brake Curriculum

By

Manuel Rodriguez

The purpose of this project was to develop a curriculum for servicing automotive brakes to meet the high priority standards for the National Institute for Automotive Service Excellence (ASE).

The National Automotive Technician Education Foundation (NATEF) provides a validated task list to ASE certified training programs for the areas of program certification. NATEF does not however provide a course curriculum for the training programs. NATEF realizes that no two training programs will be the same therefore it is the responsibility of the individual training program Instructors to develop their own curriculums. ASE requires that certified training programs maintain a current curriculum for certification.

The project was accomplished by gathering data that was relevent to the development of an automotive brake training program. The NATEF task list for automotive brakes was used as a guide for the development of the training program curriculum. The California State Model Curriculum Standards and Program Frameworks for Industrial Technology
Education - Power and Energy Technology: Automotive - was integrated with the NATEF Task List to also meet California State curriculum requirements.

This project has been developed in two sections. The first section is the introduction to the project. In the introduction the objective of the project is stated along with problems encountered in the development and the purpose of the completed project. Definitions of terminology used in the development of the project was included to clarify unfamiliar terms used in the writing. Limitations and delimitations of the project were expressed. The significance of the project for the training program it has been developed for has been included. A review of literature that was researched in the development of the project illustrates the importance of the project. The method in which the curriculum was developed is the final part of section one.

Section two of the project is the curriculum that was developed for the automotive brakes training program. This section contains the course description and outline for the program. The curriculum has been divided into six units of instruction. Each unit of instruction contains the lesson plans for that unit along with information sheets, checklists, evaluation sheets, assignment sheets, tests and answer sheets. Finally there are matrixes from the California State Model Curriculum Standards that indicate areas where the automotive brakes training program can enhance academic core skills.
# TABLE OF CONTENTS

Abstract ................................................................. iii
Table of Contents ....................................................... v
Introduction ............................................................... 1
Statement of the Objective ........................................... 1
The Objective ............................................................ 1
Context of the Problem ............................................... 1
Problem Statement .................................................... 2
Purpose of the Project ................................................ 2
Definitions ............................................................... 3
Assumptions ............................................................ 4
Delimitations ........................................................... 4
Limitations ............................................................. 5
Significance of the Project ........................................... 5
Organization of the Project .......................................... 6
Literature Review ...................................................... 6
Methodology ............................................................ 11
Bibliography ........................................................... 14
Curriculum Materials ................................................ 16
INTRODUCTION

Statement of the Objective

The Objective

The objective of this project was to develop a curriculum that includes the high priority task list requirements of an ASE model training site for servicing automotive brakes.

Context of the Problem

"Today's rapidly-changing technology demands continuous training for automotive technicians." (Rumberger, 1984) "Tomorrow's generation of automotive service professionals is in the hands of today's vocational educators." (Carr, 1986) Central to these quotations was the idea that automotive instructors at the secondary and postsecondary levels have the responsibility not only to train students for entry-level jobs, but to encourage and foster professionalism in the minds of young mechanics. By demonstrating to employers that students are ready for entry level positions in the industry, graduates may have a competitive advantage in obtaining employment and a school's job placement record can improve. The automotive service industry needs competent mechanics who are able to repair technically-complex vehicles. To further this effort, the National Automotive Technicians Education Foundation (NATEF) in conjunction with the National Institute for Automotive Service Excellence (ASE) offer an evaluation and a
certification program for automobile mechanic training programs that have met the NATEF standards for certification.

Problem Statement

The problem was that NATEF Directors realize that no two automobile technician training programs would be the same, therefore the method of learning, delivery systems and tests to monitor student progress were assumed to be the responsibility of the individual training program. Therefore, in order to achieve NATEF certification, each training program had to develop it's own curriculum, which included a minimum of 80% of the high priority items on the task list for NATEF certification standards. Clearly automobile technician instructors needed a well-developed task list that served as a solid base for a course of study outline. The NATEF task lists were validated for content, accuracy, and completeness using detailed job/task analysis approaches and methods. Theory instruction and hands-on performance of all the basic tasks would provide training for employment in the automotive service field.

Purpose of the Project

The purpose of this project was to produce a curriculum for a secondary school automobile technician training program that met the high priority standards for ASE certification in servicing of automotive brakes. NATEF required that 80%
of the high priority tasks in the task list were to be included in the training program and curriculum to satisfy certification standards.

This curriculum was presented to Colton Joint Unified School District for adoption into the vocational segment of the automotive technician training program at Colton High, which has been certified as an ASE model training site.

Definitions

For the purpose of this project the terms listed here have been defined as follows.

National Institute for Automotive Service Excellence (ASE): A non-affiliated, non-profit organization with a program designed to organize and promote the highest standards of automotive service by certifying technicians in the field of auto repair. (created in 1972)

National Automotive Technician Education Foundation (NATEF): Founded and directed by ASE, certifies automotive technician programs in secondary and post secondary schools using the same eight service areas as ASE to promote excellence in automotive repair. (created in 1982)

Curriculum: All the objectives, content, and learning activities arranged in a sequence for a particular instructional area.
Competency: Performance of a task to the level or degree specified in the performance standard for the task to be performed.

Goal: A statement of the intended outcome of participation in the training program.

Specialty/Specialist Area: Relates to one or more of the eight ASE specialty service areas.

Standard: Something established for use as a rule or basis of comparison in measuring, quantity, and quality.

Standard Performance: A written specification of the results of acceptable task performance.

Assumptions

It was assumed that through certification by ASE individual technician training programs were able to offer quality automotive courses while securing employer support for future growth. It was also assumed that graduates would have a competitive edge because employers would recognize that they are ready for entry level positions.

Delimitations

This project, if adopted by Colton Joint Unified School District, is for use by Colton High School's Vocational Automotive program. It has not been designed for any other automotive program, but could be used if it met local need.
Limitations

This project is limited to Colton High School's vocational auto program and not the auto principles segment of the automotive program. Other limitations of this curriculum are that it covered only the automotive brakes service area for ASE certification.

Significance of the Project

The significance of this project was that "A technological revolution was taking place in the automotive industry, not in the future but now." (Grosse, 1983) This revolution required that vocational education programs for automotive service needed to move quickly to restructure and redesign their curriculums to keep up with the current changes. This change needed to occur if the vocational programs were to meet today's challenges to stay in tune and not become obsolete. To further this effort ASE offered certification to automobile technician training programs that were recommended by NATEF for certification. "NATEF's goals are to develop, encourage and improve automotive technician education." (Policies, 1984) With NATEF's help automotive technician programs were able to keep abreast of current changes in technology and repair procedures to keep their programs and curriculums current with the technological changes as they occurred.
Organization of the Project

The organization of this project was to use the task list provided by NATEF as a basis for development of a workable curriculum that would contain the necessary tasks needed to be an automotive brake specialist. Theory instruction and hands-on hands on performance of all the basic tasks and a method of checking for comprehension and performance competency of the high priority items on the task list were included.

Literature Review

The literature search indicated that there was not an abundance of material available on automotive technology. What was available stated that there was an urgency for maintaining and constant updating of curricula in all vocational programs to keep up with the high-tech challenge. "Technology is rapidly changing the nature of work in all sectors of the economy." (Rumberger, 1984) With that thought in mind it is of utmost importance that vocational educators stay current in their area of specialization and maintain a current curriculum for educating the students in that area of specialization.

On October 9, 1986 Bill Honig, California Superintendent of Public Instruction, spoke at a convention for the California Association of Vocational Administrators (CAVA). In his speech on "Expectations for Excellence" Mr. Honig stressed the importance of career-vocational preparation
reinforcing the academic core, as well as training for employment. He also brought up five main points that are essential for career-vocational preparation, these points are.

a) An academic core is necessary for all of our students, including career-vocational preparation students.
b) Taking career-vocational preparation courses, in turn, is an excellent way to reinforce the core curriculum.
c) We must have high standards of quality for our career-vocational preparation programs.
d) We must coordinate instruction among and within institutions, so that career-vocational preparation is offered as a sequential program.
e) We must find ways to adapt our career-vocational preparation programs to the ever-changing technology.

With an ever changing job market and the high tech revolution in full swing it is important for career-vocational preparation and the core curriculum to be as one.

Harold Carr wrote about the criticism from academic educators over the value of vocational programs. In his article, What Makes A Curriculum Exemplary? he also pointed out that vocational education was a "Methodology that blends and integrates theory and applied learning so that the learner
progresses toward specific goals." (Carr, 1986) Another important characteristic was that of an integrated learning system which included technical knowledge, manipulative skills, core competencies, employable skills, and occupational skills that were blended into a comprehensive educational experience so that the learner sees meaning for each and the relationship of all.

Another article that stressed the importance of curriculum reform was, *Is Your Curriculum Ready for the Nineties?* by Curtis Finch and John Crunkilton. The authors have written a checklist that would help diagnose the effectiveness of a vocational curriculum and to test whether students were being prepared for their future. According to the authors, "No curriculum can entirely prepare students for a lifetime of work." (Finch, Crunkilton, 1985) A program that would focus solely on the jobs and problems of today would not prepare students for the world of work five years from now.

In an article by Len Mrachek, *Voc Ed Students need Math And Science*, Mr. Mrachek demonstrated an urgent need for career vocational programs to reinforce the academic core. He also stated that in order for students to succeed in the high tech jobs they must have a solid background in math and science. "Workers must be matched to today's and future jobs-jobs that require a broad background of knowledge from which to build specific skills." (Mrachek, 1984)
In a final article on curriculum development the authors mentioned that an effective curriculum cannot be created by any centralized unit and used as a finished product. *Updating Curriculum - A Process that Never Ends* by Donald Sanders and Nancy Chism. The article discussed the need for effective curriculum and the need for maintaining a curriculum. "What skills and characteristics do students need to become effective workers and citizens?" (Sanders, Chism, 1985)

This next article stressed the importance for Industry and education programs to work together. *Partnership Building - The Beat Goes On* by John Choulochas and Jim Mckenney. The article discussed a program between postsecondary and trade technical schools and General Motors Corporation to train GM's service technicians and future technicians for GM. "Training experts also foresaw the need for a qualitatively different kind of service technician. The mechanic of the past would be replaced by the highly skilled service technician, trained in many phases of the emerging electronic and computer technology." (Choulochas, Mckenney, 1986)

Another article that demonstrated how industry has come to the support of technical training programs was, *Energy Technologies and Training for the 1980's - An Industry Perspective* by Michael J. Fischer. The author discussed various energy sources that could use good vocational programs to train future service technicians. He also stated how the
new sophisticated fuel systems, front wheel drive and automotive diesels require that automechanics learn new skills and specialize. In the article it brought up the 1981 Automotive Mechanic Training Evaluation Project (AMTEP), which gained industry support from the Motor Vehicle Manufacturers Association (MVMA) in an attempt to update automotive training and keep up with the growing need for automotive specialists. (Fischer, 1982)

In the article, Automotive Mechantronics by Burck E. Grosse, the author stated that the "Technological revolution in the automotive industry, especially in servicing products, was not something that will happen in the future. The revolution is here, right now, and it will continue." (Grosse, 1983)

Mr. Hull and Mr. Pedrotti discussed robotics in automotive assembly as a part of the high-tech movement. They also mention in their article that many postsecondary school programs may be obsolete and that replacing expensive equipment was not enough, curriculums should also be restructured to meet the needs of the high-tech movement. The article was, Meeting the High-Tech Challenge by Daniel M. Hull and Leno S. Pedrotti. (Hull, Pedrotti, 1983)

In another article Russell Rumberger questioned how technology will affect the number of jobs and the type of jobs available and skills required for those jobs. The article was, How Much "Tech" Do High-Tech Workers Need? It was
unknown just what these effects will be. He stated that "This uncertainty about the future makes the task of education – particularly vocational education – extremely difficult."

Through the use of a chart Mr Rumberger listed jobs that would have the largest growth between 1982-1995. Automechanics showed an increased demand for 324,000 or a 38.3% more technicians than presently available. (Rumberger, 1984)

The NATEF Automobile Technician Training Certification Program information was vital to the research of this project, as it established the need for qualified technicians. NATEF with the help of recognized content experts, persons in various areas of automotive repair, including working technicians certified by ASE have validated the tasks performed by recognized competent automotive service personnel, as those to be taught for competency of entry level personnel.

Methodology

The final section of the project methodology addressed how the NATEF automotive brakes curriculum was developed for Colton High school. The curriculum met the requirements of the California State Model Curriculum Standards for power and energy technology: automotive.

In order to accomplish this task several areas of concern were addressed. The primary task was to establish an advisory committee to aid in an analysis of data applicable to
an automotive brake program. Secondly applicable data related to teaching an automotive brake program had to be researched. Thirdly the Colton Joint Unified School District Curriculum Specialist was consulted so that the Districts curriculum requirements could be met.

To assist in developing an effective curriculum an advisory committee that contributes to the success of the program is vitally important. The advisory committee members assisted in setting up the program goals and prioritizing the tasks that should be taught and applicable teaching strategies. An essential element of any curriculum is a validated task list. Advisory committee members are members of the community that are recognized experts in their field. This expertise gives credibility to the importance of tasks and order of importance of these tasks.

Data related to teaching an automotive brake program was acquired from various sources. Among these sources was the California State Model Curriculum Standards and Program Framework for Industrial Technology Education. The curriculum standards and program frameworks were used as a model not a mandate. "Any school district which adopts a required curriculum which meets or exceeds the model standards developed by the State Board of Education pursuant to Section 51226 shall be deemed to have fulfilled its responsibilities pursuant to this section." (Model, 1986)
The training program for automotive brakes at Colton High School has been certified by ASE as a NATEF model training program therefore it was also important that the NATEF guidelines and Task List be considered when developing an automotive curriculum. NATEF requires that 80% of the high-priority items in its task list be included in the program curriculum.

The Colton Joint Unified School District curriculum Specialist recommended including the Districts required Exit Criteria and a method that would reinforce the Academic Core Skills for alternative graduation credit before the curriculum is presented to the District.

Funding for a vocational automotive program was accomplished by the use of several methods.

a) Application to the State Department of Education for grant funds (RFB'S) or other funds that would be available to fund the program.
b) Use of Vocational Education Association funds (VEA) for the use of trade and industry classes (T&I).
c) Use of funds distributed by the individual school districts for local funding of the secondary school programs.
d) Use of State Lottery funds that are distributed to the school districts by the state to be funneled to the individual schools for disbursement.
Bibliography


_Model curriculum standards_. (1986, Oct.). California State Department of Education Vocational Education Division.


CURRICULUM
MATERIALS
AUTOMOTIVE
BRAKE
MECHANIC
CURRICULUM

An Automotive Brake Training Program
that meets NATEF certification standards.
<table>
<thead>
<tr>
<th>CURRICULUM INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Index ........................................ 18</td>
</tr>
<tr>
<td>Course Information ......................................... 23</td>
</tr>
<tr>
<td>Course Description .......................................... 23</td>
</tr>
<tr>
<td>Academic Core Skills ........................................ 23</td>
</tr>
<tr>
<td>Course Outline ............................................... 24</td>
</tr>
<tr>
<td>Exit Criteria ................................................. 24</td>
</tr>
<tr>
<td>Student Performance Standards .............................. 25</td>
</tr>
<tr>
<td>Unit One ...................................................... 26</td>
</tr>
<tr>
<td>Lesson Plan One ............................................... 27</td>
</tr>
<tr>
<td>Information Sheet #1 ........................................ 28</td>
</tr>
<tr>
<td>Information Sheet #2 ......................................... 29</td>
</tr>
<tr>
<td>Lesson Plan Two ............................................... 30</td>
</tr>
<tr>
<td>Assignment Answer Key ........................................ 31</td>
</tr>
<tr>
<td>Lesson Plan Three ............................................ 35</td>
</tr>
<tr>
<td>Vocabulary Worksheet ......................................... 36</td>
</tr>
<tr>
<td>Comprehension Worksheet ..................................... 38</td>
</tr>
<tr>
<td>Spelling Worksheet ........................................... 39</td>
</tr>
<tr>
<td>Grammar Worksheet ............................................ 40</td>
</tr>
<tr>
<td>Sentence Structure Worksheet ............................... 41</td>
</tr>
<tr>
<td>Lesson Plan Four ............................................... 42</td>
</tr>
<tr>
<td>Instructor Checklist .......................................... 43</td>
</tr>
<tr>
<td>Unit Two ....................................................... 44</td>
</tr>
<tr>
<td>Lesson Plan One ............................................... 45</td>
</tr>
<tr>
<td>Filmstrip Quiz ................................................ 46</td>
</tr>
<tr>
<td>Filmstrip Quiz Answer Key .................................... 54</td>
</tr>
<tr>
<td>Title</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Worksheet Answer Key</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
<td>Instructor Checklist</td>
</tr>
<tr>
<td>Lesson Plan Six</td>
</tr>
<tr>
<td>Information Sheet #12</td>
</tr>
<tr>
<td>Information Sheet #13</td>
</tr>
<tr>
<td>Information Sheet #14</td>
</tr>
<tr>
<td>Information Sheet #15</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
<td>Instructor Checklist</td>
</tr>
<tr>
<td>Lesson Plan Seven</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
<td>Instructor Checklist</td>
</tr>
<tr>
<td>Unit Three</td>
</tr>
<tr>
<td>Lesson Plan One</td>
</tr>
<tr>
<td>Filmstrip Quiz</td>
</tr>
<tr>
<td>Filmstrip Quiz Answer Key</td>
</tr>
<tr>
<td>Lesson Plan Two</td>
</tr>
<tr>
<td>Worksheet Page 144</td>
</tr>
<tr>
<td>Worksheet Answer Key</td>
</tr>
<tr>
<td>Worksheet Page 145</td>
</tr>
<tr>
<td>Worksheet Answer Key</td>
</tr>
<tr>
<td>Information Sheet #16</td>
</tr>
<tr>
<td>Lesson Plan Three</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Filmstrip Quiz</td>
</tr>
<tr>
<td>Filmstrip Quiz Answer Key</td>
</tr>
<tr>
<td>Lesson Plan Five</td>
</tr>
<tr>
<td>Worksheet Page 146</td>
</tr>
<tr>
<td>Worksheet Answer Key</td>
</tr>
<tr>
<td>Information Sheet #17</td>
</tr>
<tr>
<td>Lesson Plan Six</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
<td>Instructor Checklist</td>
</tr>
<tr>
<td>Unit Four</td>
</tr>
<tr>
<td>Lesson Plan One</td>
</tr>
<tr>
<td>Worksheet Page 147</td>
</tr>
<tr>
<td>Worksheet Answer Key</td>
</tr>
<tr>
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</tr>
<tr>
<td>Information Sheet #19</td>
</tr>
<tr>
<td>Information Sheet #20</td>
</tr>
<tr>
<td>Lesson Plan Two</td>
</tr>
<tr>
<td>Student Performance Task List</td>
</tr>
<tr>
<td>Instructor Checklist</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
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</tr>
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COURSE INFORMATION

PROGRAM TITLE: Automotive Brake Mechanic.


USOE CODE NUMBER: 17.030300. Specialization, other.

HOURS OF INSTRUCTION: 80.

This program will prepare students for the following occupations.

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<td>Automotive Brake Adjuster</td>
<td>620.884.014</td>
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<tr>
<td>Automotive Brake Lathe Operator</td>
<td>620.682.010</td>
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COURSE DESCRIPTION:

This course was designed to train prospective automotive technicians in the field of automotive brakes. Students completing the course would be able to pass the National Institute for Automotive Service Excellence (ASE) exam within two years of entering the automotive service field.

In order to insure the proper operation of braking systems, the student must understand their fundamentals, the required safety precautions when performing brake repairs, measurement tolerances, and analysis and repair of applicable automotive brake systems.

ACADEMIC CORE SKILLS ENHANCEMENT (Model, 1986)

Automotive brakes integrates academic core skills including:
Language Arts: Interpreting text, service manuals and other brake system references. Participating in discussions on brake systems. Employing a technical vocabulary in brake system reports.

Mathematics: Reading micrometers when measuring inside and outside diameters, lengths and widths. Using algebraic functions to determine hydraulic, pad, shoe and piston pressures and forces.

History-Social Science: Tracing the historical development of the braking system from drum to modern disk. Exploring the historical development of high efficiency and anti-skid systems used in modern automobiles.

Science: Examining the physical principles of inertia, deceleration, hydraulic pressure, mechanical leverage; studying the theories of heat, heat transfer, and heat dissipation.

COURSE OUTLINE:

The automotive brake curriculum will integrate the six standards for Power and Energy Technology: Automotive, from the California State Model Curriculum Frameworks and the tasks from the Task List recommended by the National Automotive Technicians Education Foundation (NATEF).

EXIT CRITERIA:

By the completion of the 80 hour automotive brake course, students are expected to be able to competently perform the tasks for the six student performance standards.
STUDENT PERFORMANCE STANDARDS:

STANDARD 1: Automotive Brake Fundamentals.

The student will diagnose, measure, and repair brake problems.

STANDARD 2: Automotive Brake Hydraulics.

The student will identify wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

STANDARD 3: Automotive Brake System Service.

The student will repair different brake designs, both drum and disc, in conformance with industrial standards.

STANDARD 4: Automotive Power Brakes.

The student will diagnose problems with power brakes and will make repairs consistent with industrial standards.

STANDARD 5: Automotive Brake Problems And Diagnosis.

The student will recognize, diagnose, and effectively repair identified brake system problems.

STANDARD 6: Automotive Brake Service Standards.

The student will demonstrate why drums and rotors cannot be turned beyond maximum size. The student will recognize that front drums and rotors must be turned to approximately the same size.
UNIT ONE

AUTOMOTIVE BRAKE FUNDAMENTALS

UNIT 1 GOAL:

The Student will be able to identify the basic fundamentals of an automotive brake system, related brake components and observe all brake service safety precautions. The student will diagnose, measure and repair brake problems.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. Test brake operation (core).
2. Inspect brake hoses and lines (core).
3. Flush brake system.
4. R&R brake hoses.
5. R&R brake lines.
6. Adjust brake shoes (core).
7. Free-up parking brake cable and linkage (core).
8. Adjust parking brake linkage (core).
9. R&R parking brake cable and linkage (core).
10. R&R parking brake external band.
STUDENT PERFORMANCE OBJECTIVE:

Given information on safety relative to the brake system. Students will identify the major hazard associated with servicing automotive brake systems and describe the safety precautions that need to be taken in order to eliminate those hazards.

LEARNING ACTIVITIES:

1. Students will view a California E.P.A. VHS video concerning automotive brake safety entitled "Don't Blow It".
2. Instructor will lecture to reinforce information covered by the video.
3. Students will be provided with Info sheet #1.
4. Students will be provided with Info sheet #2.

EVALUATION:

Students will demonstrate awareness of health and safety requirements while performing automotive brake repairs as per E.P.A. standards by using proper equipment.
!! WARNING !!

BRAKE FRICTION MATERIALS CONTAIN ASBESTOS.

A KNOWN CARCINOGEN

(A SUBSTANCE THAT CAN CAUSE CANCER).

GRINDING LININGS, CLEANING BRAKE ASSEMBLIES, ETC.,

CAN PRODUCE SMALL AIRBORNE PARTICLES OF ASBESTOS.

THESE ARE EASILY INHALED BY THE MECHANIC.

BREATHING THESE PARTICLES MAY CAUSE CANCER.

1. Never use compressed air to blow brake assemblies clean. Use a vacuum source or flush with water.

2. Equip brake shoe grinders with an efficient dust removal system. Turn on system whenever grinder is in operation.

3. When some exposure might be unavoidable, wear an approved filter mask.
!! WARNING !!

BRAKE LINING DUST SHOULD NEVER BE INHALED.

THESE MINUTE PARTICLES OF ASBESTOS,
WHEN DRAWN INTO THE LUNGS,
CAN CAUSE CANCER.

WHEN GRINDING LININGS, CLEANING BRAKE ASSEMBLIES, ETC.,
USE CARE TO AVOID BREATHING THE DUST.

HAVE PROPER VENTILATION.

NEVER CLEAN WITH AN AIR HOSE.

HAVE A DUST DISPOSAL SYSTEM ON GRINDER AND WHEN NEEDED,
WEAR A SUITABLE RESPIRATOR!
STUDENT PERFORMANCE OBJECTIVE:

Given the automotive textbook, the student will read the chapter relative to automotive brakes and answer the questions at the end of the chapter.

LEARNING ACTIVITIES:


2. Students will answer the Chapter Review Questions at the end of the chapter on pages 463 and 464.

3. Instructor will review the chapter with the student to reinforce student comprehension of the material.

Evaluation:

Students will correctly answer all of the Chapter Review Questions at the end of the chapter.
Auto Mechanics Fundamentals, questions on pages 463 and 464:

1. False.
2. Motion, pressure.
3. When pressure is exerted on a confined liquid, it is transmitted undiminished.
4. Fluid is drawn from a reservoir through a check valve, then is subjected to pressure by the actuating piston. This closes the inlet check and forces the outlet check open. The fluid then passes into a cylinder with a piston much larger in diameter than that of the actuating piston. The difference in piston surface area greatly increases the force of the actuating piston.
5. 1,000 pounds.
6. To produce pressure and a flow of fluid to actuate the wheel cylinders.
7. See text. Pages 436, 437.
8. 1/4 to 1/2 in. (6.35 to 12.7 mm).
10. To provide sufficient fluid to replace that lost due to slow seepage and to provide fluid enough to flow through the lines to move the wheel cylinder pistons outward.
11. It keeps some static pressure in the brake lines.
12. Double thickness, coated steel tubing.


15. False.

16. It allows the front wheel assembly to move up and down without bending the brake tubing. It can also be used at points where harmful vibration is present.

17. Double piston, single piston.

18. To provide more pressure on one brake shoe than on the other.

19. False.

20. The flare is pressed outward by the force of the brake fluid.


22. False.

23. It provides a mounting surface for the wheel cylinders and brake shoes. It also protects the brake assembly from dust and water.

24. Primary, secondary.

25. To pull the shoes away from the drum when master cylinder pressure drops.
26. Asbestos (generally). Other special linings are sometimes used.

27. Brake drum or disc.

28. The wheel cylinder pistons move outward and apply the brake shoes to the revolving drum.

29. Loss of braking power due to overheating of the brakes.

30. Servo action is when one brake shoe helps to apply the other. Self-energizing is when the shoe tends to apply itself due to the jamming action set up by the wheel cylinder pressure, the direction of drum rotation and the anchor bolt.

31. Star wheel adjuster or brake shoe eccentrics.

32. Drive line and rear wheel brake assembly.

33. It uses engine vacuum applied to a large piston to increase force on the fluid in the master cylinder.

34. See text. Page 455.

35. Special diaphragm or reaction disc.

36. Bellows booster, diaphragm booster, and piston booster.

37. It provides several powered brake applications in the event the engine is stopped.

38. Prevents complete brake failure.

39. True.
40. D. Prevents disc brake application until line pressure reaches a certain point.

41. See text. Page 455.

42. B. Diaphragm.

43. Power steering.

44. Maintains even viscosity. Boiling point above operating temperature. Hydroscopic. Acts as a lubricant. Fluid must not corrode system. (Select any four.)

45. See text. Page 438.
STUDENT PERFORMANCE OBJECTIVE:

Given work sheets that incorporate Language Arts Skills with Automotive Brake Skills. The students will perform the writing exercises for each worksheet.

LEARNING ACTIVITIES:

1. Students will accomplish the Vocabulary exercise on worksheet one
2. Students will accomplish the Comprehension exercise on worksheet two
3. Students will accomplish the Spelling exercise on worksheet three.
4. Students will accomplish the Grammar exercise on worksheet four.
5. Students will accomplish the Sentence Structure exercise on worksheet five.
6. Instructor will review the worksheets with the students to reinforce student comprehension.

EVALUATION:

Students will demonstrate comprehension of exercises by correctly accomplishing each exercise.
Worksheet 1 - Vocabulary

Directions: Briefly define each word and write a sentence using each.

1. compressible

2. transmit

3. principle

4. viscosity

5. reservoir

6. exploded

7. primary

8. secondary

9. dual

10. applied
11. compensated 

12. drum 

13. bleeder 

14. shoe 

15. fade 

16. caliper 

17. booster 

18. tandem 

19. accumulator 

20. diagonal 

Worksheet 2 - Comprehension

Directions: Fill in each blank with the correct word or words.

1. When air is put under pressure, it ________________.
2. A quality brake fluid maintains even ________________.
3. In the cylinder, you will find two close fitting aluminum ________________.
4. Both pistons are ________________, when the brake pedal is in the released position.
5. ________________ causes metal fatigue which results in brake line failure.
6. The brake shoe that faces the front of the car is the ________________ brake shoe.
7. Overheating causes a loss of ________________ properties in the brake lining.
8. A caliper is bolted to the ________________.
9. The parking brake is put into action by a lever located on the inboard side of the ________________.
10. A spring loaded accumulator is filled with ____________.
Worksheet 3 - Spelling

Directions: In the blank, write the correct spelling of each word.

1. undeminished, undiminished, undiminished
2. viscosity, vizcosity, viscosity
3. reservoir, reservor, reservoir
4. contaminated, contamenated, conteminated
5. manufacturer, manufacturor, manufacturer
6. transmitting, transmitting, transmetting
7. simplafied, simplified, simplefied
8. submurged, submirged, submerged
9. rigidity, rigidity, rigidity
10. ankor, ancher, anchor
11. kinetic, kenetic, kenitic
12. excentrics, eccentrics, ecclntrles
13. utilization, utilizezation, utilization
14. sufficient, sufflcent, suffecient
15. calaper, caliper, calipar
16. continude, contained, continued
17. atmospherec, atmosheric, atmospheric
18. proporsional, proportional, preportional
19. depleted, depleeted, dipleted
20. diminished, deminishned, dimenished
Worksheet 4 - Grammar

Directions: Punctuate the following sentences.

1. In modern cars hydraulic brakes are used to stop the car
2. Two port holes have a connecting cylinder which contains two aluminum pistons
3. When the brake shoes retract the wheel cylinders are squeezed together
4. Mr. Stokes our auto mechanics instructor explained that proportioners are the same as proportioning valves
5. Why must the high pressure hose be flexible
6. Brake lining is made of asbestos a heat-tolerant material
7. Wow my brakes are failing
8. Some power boosters use the following reaction plates levers and diaphragms
9. The hydraulic power booster a Hydro Boost is found on some vehicles
10. If the booster or vacuum fails the brakes may be applied by only foot pressure
Worksheet 5 - Sentence Structure

Directions: Use each of the words in a sentence and underline the complete predicate.

1. compressed

2. using

3. depresses

4. maintains

5. are placed

6. is activated

7. are retracted

8. is connected

9. is operated

10. moves
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components and actual vehicles.
2. Instructor will demonstrate proper procedures for performing the 10 manipulative tasks for Unit One.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Fundamentals to verify the students ability to perform the demonstrated manipulative skills as they are performed by the student.
INSTRUCTOR CHECKLIST

Automotive Brake Fundamentals.

Standard 1: Student will diagnose, measure, and repair brake problems.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Test brake operation (core).
2. Inspect brake hoses and lines (core).
3. Flush brake system.
4. R&R brake hoses.
5. R&R brake lines.
6. Adjust brake shoes.
7. Free-up parking brake cable and linkage (core).
8. Adjust parking brake linkage (core).
9. R&R parking brake cable and linkage (core).
10. R&R parking brake external band.

STUDENT PERFORMING TASKS: ____________________________________________

DATE TASKS COMPLETED: _______________________________________________

INSTRUCTOR SIGNATURE: _______________________________________________
UNIT TWO

AUTOMOTIVE BRAKE HYDRAULICS

UNIT 2 GOAL:

The student will be able to identify hydraulic functions related to automotive brake operation, demonstrate wheel cylinder and master cylinder operation and recognize the need for brake control devices and proper brake fluid maintenance.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).
STUDENT PERFORMANCE OBJECTIVE:

Given a filmstrip presentation relative to the automotive brake system. The student will recognize the importance of hydraulics in relation to automotive brake use.

LEARNING ACTIVITIES:

1. Students will view two filmstrips from Bergwall Productions Inc. entitled "Basic Parts and Principles" and "Problems: Causes and Corrections".
2. Students will be given a quiz that directly relates to the filmstrips.
3. Instructor will lecture to reinforce information covered by the filmstrips.

EVALUATION:

Students will demonstrate comprehension of automotive brake hydraulics by scoring a minimum of 90% on the quiz.
BASIC PARTS AND PRINCIPLES FOR AUTOMOTIVE BRAKES

Filmstrip 404.1 Quiz.

Directions: Circle the letter that best answers the question.

1. The efficiency of the hydraulic brake system depends on which of the following?
   a. Hydraulic pressure.
   b. Friction between the brake shoe and the brake drum.
   c. Friction between the tire and the road.
   d. All of the above.

2. Why is hydraulic pressure used in a brake system?
   a. It is easy to manufacture.
   b. Fluid can be easily compressed.
   c. Fluid under pressure exerts even pressure in all directions.
   d. It is impossible for a hydraulic brake system to fail.

3. Why is the front brake lining wider on the front set of brakes than the rear set?
   a. Because the front end of a car is heavier than the rear end.
   b. So it can handle the weight shift of a vehicle when the brakes are applied.
   c. Because the front wheels must turn the vehicle and rotate at the same time.
   d. None of the above.

4. What is the purpose of the master cylinder?
   a. To exert hydraulic pressure to the brake shoes.
   b. To maintain a static pressure on the brake lines.
   c. To contain a reservoir of brake fluid.
   d. All of the above.

5. The pressure chamber of the master cylinder is always located:
   a. At the rear of the piston.
   b. In the front of the piston.
   c. In the reservoir.
   d. Behind the dust boot.

46
6. Where is the reservoir of the master cylinder located?
   a. At the rear of the pressure chamber.
   b. At the front of the pressure chamber.
   c. On the top of the pressure chamber.
   d. Before the dust boot.

7. What is the function of the compensating port of the master cylinder?
   a. To supply the pressure chamber with brake fluid.
   b. To maintain static pressure in the brake lines.
   c. To permit air to enter the pressure chamber during each brake application.
   d. All of the above.

8. Stepping on the brake pedal moves the lip of the primary cup, past the compensating port, which causes:
   a. A loss of hydraulic pressure in the reservoir.
   b. A continuous build-up of hydraulic pressure in the pressure chamber.
   c. A continuous build-up of hydraulic pressure behind the piston.
   d. None of the above.

9. How is the secondary cup of the master cylinder lubricated?
   a. By brake fluid fed through the breather port.
   b. By brake fluid fed through the compensating port.
   c. By brake fluid stored in the dust boot.
   d. By a special fluid line connected to the check valve.

10. What causes the pressurized fluid to return to the master cylinder after the brake release?
    a. Atmospheric pressure working on the pressure chamber.
    b. Atmospheric pressure working on the reservoir.
    c. Strong retracting springs connected to the brake shoes.
    d. All of the above.
11. Why is a static pressure of 8 to 10 pounds necessary in the brake lines, after a brake release?

a. To lubricate the wheel cylinder cups.
b. To hold the check valve in place.
c. To maintain a firm pedal after using the brake.
d. To operate the brake light switch.

12. The main advantage of the dual master cylinder, is that it provides:

a. A safer driving situation at all times.
b. A fool-proof brake system.
c. Enough hydraulic pressure to make the power brakes unnecessary.
d. All of the above.

13. Which of the following prevents water and dirt from entering the wheel cylinders?

a. Piston seals.
b. Piston rings.
c. Dust boots.
d. Metal shields.

14. In operation, what are the special requirements of a good grade of brake fluid?

A. It must be able to withstand heat from friction.
b. It must be able to lubricate moving parts.
c. It must be able to keep from freezing during cold weather operations.
d. All of the above.

15. What material is the brake shoe made of, on a system using drum brakes?

a. Aluminum.
b. Steel.
c. Cast iron.
d. Fiberglass.
16. The forward brake lining of the drum type brakes is called the:
   a. Primary.
   b. Secondary.
   c. Anchor.
   d. None of the above.

17. Why is cast iron used as the base material for making brake drums?
   a. It is easy to manufacture.
   b. It will not rust.
   c. It will not easily distort.
   d. It is lighter than any other metal.

18. Why are some brake drums constructed with fins on the exterior of the drum?
   a. To strengthen the drum.
   b. To protect it from the elements.
   c. To help it run cooler.
   d. All of the above.

19. Which of the following is (are) a problem in stopping a vehicle even with a good set of brakes?
   a. A wet road.
   b. Snow on the road.
   c. Gravel on the road.
   d. All of the above.

20. "Locking" of the wheels is caused by:
   a. Proper operation of brake pedal on bad roads.
   b. A normal brake system making a good stop.
   c. A worn set of brake lining.
   d. None of the above.
PROBLEMS: CAUSES AND CORRECTIONS FOR AUTOMOTIVE BRAKES

Filmstrip 404.2 Quiz.

Directions: Circle the letter that best answers the question.

1. Which of the following is a problem connected with the hydraulic brake system?
   a. The car vibrates at high speeds.
   b. The car wanders to the side of the road.
   c. The wheel cylinder pistons are frozen.
   d. All of the above.

2. What is the first sign of a "slow" leak in the hydraulic circuit of a brake system?
   a. Complete brake failure.
   b. A spongy brake pedal.
   c. The brake pedal drops at intervals to the floor board.
   d. Pedal fails after awhile, driving on mountain roads.

3. Which statement below best describes a leak caused by the secondary cup of the master cylinder?
   a. A sudden leak causing complete brake failure.
   b. A hydraulic leak causing a low pedal but no fluid loss.
   c. A slow brake fluid leak at the rear of the master cylinder.
   d. None of the above.

4. An inspection of the front brakes shows brake fluid on the lining. How will it affect the stopping of the vehicle?
   a. It will not stop at all.
   b. It will pull to one side when the brakes are applied.
   c. It will cause the brake pedal to fade.
   d. It will cause a spongy brake pedal.

5. If you suspect a slow fluid leak from a faulty rear wheel cylinder, what should you do?
   a. Wait until it gets worse so you can see it on the inside of the rear tire.
   b. Remove the wheel and examine the outside of the drum for fluid loss.
Filmstrip 404.2 Quiz (continued).

c. Remove the brake drum and check the condition of the lining.
d. Remove the drum and check for a fluid leak behind the dust boot of the wheel cylinder.

6. How is the middle of a wheel cylinder restored to a useful condition?

a. By rubbing it with coarse, emery cloth.
b. By cleaning it with gasoline.
c. By honing it.
d. Any of the above.

7. How do you trouble-shoot an exterior brake fluid leak?

a. Make a visual inspection.
b. Make a visual inspection while applying pressure to the foot pedal.
c. Smell any brake fluid near brake lines or junctions.
d. All of the above.

8. One of the following jobs requires the bleeding of brakes. Which is it?

a. The replacement of brake lining.
b. The replacement of a junction block for hydraulic brake lines.
c. The replacement of a rear brake drum.
d. The repacking of front wheel bearings on drum type brakes.

9. What is the recommended material to be used for replacement of brake fluid lines in the auto industry?

a. Steel
b. Copper.
c. Brass.
d. Aluminum.

10. Which of the following parts should always be replaced in pairs?

a. Tires.
b. Rear axles.
c. Front fenders.
d. Front flex brake lines.
11. How does the vehicle react when one front wheel cylinder is "frozen" during brake applications?
   a. It will not stop the vehicle.
   b. The vehicle will pull to the side that is in good operation.
   c. The vehicle will pull toward the defective side.
   d. The brake pedal will refuse to go down.

12. What is "Brake Pedal Fade"?
   a. A hard pedal, but a poor stopping effect.
   b. A low, hard pedal with a good stopping effect.
   c. An unreliable brake pedal affected by hot weather driving conditions.
   d. None of the above.

13. What can be done to avoid brake fade?
   a. Use a good grade of brake fluid.
   b. Pump the brakes when descending on mountain roads.
   c. Gear down the transmission when descending on mountain roads.
   d. All of the above.

14. How will it affect the braking system when the brakes are in need of a minor adjustment?
   a. The vehicle will pull to one side during braking applications.
   b. The stop will be normal, but the pedal will be lower than it should be.
   c. The brake pedal will remain in the down position when applied suddenly.
   d. All of the above.

15. Adjusting the brakes on a Bendix Brake is accomplished by:
   a. Expanding the star adjusting screw.
   b. Turning the anchor pin.
   c. Turning a cam adjustment.
   d. Bleeding the hydraulic circuit.

16. A periodic inspection of the brake lining should be done every:
   a. 1,000 miles.
   b. 5,000 miles.
   c. 20,000 miles.
   d. 50,000 miles.
17. A small portion of new lining contacts the drum face. How is this condition corrected?
   a. Replace the brake lining with another type.
   b. Renew the drums.
   c. Re-surface the drum, arc the new lining accordingly.
   d. Adjust the brakes a little tighter.

18. A glazed condition of the brake lining is "usually" caused by:
   a. Poor driving habits.
   b. Brake lining material that is too soft to work efficiently.
   c. A cheap braking system that does not use cooling fins on the brake drums.
   d. Inferior brake fluid.

19. The brake pedal slowly drops to the floor. There is no fluid loss. What is wrong with the hydraulic brake system?
   a. A wheel cylinder is leaking.
   b. There is a hydraulic pressure leak in the primary cup.
   c. The secondary cup is leaking.
   d. The brakes need bleeding.

20. Which of the following will cause brakes to bind?
   a. A clogged compensating port in the master cylinder.
   b. Insufficient play in the brake pedal linkage.
   c. Brakes adjusted too tight.
   d. All of the above.
# AUTOMOTIVE BRAKES FILMSTRIP 1&2 QUIZ ANSWER KEY

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STUDENT PERFORMANCE OBJECTIVE:

Given assignment sheets from the student automotive workbook. Students will perform the workbook assignments.

LEARNING ACTIVITIES:

1. Students will complete assignments on pages 140 and 141 of the Auto Mechanics Fundamentals workbook.
2. Students will complete the assignment on page 148 of the Auto Mechanics Fundamentals workbook.
3. Students will be provided with Info sheet #70. (3)

EVALUATION:

Students will perform the work book assignments with a minimum competency of 90%.
OBJECTIVE: After completion of this chapter, you will be able to identify and define the major parts of an automotive brake system.

SHOP TALK: Automobile brake linings normally contain asbestos as a heat resistant, friction material. Asbestos, however, is one of the most powerful cancer causing substances in existence. To protect your health, never breathe airborne brake lining dust. Wear an approved filter mask. Turn on a ventilation fan or clean off the brake dust with a vacuum brush or damp rag.

INSTRUCTIONS: As you read text pages 431 through 464, complete the workbook statements. Define the terms and identify the parts and actions in the illustrations. In Fig. 20-1, label the parts of the basic hydraulic jack.

---

**BASIC HYDRAULICS**

1. Hydraulic brakes (define) __________________________
   __________________________
   __________________________
   __________________________

2. A liquid, under confinement, can be used to __________________________

3. Air confined under pressure will __________________________
   __________________________

4. When a liquid is confined and placed under pressure, it cannot be __________________________

---

**Fig. 20-1**

A. __________________________
B. __________________________
C. __________________________
D. __________________________
E. __________________________
F. __________________________
G. __________________________
H. __________________________
I. __________________________
BASIC HYDRAULICS, page 140:

1. They are used to stop a car. A special brake fluid is confined in rubber hose and steel tubing to transmit both motion and pressure from the pedal to the wheels.

2. Transmit pressure, increase or decrease pressure, transmit motion.

3. Compress, thereby reducing its volume.

4. Compressed.

A. Jack handle.

B. Ram head.

C. Ram.

D. Piston B.

E. Pressure same in both areas.

F. Check valve.

G. Check valve.

H. Reservoir.

I. Piston A.
In Fig. 20-2, draw the dots for brake fluid and arrows showing part movement. Then, identify the brake system components.

**BASIC BRAKE HYDRAULIC SYSTEM**

---

Complete the following statements which cover hydraulic brakes.

1. Basically, a car's hydraulic brake system consists of ____________________________
2. When the driver pushes the brake pedal and exerts a force on the ____________________________ piston, this force is transmitted to each wheel cylinder.
3. The wheel cylinder pistons transfer the hydraulic force to the ____________________________
4. When the wheel cylinders push out, the ____________________________ engage the revolving ____________________________ to stop the car.
5. The master cylinder is the central unit in which hydraulic ____________________________ is developed.
6. Pressure of the driver's foot on the brake pedal is transmitted, via various ____________________________ arrangements, to the master cylinder piston.
7. As the master cylinder piston is pushed forward in the cylinder, it pushes ____________________________
BASIC BRAKE HYDRAULIC SYSTEM, HYDRAULIC BRAKES, page 141:

A. Foot pressure.
B. Pedal.
C. Brake lever.
D. Linkage.
E. Master cylinder.
F. Steel tubing line.
G. Left front wheel cylinder.
H. Right front wheel cylinder.
I. Piston B.
J. Distribution block.
K. Right rear wheel cylinder.
L. Piston A.
M. Left rear wheel cylinder.

1. A master cylinder, steel tubing to form connecting lines, one or two wheel cylinders for each wheel.
4. Brake shoes, brake drum.
5. Pressure.
7. Brake fluid ahead of it.
Complete the drawing of the automotive brake system. Use an ink pen to sketch the hydraulic brake lines and a pencil to fill in the emergency brake cable. Label all of the parts as they are connected.

TYPICAL BRAKE SYSTEM

Fig. 20-13

A. ____________________________ K. ____________________________
B. ____________________________ L. ____________________________
C. ____________________________ M. ____________________________
D. ____________________________ N. ____________________________
E. ____________________________ O. ____________________________
F. ____________________________ P. ____________________________
G. ____________________________ Q. ____________________________
H. ____________________________ R. ____________________________
I. ____________________________ S. ____________________________
J. ____________________________ T. ____________________________
AUTOMOTIVE BRAKES CHAPTER 20 WORKBOOK ASSIGNMENT ANSWER KEY

TYPICAL BRAKE SYSTEM, page 148:

A. Splash shield.  
B. Flex brake hose.  
C. Reservoir.  
D. Master cylinder.  
E. Power brake.  
F. Firewall.  
G. Brake pedal.  
H. Foot operated parking brake.  
I. Backing plate.  
J. Flex hose.  
K. Parking brake cable.  
L. Drum brake (rear).  
M. Brake shoes.  
N. Wheel cylinder.  
O. Proportioning valve.  
P. Brake warning light.  
Q. Metering valve.  
R. Caliper.  
S. Disc.  
T. Disc brake (front).
COMPLETE BRAKE SYSTEM

- SINGLE PISTON DISC BRAKE
- SELF-ADJUSTING DRUM BRAKE (LEVER TYPE)
- FOUR PISTON DISC BRAKE
- DUAL MASTER CYLINDER
- SELF-ADJUSTING DRUM BRAKE (CABLE TYPE)
- TO DASHBOARD LIGHT
- DUST BOOT
- PUSH ROD
- BACKING PLATE
- RETRACTING SPRINGS
- IN-LINE STOPLIGHT SWITCH
- PROPORTIONING VALVE
- REAR HOSE
- STEEL HYDRAULIC TUBING
- WHEEL CYLINDER
- LINED BRAKE SHOE
- PRESSURE DIFFERENTIAL SWITCH
- FRONT ROTORS
- REAR
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R and rebuilding of actual brake wheel cylinders.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with Info sheets #4, 5 & 6.
5. Students will complete the assignment on page 143 of the Auto Mechanic Fundamentals workbook.
6. Students will be provided with a student performance task list for "Hydraulic System Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Hydraulics to verify the students ability to perform the demonstrated manipulative skills.
Wheel Cylinders

DESCRIPTION

Wheel cylinders convert hydraulic pressure supplied by the master cylinder into a mechanical force at the wheel brakes.

The three types of wheel cylinders that are used with drum brakes are...

.. Double Piston Straight Bore,
.. Double Piston Step Bore, and
.. Single Piston.

DOUBLE PISTON STRAIGHT BORE

The double piston, straight bore wheel cylinder is the type most commonly used on modern automobile brakes.

A cross section of a typical double piston straight bore cylinder is shown in Figure 1. All of the components of a typical cylinder are shown except a bleeder screw which is not illustrated.

Figures 2 and 3 also show double piston straight bore cylinders but with variations in the method of attaching the dust boots to the cylinder body.
SINGLE PISTON

A single piston wheel cylinder has only one cup, piston and dust boot as shown in Figure 5.

OPERATION

The space in the cylinder bore between the cups must remain filled with fluid at all times. When the brake pedal is depressed, additional brake fluid is forced into the cylinder bore.

The additional fluid, which is under pressure, moves the cups and pistons outward in the bore (Figure 6). This, of course, moves the shoe links and brake shoes outward to contact the drum and apply the brakes.

NOTE: On some brakes, the end of the shoe web bears directly against the pistons, and shoe links are not used.

SERVICE PROCEDURES

Wheel cylinders should be re-built or replaced whenever the brake shoes are replaced or more often when required.

CLEANING AND INSPECTION

Whenever a wheel cylinder is disassembled, always inspect the cylinder bore for scoring, pitting and corrosion (Figure 7). A hard, crystal-like substance sometimes forms a ring in the cylinder bore near where the piston stops when the brakes are released.

Crocus cloth or an approved cylinder hone may be used to remove light roughness or deposits from the bore. Hone lightly and use brake fluid as a lubricant while...
honings. If the bore does not clean up readily, the cylinder must be replaced.

NOTE: Some wheel cylinders have a baffle between the piston and bores (Figure 8). These cylinders cannot be honed and should be replaced if the bore is pitted or corroded.

After using crocus cloth or a hone, flush the inside of the cylinder with clean alcohol or brake fluid and then wipe dry with a lintless cloth. Be sure that all dust and grit are removed and that the bleeder screw and brake tube passages are clean and open.

The clearance between the cylinder bore wall and the pistons must be checked after the cylinder is cleaned up. If a narrow (1/8" to 1/4" wide) .006" feeler gauge can be inserted between the bore wall and a new piston, the clearance is excessive, and the wheel cylinder must be replaced.

NOTE: If the clearance between the pistons and the bore wall exceeds .005", a condition known as heel drag may exist (Figure 9). This causes rapid cup wear and may cause the pistons to retract very slowly when the brakes are released.

ASSEMBLY TIPS

Always use a wheel cylinder repair kit to rebuild a wheel cylinder.

Dip the pistons and cups in clean brake fluid. Also coat the cylinder bore with clean brake fluid.

CAUTION: Do not handle hydraulic system parts with greasy hands or permit parts to come in contact with oil or grease. Just a trace of grease or oil in the hydraulic system may cause damage to the rubber parts.
WHEEL CYLINDERS

1. To prevent breakage of steel tubing, it is necessary to use ____________ to carry brake fluid to each wheel cylinder.

2. The wheel cylinder is used to ____________

3. The wheel cylinder consists of ____________

4. The wheel cylinder has a small fitting, called a ____________, which allows the removal of air from the system.

5. The wheel cylinders are usually bolted to the ____________

6. When the master cylinder forces fluid into the wheel cylinders, the two pistons move apart. This action forces the ____________ against the revolving ____________.

7. Brake bleeding (define)_

8. Caution! Kerosene, gasoline, etc., should never enter a hydraulic brake system. They can swell and destroy the ____________ in the system.

In Fig. 20-4, identify the brake line parts. Identify the wheel cylinder parts in Fig. 20-5.
WHEEL CYLINDERS, page 143:

1. Flexible rubber hose.
2. Transmit master cylinder pressure to the brake shoes and force them outward against the drum.
3. A cast iron housing, two aluminum pistons, two rubber cups, coil spring, two push rods, and two dust boots.
5. Brake backing plate.
7. It is a procedure of forcing brake fluid through the system until any trapped air is removed.
8. Rubber cups.

A. Mounting bracket.  J. Bleeder screw.
B. Retaining clip.  K. Cup.
C. Steel brake line.  L. Piston.
D. Rubber grommet.  M. Boot.
E. Retaining cup.  N. Spring.
F. Front caliper assembly.  O. Cylinder housing and tube seat assembly.
G. Flexible hose.  
H. Piston.  P. Boot.
I. Cup.
Hydraulic System Diagnosis and Repair.

1. Diagnose poor stopping or dragging caused by problems in the master cylinder; determine needed repairs. (HP)

2. Diagnose poor stopping, dragging, high/low pedal, or hard pedal caused by problems in a step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs. (HP)

3. Measure and adjust pedal pushrod length. (HP)

4. Check master cylinder for internal and external leaks and proper operation; determine needed repairs. (HP)

5. Remove, bench bleed, and replace master cylinder. (HP)

6. Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs.

7. Inspect brake lines and fittings for leaks, dents, rust, kinks, cracks, or wear; tighten loose fittings and supports. (HP)

8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; tighten loose fittings and supports. (HP)

9. Replace brake lines (double flare and ISO types), hoses, fittings, and supports. (HP)

10. Select, handle, store and install brake fluids (including silicone fluids). (HP)

11. Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve (s). (HP)

12. Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (HP)

13. Inspect, test, and replace, and adjust load or height sensing-type proportioning valve (s).
Hydraulic System Diagnosis and Repair (continued).

14. Inspect, test, and replace brake warning light system switch and wiring. (HP)

15. Reset brake pressure differential valve (if necessary). (HP)

16. Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system. (HP)

17. Check and adjust master cylinder fluid levels. (HP)

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST
Automotive Brake Hydraulics

Standard 2: The student will demonstrate wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).

STUDENT PERFORMING TASKS: ____________________________________________
DATE TASKS COMPLETED: ____________________________________________
INSTRUCTOR SIGNATURE: ____________________________________________

71
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor.
Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R and rebuilding of actual disc brake calipers.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with Info sheets #7, &8.
5. Students will be provided with a student performance task list for "Hydraulic System Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Hydraulics to verify the students ability to perform the demonstrated manipulative skills.
INFORMATION SHEET #7

HYDRAULICS

Caliper Disassembled - Ford Floating Caliper Disc Brake

Caliper Disassembled - Chrysler Floating Caliper Disc Brake

Caliper Disassembled - Gmea-Morsa Floating Caliper Disc Brake
1. Diagnose poor stopping or dragging caused by problems in the master cylinder; determine needed repairs. (HP)

2. Diagnose poor stopping, dragging, high/low pedal, or hard pedal caused by problems in a step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs. (HP)

3. Measure and adjust pedal pushrod length. (HP)

4. Check master cylinder for internal and external leaks and proper operation; determine needed repairs. (HP)

5. Remove, bench bleed, and replace master cylinder. (HP)

6. Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs. (HP)

7. Inspect brake lines and fittings for leaks, dents, rust, kinks, cracks, or wear; tighten loose fittings and supports. (HP)

8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; Tighten loose fittings and supports. (HP)

9. Replace brake lines (double flare and ISO types), hoses, fittings, and supports. (HP)

10. Select, handle, store and install brake fluids (including silicone fluids). (HP)

11. Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve(s). (HP)

12. Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (HP)

13. Inspect, test, and replace, and adjust load or height sensing-type proportioning valve(s).
Hydraulic System Diagnosis and Repair (continued).

14. Inspect, test, and replace brake warning light system switch and wiring. (HP)

15. Reset brake pressure differential valve (if necessary). (HP)

16. Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system. (HP)

17. Check and adjust master cylinder fluid levels. (HP)

(HP)—NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Hydraulics

Standard 2: The student will demonstrate wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
LESSON PLAN 5
UNIT TWO

HYDRAULICS

STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor.

Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R and rebuilding of actual brake master cylinders.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with Info sheets #9,10&11.
5. Students will complete the assignment on page 142 of the Auto Mechanics Fundamentals workbook.
6. Students will be provided with a student performance task list for "Hydraulic System Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Hydraulics to verify the students ability to perform the demonstrated manipulative skills.
INFORMATION SHEET #9
HYDRAULICS

MASTER CYLINDER

FLOW THROUGH BLEEDER HOLES

BREATHER PORT

PISTON / PRIMARY CUP

CHECK VALVE SEATED

COMPENSATING PORT

PRESSURE CHAMBER

CHECK VALVE
MASTER CYLINDER OPERATION

- Boot
- Bleeder
- Body piston
- Expander
- Cup
- Static pressure 8 to 16 PSI
- Compensating port
- Breather port (secondary piston breather port not shown)
- Reservoir
- Stop plate
- Primary piston
- Primary cup
- Pressure chamber
- Secondary piston
- Primary cup
- Pressure chamber
- Spring
- Check valve
- Brake drum
- Wheel cylinder
- Cups
- Shoe and lining

GOODHEART-WILCOX CO. INC
MASTER CYLINDER OPERATION

FLOW THROUGH CHECK VALVE

SECONDARY PISTON

COMPENSATING PORT

PRIMARY PISTON

PISTON

SECONDARY CUP

PRIMARY CUP

SPRING

PRESSURE CHAMBER

CHECK VALVE

BRAKE DRUM

LINING

CUP

PISTON

AUTO MECHANICS FUNDAMENTALS
GOODHEART WILCOX CO. INC

INFORMATION SHEET #11
HYDRAULICS
As you read the textbook, complete the following statements.

### MASTER CYLINDER

1. The master cylinder reservoir should be filled to ____________________________
   ____________________________

2. For many years, one real danger in the brake system was the fact that a line rupture, blown wheel cylinder, etc., could cause a sudden and ____________________________

3. To improve brake system safety and prevent complete failure, the ____________________________ was developed and is now in universal use in this country.

4. Two other names for a dual master cylinder are ____________________________

5. The quick take-up master cylinder is designed to supply a large ____________________________ during initial brake application. This action is needed to supply enough fluid for modern, no-drag brake assemblies.

6. To operate a warning light when there is low pressure in one section of the brake system, a ____________________________ can be used.

7. The master cylinder is connected to the wheel cylinders by high quality, double thickness ____________________________

8. Brake tubing, where connections are made, uses a ____________________________ type flare.

Identification the following master cylinder parts. Use your text as needed.

### DUAL MASTER CYLINDER—EXPLODED VIEW

|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|

Fig. 20-3
MASTER CYLINDER, DUAL MASTER CYLINDER-EXPLODED VIEW,

page 142:

1. Within 1/2 to 1/4 in. (12.7 to 6.35 mm) of the top of the reservoir, depending upon manufacturer's recommendations.

2. Complete loss of braking.

3. Dual master cylinder.

4. Tandem or double-piston master cylinder.

5. Volume of brake fluid.

6. Pressure differential warning switch.

7. Steel tubing.

8. Double lap.

A. Nylon cover cap.  J. Secondary piston.

B. Cover seal.  K. Primary cup.


D. Seat (2).  M. Anodized master cylinder body of aluminum.

E. Seal retainer.  N. Piston retainer pin.

F. Check flow washer.  O. Body to reservoir grommet.

G. Primary piston assembly.  P. Secondary cup.

H. Piston retainer snap ring.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Hydraulic System Diagnosis and Repair.

1. Diagnose poor stopping or dragging caused by problems in the master cylinder; determine needed repairs. (HP)

2. Diagnose poor stopping, dragging, high/low pedal, or hard pedal caused by problems in a step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs. (HP)

3. Measure and adjust pedal pushrod length. (HP)

4. Check master cylinder for internal and external leaks and proper operation; determine needed repairs. (HP)

5. Remove, bench bleed, and replace master cylinder. (HP)

6. Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs. (HP)

7. Inspect brake lines and fittings for leaks, dents, rust, kinks, cracks, or wear; tighten loose fittings and supports. (HP)

8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; tighten loose fittings and supports. (HP)

9. Replace brake lines (double flare and ISO types), hoses, fittings, and supports. (HP)

10. Select, handle, store and install brake fluids (including silicone fluids). (HP)

11. Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve (s). (HP)

12. Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (HP)

13. Inspect, test, and replace, and adjust load or height sensing-type proportioning valve (s).
Hydraulic System Diagnosis and Repair (continued).

14. Inspect, test, and replace brake warning light system switch and wiring. (HP)

15. Reset brake pressure differential valve (if necessary). (HP)

16. Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system. (HP)

17. Check and adjust master cylinder fluid levels. (HP)

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Hydraulics

Standard 2: The student will demonstrate wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor.
Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R proportioning, metering valve (combination), assembly and checking and service of brake fluid.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with Info sheets # 12, 13, 14 & 15.
5. Students will be provided with a student performance task list for "Hydraulic System Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Hydraulics to verify the students ability to perform the demonstrated manipulative skills.
METERING VALVES

INTRODUCTION

Some automobiles equipped with front wheel disc brakes and rear wheel drum brakes have a metering valve installed in the hydraulic line to the disc brakes. Typical valves are shown in Figures 1, 2 and 3.

METERING VALVE FUNCTION

The basic function of a metering valve is to improve braking balance, particularly during light brake applications. The valve does this by preventing application of the front disc brakes until 75 to 135 PSI has built up in the hydraulic system.

This hydraulic pressure overcomes the tension of the shoe return springs on the rear drum brakes. Thus, the rear brake shoes move outward to contact the drums at the same time that the pads in the front disc brakes contact the rotor.

SERVICING METERING VALVES

The metering valve should be inspected whenever the brakes are serviced. If there is fluid leakage inside the boot on the end of the valve, the valve is defective and should be replaced.

NOTE: A slight amount of moisture inside the boot does not indicate a defective valve.

Metering valves are non-adjustable and non-repairable. If a valve is defective, it should be replaced as an assembly.

When a metering valve is replaced, be sure to mount the new valve in the same position as the old valve.

BLEEDING THE HYDRAULIC SYSTEM

If a pressure bleeder ball is used to bleed a hydraulic system that includes a metering valve, the valve stem (inside the boot on some valves) must either be pushed in or pulled out, depending on the type of valve.
Valves

If the valve is similar to those shown in Figures 1 and 2, the valve stem must be held (pushed) in the depressed position. Do not apply excessive pressure as this may damage the valve. Tape may be used to hold the stem down, but be sure to remove the tape after bleeding is completed.

If the valve has a knob on the end of the stem as shown in Figure 3, the stem must be held (pulled) in the outward position. Several companies offer tools to accomplish this.

If the brakes are bled manually using the pedal, the pressures developed are sufficient to overcome the metering valve, and the stem need not be pushed in or pulled out.

PROPORTIONING VALVES

INTRODUCTION

A proportioning valve also is used on some cars equipped with front disc brakes and rear drum brakes. This valve is installed in the line to the rear drum brakes. A typical valve is shown in Figure 4.

SERVICING PROPORTIONING VALVES

The proportioning valve should be inspected whenever the brakes are serviced. If the valve is leaking, it is defective and should be replaced.

Proportioning valves are non-adjustable and non-repairable. If a valve is defective, it should be replaced as an assembly.

Combination Valves

INTRODUCTION

Starting with 1970 models, some cars equipped with front disc brakes and rear drum brakes have a combination valve in the hydraulic system.

Combination valves are described as three-function valves or two-function valves depending upon the number of functions they perform in the hydraulic system.

THREE-FUNCTION VALVES

The functions performed by the three-function valve are...

1. Metering Valve,
2. Proportioning Valve, and
3. Brake Warning Light Switch.

Typical three-function valves are shown in Figures 5 and 6.

TWO-FUNCTION VALVES

There are two variations of the two function combina-
INFORMATION SHEET #14

HYDRAULICS

Valves

BRAKE WARNING LIGHT SWITCH

Figure 6. Three-Function Combination Valve

BRAKE WARNING LIGHT SWITCH

Figure 7. Two-Function Valve (Proportioning-Brake Warning Light)

BRAKE WARNING LIGHT SWITCH

Figure 8. Two-Function Valve (Proportioning-Brake Warning Light)

BRAKE WARNING LIGHT SWITCH

Figure 9. Two-Function Valve (Metering-Brake Warning Light)

Servicing combination valves

The combination valve should be inspected whenever the brakes are serviced. If there is leakage inside the boot or if there is leakage around the large nut on the proportioning end, the valve is defective and should be replaced.

Note: A slight amount of moisture inside the boot or a slight dampness around the large nut does not indicate a defective valve.

Combination valves are non-adjustable and non-repairable. If a valve is defective, it should be replaced as an assembly.

The appearance of some two-function (metering-warning light) combination valves is similar to the valve shown in Figure 5. The difference is in the internal components of the valve.

Servicing combination valves

The combination valve should be inspected whenever the brakes are serviced. If there is leakage inside the boot or if there is leakage around the large nut on the proportioning end, the valve is defective and should be replaced.

Note: A slight amount of moisture inside the boot or a slight dampness around the large nut does not indicate a defective valve.

Combination valves are non-adjustable and non-repairable. If a valve is defective, it should be replaced as an assembly.

The other variation, shown in Figure 9, performs the metering valve and brake warning light switch functions.
Brake Fluid

DESCRIPTION
Brake fluid is one of the more important components of the hydraulic brake system because it ties all of the other components of the system together into an integral operating unit.

Hydraulic brake fluid is a specially blended liquid that provides a means of transmitting hydraulic pressure from the master cylinder to the wheel cylinders and calipers.

Federal laws require that brake fluid must meet SAE (Society of Automotive Engineers) specifications, and only brake fluid that meets these specifications should be used.

Brake fluid must possess the following characteristics:

1. Viscosity (free flowing at all temperatures).
2. High boiling point (remain liquid at highest operating temperatures).
3. Non-corrosive (must not attack metal or rubber parts).
4. Water tolerance (must be able to absorb and retain moisture that collects in the system).
5. Lubricating ability (must lubricate pistons and cups to reduce wear and internal friction).
6. Low freezing point (must not freeze even at lowest operating temperatures).

CHANGING BRAKE FLUID DUE TO USAGE

As a result of use, brake fluid loses some of its original qualities and may become contaminated. When performing major brake work, it is good practice to flush the hydraulic system to remove old fluid and replace it with clean brake fluid.

If any of the hydraulic system parts are corroded or the fluid is discolored, the hydraulic system also should be flushed to remove old fluid, and then filled with clean brake fluid.

DUE TO CONTAMINATION

Soft or swollen rubber parts in the hydraulic system are an indication that the brake fluid is contaminated. If this happens . . .

. . The old fluid should be drained from the system.
. . All cups and seals should be replaced.
. . The hydraulic system should be flushed with clean brake fluid or alcohol.
. . The system should be refilled with clean brake fluid.

HANDLING AND STORING BRAKE FLUID

The following basic rules should be applied when handling and storing brake fluid.

1. Keep the brake fluid clean. Do not get any foreign material in the fluid.
2. Be very careful to keep any petroleum product (gasoline, kerosene, oil, grease, etc.) from getting into the brake fluid.
3. Use only clean containers for dispensing brake fluid. Do not use containers contaminated with dirt, oil, grease, rust, etc.
4. Always cover or cap brake fluid containers when not actually dispensing the fluid. If containers are left open or uncovered, the fluid tends to absorb moisture from the air.
5. Discard old brake fluid drained from the hydraulic system. Used brake fluid is contaminated to some degree.
6. Store brake fluid containers in a clean, dry place.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

**Hydraulic System Diagnosis and Repair.**

1. Diagnose poor stopping or dragging caused by problems in the master cylinder; determine needed repairs. (HP)

2. Diagnose poor stopping, dragging, high/low pedal, or hard pedal caused by problems in a step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs. (HP)

3. Measure and adjust pedal pushrod length. (HP)

4. Check master cylinder for internal and external leaks and proper operation; determine needed repairs. (HP)

5. Remove, bench bleed, and replace master cylinder. (HP)

6. Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs. (HP)

7. Inspect brake lines and fittings for leaks, dents, rust, kinks, cracks, or wear; tighten loose fittings and supports. (HP)

8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; tighten loose fittings and supports. (HP)

9. Replace brake lines (double flare and ISO types), hoses, fittings, and supports. (HP)

10. Select, handle, store and install brake fluids (including silicone fluids). (HP)

11. Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve(s). (HP)

12. Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (HP)

13. Inspect, test, and replace, and adjust load or height sensing-type proportioning valve(s).
Hydraulic System Diagnosis and Repair (continued).

14. Inspect, test, and replace brake warning light system switch and wiring. (HP)

15. Reset brake pressure differential valve (if necessary). (HP)

16. Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system. (HP)

17. Check and adjust master cylinder fluid levels. (HP)

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Hydraulics

Standard 2: The student will demonstrate wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).

STUDENT PERFORMING TASKS: _______________________________________

DATE TASKS COMPLETED: _______________________________________

INSTRUCTOR SIGNATURE: _______________________________________

94
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor.
Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for testing and R&R of brake anti-lock components.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Hydraulic System Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Hydraulics to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Hydraulic System Diagnosis and Repair.

1. Diagnose poor stopping or dragging caused by problems in the master cylinder; determine needed repairs. (HP)

2. Diagnose poor stopping, dragging, high/low pedal, or hard pedal caused by problems in a step bore master cylinder and internal valves (e.g. volume control devices, quick take-up valve, fast-fill valve, pressure regulating valve); determine needed repairs. (HP)

3. Measure and adjust pedal pushrod length. (HP)

4. Check master cylinder for internal and external leaks and proper operation; determine needed repairs. (HP)

5. Remove, bench bleed, and replace master cylinder. (HP)

6. Diagnose poor stopping, pulling, or dragging caused by problems in the brake fluid, lines, and hoses; determine needed repairs. (HP)

7. Inspect brake lines and fittings for leaks, dents, rust, kinks, cracks, or wear; tighten loose fittings and supports. (HP)

8. Inspect flexible brake hoses for leaks, kinks, cracks, bulging, or wear; tighten loose fittings and supports. (HP)

9. Replace brake lines (double flare and ISO types), hoses, fittings, and supports. (HP)

10. Select, handle, store and install brake fluids (including silicone fluids). (HP)

11. Diagnose poor stopping, pulling, or dragging caused by problems in the hydraulic system valve(s). (HP)

12. Inspect, test, and replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (HP)

13. Inspect, test, and replace, and adjust load or height sensing-type proportioning valve(s).
Hydraulic System Diagnosis and Repair (continued).

14. Inspect, test, and replace brake warning light system switch and wiring. (HP)

15. Reset brake pressure differential valve (if necessary). (HP)

16. Bleed (manual, pressure, vacuum, or surge) and/or flush hydraulic system. (HP)

17. Check and adjust master cylinder fluid levels. (HP)

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Hydraulics

Standard 2: The student will demonstrate wheel cylinder and master cylinder operation. The student will recognize the need for brake control devices and proper brake fluid maintenance.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R wheel cylinders.
2. Rebuild wheel cylinders.
3. R&R caliper assemblies.
4. Rebuild caliper assemblies.
5. R&R master cylinder.
6. Rebuild master cylinder.
7. R&R proportioning, metering valve (combination) assembly.
8. Test brake anti-lock system.
9. R&R brake anti-lock components.
10. Check and service fluid level (core).

STUDENT PERFORMING TASKS: _______________________________________

DATE TASKS COMPLETED: _______________________________________

INSTRUCTOR SIGNATURE: _______________________________________

98
UNIT THREE

AUTOMOTIVE BRAKE SYSTEM SERVICE

UNIT 3 GOAL:

The student will be able to repair and service different types of brake designs and systems, both drum and disc, in conformance with industrial standards.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. R&R brake shoes.
2. R&R self adjusters and springs.
3. R&R disc brake pads.
STUDENT PERFORMANCE OBJECTIVE:

Given a filmstrip presentation relative to the automotive brake system. The student will demonstrate knowledge of procedures for performing automotive brake brake repairs and service within industry standards.

LEARNING ACTIVITIES:

1. Students will view two filmstrips from Bergwall Productions Inc. entitled "How to Reline Drum Type Brakes" and "Servicing the Hydraulic System, Drum Type."

2. Students will be given a quiz that directly relates to the filmstrips.

3. Instructor will lecture to reinforce information covered by the filmstrips.

EVALUATION:

Students will demonstrate comprehension of automotive brake service and repair procedures by scoring a minimum of 90% on the quiz.
HOW TO RELINE DRUM TYPE AUTOMOTIVE BRAKES

Filmstrip 404.3 Quiz.

Directions: Circle the letter that best answers the question.

1. The best way to tell if the brakes should be relined is:
   a. To test the brakes on a steep hill.
   b. To test the brakes during high speed stops.
   c. To make a visual inspection of the lining.
   d. To test the brakes on a gravel road.

2. When preparing for a brake job, wheel lugs should be loosened,
   a. Before the vehicle is jacked up.
   b. After the vehicle is placed on horses.
   c. While the vehicle is on the jack.
   d. None of the above.

3. What does the letter "L" stamped on a wheel lug signify?
   a. It is a code, used to determine metal thickness of the wheel lug.
   b. It means that the threads on the wheel lugs are left handed.
   c. It is a code used by the car manufacturer to classify the type of thread being used.
   d. None of the above.

4. How can you avoid damaging the hub caps while doing a brake job?
   a. Put them on the front seat.
   b. Put them in the trunk.
   c. Put them on the work bench.
   d. Any one of the above.

5. Which of the following should be examined during the course of a brake job to avoid ruining your brake work?
   a. Check all hydraulic brake lines for leakage.
   b. Check the rear axle for signs of leakage.
   c. Check the rear of the master cylinder for signs of leakage.
   d. All of the above.
6. What is a good trade practice concerning service to wheel cylinders during a brake reline job?
   a. Rebuild or renew them with every brake job.
   b. Do not service them unless they are leaking.
   c. Do not service them, a slight leak can always be repaired at a later date.
   d. Rebuilding wheel cylinders is a waste of time: persuade the car owner not to do it.

7. The first thing to remove when disassembling a set of brake shoes is:
   a. The hold down springs.
   b. The retracting springs.
   c. The wheel cylinders.
   d. The wheel adjustment screw.

8. The inner front wheel bearing and seal is removed by the use of a hammer and:
   a. A sharp chisel.  c. A wide blunt drift punch.

9. How could you tell if a brake drum were not mounted on a drum lathe properly?
   a. It would wobble while it spins around.
   b. The rate of turning speed of the lathe will be reduced.
   c. The rate of turning speed of the lathe will be increased.
   d. None of the above.

10. Which part of the brake drum should receive the first cut from the drum lathe?
    a. The inside of the drum face.
    b. The middle of the drum face.
    c. The outer ridge of the drum face.
    d. Any of the above.

11. During a drum refacing job, why must the cutter be set as far into the drum face as possible?
    a. To assure full shoe to drum contact.
    b. To prevent full shoe to drum contact.
    c. To allow room for dust to accumulate.
    d. None of the above.
12. What is the limit a drum can be cut, over the original standard size?
   a. .010 of an inch.
   b. .030 of an inch.
   c. .060 of an inch.
   d. .120 of an inch.

13. A drum has been cut way beyond the allowable limits, what are the possible consequences?
   a. Poor heat dissipation.
   b. Glazed brake lining.
   c. Brake fade in hot weather.
   d. All of the above.

14. A drum has been refaced. What is to be considered in the selection of the replacement brake lining?
   a. It must be of standard thickness.
   b. It should be oversize.
   c. It must be wider than the original.
   d. It should be narrower than the original.

15. In operation, the brake shoes rub on the backing plate. What type of lubricant should be put on these friction points?
   a. Engine oil.
   b. Chassis grease.
   c. Heat resistant grease.
   d. Any of the above.

16. Where is the equalizer bar located, on the drum type brake?
   a. On the secondary shoe of the front brakes.
   b. On the primary shoe of the front brakes.
   c. Between the primary and secondary shoes of the rear brakes.
   d. It is part of the hand brake lever.

17. A brake clearance guage is used to:
   a. Measure the diameter of the wheel cylinder.
   b. Measure the width of the brake drum face.
   c. Make a brake adjustment on drum type brakes.
   d. All of the above.
18. Which one (or more) of the following are a must if a first class brake job is expected?
   a. Front wheel bearings should be packed with fresh grease.
   b. A new front wheel seal must be installed.
   c. A new cotter pin of the correct size must be installed.
   d. All of the above.

19. The term "pre-load" is a trade term which means:
   a. A bearing has too much clearance.
   b. To tighten a bearing.
   c. To loosen a bearing.
   d. None of the above.

20. At the completion of a brake reline job, you road test the vehicle. Which of the following conditions are you checking for?
   a. Pedal is firm and high.
   b. Vehicle does not pull to one side on brake applications.
   c. No noises on brake applications.
   d. All of the above.
SERVICING THE AUTOMOTIVE BRAKE HYDRAULIC SYSTEM (DRUM-TYPE)

Filmstrip 404.4 Quiz.

Directions: Circle the letter that best answers the question.

1. How often should you service the master cylinder of the hydraulic brake system?
   a. At least every 10,000 miles.
   b. At least every 20,000 miles.
   c. At least every 50,000 miles.
   d. Every 100,000 miles.

2. When should you service wheel cylinders?
   a. Only when they leak fluid.
   b. Only when they have frozen pistons.
   c. During every brake relining job.
   d. Only when you service the master cylinder.

3. What could cause a wheel cylinder to leak?
   a. Dirt under the piston seal.
   b. Pits in the cylinder bore.
   c. A worn piston seal.
   d. All of the above.

4. Resurfacing the inside of a wheel cylinder is done best with:
   a. A piece of sandpaper.
   b. A piece of emery cloth.
   c. Abrasive honing stones.
   d. Any of the above.

5. Why is a replacement master cylinder bled before it is installed on the vehicle?
   a. Because it can be done by one person at the work bench.
   b. Because there is less chance for brake fluid loss.
   c. To prevent air from entering the rest of the system.
   d. None of the above.

6. Which of the following should be used to wash hydraulic brake parts?
   a. Denatured alcohol.
   b. Gasoline.
   c. Kerosene.
   d. Diesel fuel.
7. What is the best way to tell if the breather and compensating ports of the master cylinder are clean?
   a. By putting a small piece of wire through them.
   b. Hold a light at the compression chamber, Look through the reservoir.
   c. Fill up the reservoir, see if fluid runs out of the hole.
   d. None of the above.

8. The very first step in the reassembling process of a master cylinder is to:
   a. Lay out the parts on a clean rag.
   b. Install the check valve.
   c. Install the dust boot.
   d. Clean your hands.

9. Service or replacement of the master cylinder must always include:
   a. A brake relining job.
   b. Replacing all wheel cylinders.
   c. An adjustment of the pedal free play of the master cylinder.
   d. All of the above.

10. Which of the following are important steps in the replacement of brake fluid lines?
    a. Steel lines must be replaced by steel lines.
    b. Avoid sharp kinks.
    c. Secure the line to the chassis.
    d. All of the above.

11. Why are flexible brake lines used in the hydraulic brake system?
    a. They are cheaper than solid lines.
    b. They do not rust.
    c. To allow for fluid to be delivered to units that vibrate during operation on the road.
    d. They are easier to service.

12. Where would a hydraulic line junction block be located?
    a. In the brake drum.
    b. On the top of the rear axle housing.
    c. Under the lower control arm of the front end.
    d. Any one of the above.
13. If one of the front flexible brake lines were partially clogged, what would happen?
   a. The vehicle would pull to one side during brake application.
   b. Both front brakes would not work correctly.
   c. The brakes would become air bound.
   d. It would cause a low brake pedal.

14. What kind of seal is located between the end of the flexible line and the front wheel cylinder?
   a. A rubber gasket.
   b. A fiber washer.
   c. An "O" ring seal.
   d. A copper washer.

15. Which of the following are important safety steps during brake service.
   a. The use of heavy duty brake fluid.
   b. Avoid installing a front brake tube so it rubs on the chassis.
   c. Secure all steel brake lines to avoid a leak due to chaffing.
   d. All of the above.

16. Using the manual bleeding method, which wheel cylinder is the first to be bled.
   a. The left rear.
   b. The right rear.
   c. The left front.
   d. The right front.

17. What happens if your assistant releases the brake pedal before you close the bleeder screw?
   a. Air will be sucked into the hydraulic system.
   b. A surge of brake fluid will be forced out of the bleeder screw.
   c. Air will be forced out of the bleeder screw.
   d. None of the above.
Filmstrip 404.4 Quiz (continued).

18. Manual brake bleeding requires that brake fluid be added to the master cylinder reservoir,
   a. At the beginning of the brake bleeding job.
   b. During the bleeding operation.
   c. At the end of the brake bleeding job.
   d. All of the above.

19. What is pressure brake bleeding?
   a. A system of brake bleeding using extra foot pressure to bleed the system.
   b. A way of bleeding brakes with a pressurized bleeder tank.
   c. A way of measuring the brake fluid while it's being bled from the hydraulic system.
   d. None of the above.

20. When bleeding disc brakes, what must be done to the combination valve?
   a. It must be removed.
   b. The pin on the end of the combination valve must be locked closed.
   c. The pin on the end of the combination valve must be held open.
   d. It must be reserved during the bleeding operations.
# AUTOMOTIVE BRAKES FILMSTRIP 3&4 QUIZ ANSWER KEY

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STUDENT PERFORMANCE OBJECTIVE:

Given assignment sheets from the student automotive workbook. Students will perform the workbook assignments.

LEARNING ACTIVITIES:

1. Students will complete assignments on pages 144 and 145 of the Auto Mechanics Fundamentals workbook.
2. Students will be provided with Info sheet # 16.

EVALUATION:

Students will perform the workbook assignments with a minimum competency of 90%.
Complete the statements and define the terms.

**WHEEL BRAKE PARTS**

1. Each wheel brake assembly consists of a

2. Most wheel brake assemblies use two brake shoes made of ____________ with brake __________ either riveted or glued to the outer surface.

3. Brake return or __________ are used to pull the shoes together when hydraulic pressure is released.

4. Primary shoe (define)

5. Secondary shoe (define)

6. Brake lining is made of __________

7. Brake fade (define)

Identify the parts of this backing plate and shoe assembly.

**BACKING PLATE AND SHOE ASSEMBLY**

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AUTOMOTIVE BRAKES CHAPTER 20 WORKBOOK ASSIGNMENT ANSWER KEY

WHEEL BRAKE PARTS, BACKING PLATE, AND SHOE ASSEMBLY,

page 144:

1. A brake backing plate, a set of brake shoes with clips, return springs, and the brake drum.

2. Stamped steel, linings.

3. Retracting springs.

4. It is the forward shoe that faces the front of the car. It often has a different lining than the other shoe.

5. It is the trailing brake shoe facing the rear of the car.

6. Asbestos impregnated with special fibers to bind the asbestos.

7. It is caused by overheating of the brake lining which results in a loss of its frictional property.

A. Wheel cylinder body.   J. Automatic adjuster cable.
B. Boot.       K. Cable guide.
C. Piston.     L. Adjuster lever return spring.
D. Cup.        M. Automatic adjuster lever.
E. Bleed Screw. N. Secondary shoe.
F. Shoes links. O. Adjusting nut.
G. Shoe holddown pin. P. Pivot screw.
H. Adjusting hole cover. Q. Parking brake lever.
I. Backing plate. R. Anchor bolt.
WHEEL BRAKE PARTS, BACKING PLATE, AND SHOE ASSEMBLY,

page 144 (continued).

S. Anti-rattle spring.

T. Lower shoe-to-shoe spring.

U. Shoe hold-down spring.

V. Upper shoe-to-shoe spring.

W. Primary shoe.
While reading the textbook, complete the statements and definitions.

Identify the following parts using your textbook illustrations. Study each part closely.

---

**1.** Brake shoes that are jammed against the brake drum with a wedging action are called ___________ type brakes.

**2.** The primary shoe on self-energizing brakes generally has a ___________ amount of lining and is of a different ___________ or material.

**3.** The secondary shoe does more of the ___________; less lining is needed on the primary shoe.

**4.** The brakes are adjusted by means of a ___________ at the bottom of the assembly. Usually a special tool is used to reach through and turn the wheel from the back side of the backing plate.

**5.** Self-adjusting brakes (define) ___________.

**6.** The three types of self-adjusting brake systems include ___________.

**7.** An adjusting lever is attached to one of the brake shoes. One end engages the teeth of the ___________ while the other is attached to the ___________ or ___________. When the car is backed up and the brakes are applied, the brakes adjust automatically by a ratcheting action of the lever and wheel.

---
BRAKE SHOE ACTION AND ADJUSTMENT, page 145:

1. Servo or self-energizing.
2. Smaller, composition.
4. Star wheel.
5. Utilize a device that automatically adjusts the drum to lining clearance as the linings wear.
6. The cable, link, and lever types.
7. Star wheel, link, cable.

A. Drum rotation.
B. Anchor pin.
C. Applying force.
D. Primary.
E. Secondary.
F. Adjusting screw.
G. Car moving forward.
H. Star wheel.
I. Lever.
J. Screwdriver.
K. Brake adjusting tool.
L. Backing plate.
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor.
Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R of brake shoes, self adjusters and springs.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Brake Drum Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake System Service to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Drum Brake Diagnosis and Repair.

1. Diagnose poor stopping, pulling, or dragging caused by problems in the drum brake wheel assembly; determine needed repairs. (HP)

2. Diagnose poor stopping, noise, pulling, grabbing, dragging, or pedal pulsation caused by problems in the drum brake mechanical assembly; determine needed repairs. (HP)

3. Remove, clean, inspect, and measure brake drums. (HP)

4. Mount brake drum on lathe and machine. (HP)

5. Remove, clean, and inspect brake shoes/linings, springs, pins, clips, levers, adjusters/self-adjusters, and other related brake hardware; determine needed repairs. (HP)

6. Clean and remove loose dirt, rust, or scale on brake backing (support) plates using proper safety procedures; inspect; R&R if necessary. (HP)

7. Remove and reinstall wheel cylinders.

8. Disassemble and clean wheel cylinder assembly; inspect parts for wear, rust, scoring, and damage; hone cylinder (if necessary and recommended by manufacturer); replace all cups, boots, and any damaged or worn parts.

9. Lubricate brake shoe support pads on backing (support) plate, adjuster/self adjuster mechanisms, and other brake hardware. (HP)

10. Determine correct brake shoe application. (HP)

11. Install brake shoes and related hardware. (HP)

12. Adjust brake shoes and reinstall brake drums or drum/hub assemblies and wheel bearings. (HP)

13. Reinstall wheel, torque lug nuts, and make final checks and adjustments. (HP)

(HP)—NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake System Service

Standard 3: The student will repair different brake designs, both drum and disc, in conformance with industrial standards.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R brake shoes. _____
2. R&R self adjusters and springs. _____
3. R&R disc brake pads. _____

STUDENT PERFORMING TASKS: ________________________________

DATE TASKS COMPLETED: ________________________________

INSTRUCTOR SIGNATURE: ________________________________
STUDENT PERFORMANCE OBJECTIVE:

Given a filmstrip presentation relative to the automotive brake system. The student will demonstrate knowledge of procedures for performing automotive brake repairs and service within industry standards.

LEARNING ACTIVITIES:

1. Students will view two filmstrips from Bergwall Productions Inc. entitled "How to Reline Disc Type Brakes" and "Servicing the Hydraulic System, Disc Type."

2. Students will be given a quiz that directly relates to the filmstrips.

3. Instructor will lecture to reinforce information covered by the filmstrips.

EVALUATION:

Students will demonstrate comprehension of automotive brake service and repair procedures by scoring a minimum of 90% on the quiz.
HOW TO RELINE DISK TYPE AUTOMOTIVE BRAKES

Filmstrip 404.5 Quiz.

Directions: Circle the letter that best answers the question.

1. The unit that controls the hydraulic pressure to the friction pads on disc brakes is called:
   a. A wheel cylinder.
   b. A caliper.
   c. A master cylinder.
   d. A combination valve.

2. In operation, friction pads stop the wheels from turning by rubbing against:
   a. A brake drum.
   b. A scrub plate.
   c. A spinning disc called a rotor.
   d. A turning hub.

3. What is the first unit to be removed when replacing pads on a disc brake?
   a. The brake drum.
   b. The caliper.
   c. The brake disc.
   d. The brake plate.

4. Automobile tradesmen also refer to the brake discs as:
   a. Rotors.
   b. Spinners
   c. Metal wheels.
   d. Drums.

5. The first step in removing a disc brake caliper is to:
   a. Bleed the brakes.
   b. Remove the rotor.
   c. Remove the inner and outer front wheel bearings.
   d. Remove some brake fluid from the master cylinder.

6. Which of the following is used to force a piston back into the caliper's bore, on a front disc brake?
   a. A "C" clamp.
   b. A pair of vise grip pliers.
   c. A large punch and steel hammer.
   d. A plastic tip hammer.
7. What is the best way to keep the caliper out of the way while replacing brake pads on disc brakes?

a. Lay it on the upper control arm.
b. Fasten it to the frame with a drop light wire.
c. Use an "S" hook, hang it on the upper control arm.
d. Any of the above.

8. A rotor is being inspected for possible defects. What are the things that you would check for?

a. Cracks.
b. Scores and glazed surfaces.
c. Run out and distortions.
d. All of the above.

9. A rotor on a disc brake is lightly scored. How can it be repaired?

a. By resurfacing it on a lathe.
b. By installing new faces on top of the scored surfaces.
c. By filling in the score marks with liquid steel.
d. None of the above.

10. A rotor on a disc brake is badly scored. What should be done with it?

a. Resurface it on the lathe.
b. It should be replaced with a new one.
c. Sand the two rubbing surfaces with emery cloth.
d. Fill in the score marks with fiberglass.

11. What holds the brake pads in position on disc brakes?

a. Expansion springs.
b. Spring clips.
c. Hold down springs.
d. All of the above.

12. During an inspection of the disc brakes, the brake pads show signs of a glazed condition. What should be done?

a. Sand the brake pads with rough sand paper.
b. Nothing; if the brake thickness is within allowable limits.
c. Replace the pads.
d. Replace the pads, resurface the rotors.
Filmstrip 404.5 Quiz (continued).

13. What is the first step in preparing a disc brake rotor for resurfacing?
   a. Fasten it to the lathe.
   b. Check it with a drum micrometer.
   c. Remove the inner and outer bearings, and grease seal.
   d. Any of the above

14. When surfacing rotors on disc brakes, both sides of the discs are:
   a. Cut; but one at a time.
   b. Cut at the same time.
   c. Not always cut; only the side that shows signs of grooves.
   d. None of the above.

15. Why does a mechanic check the rotor with a dial indicator?
   a. To see if the rotor has any runout.
   b. To see if all the score marks are out.
   c. To see if it is glazed.
   d. All of the above.

16. Disc brake rotors should always be renewed:
   a. With one of greater thickness.
   b. With one of less thickness.
   c. In pairs.
   d. On every disc brake job.

17. Besides the usual visual inspections, how else can a front grease seal be checked?
   a. By pinching it with a pair of pliers on the sealing surface.
   b. By pressing on the sealing surface with a screwdriver.
   c. By putting it over the spindle by hand.
   d. All of the above.
Filmstrip 404.5 Quiz (continued).

18. Listed below is a step by step procedure of the last few steps in replacing a disc brake pad. Which is correct?

a. Repack the wheel bearings; install grease seal; slide the disc on the spindle; adjust the wheel bearings.
b. Adjust the wheel bearings; slide the disc over the spindle; repack the front wheel bearings.
c. Slide the disc over the spindle; adjust front wheel bearings; repack front wheel bearings.
d. None of the above.

19. The last thing to be done on a disc brake job, before replacing the wheel, is to:

a. Install a new front wheel bearing seal.
b. Replace the front hub dust shield.
c. Remove all dirt and grease marks.
d. Remove all dirt and grease marks on both surfaces of the brake discs.

20. What is the correct way to restore the brake pedal height on a disc brake after repacking front wheel bearings?

a. Pump the brake pedal several times.
b. Fill up the master cylinder until the pedal is high.
c. Fill up the master cylinder and pump the brake pedal, fill up the master cylinder.
d. None of the above.
SERVICING THE AUTOMOTIVE BRAKE HYDRAULIC SYSTEM DISC TYPE

Filmstrip 404.6 Quiz.

Directions: Circle the answer that best answers the question.

1. The caliper is to disc type brakes, what the wheel cylinder is to:
   a. The brake plate.
   b. The master cylinder.
   c. The drum type brake.
   d. None of the above.

2. A dust boot on the caliper should be replaced, if it is:
   a. Cut.
   b. Cracked.
   c. Dried out.
   d. All of the above.

3. It is a good trade practice to rebuild disc brake calipers,
   a. Only if they are leaking brake fluid.
   b. Each time the brake pads are replaced.
   c. Each time the front wheel bearings are repacked.
   d. All of the above.

4. How much brake fluid should be removed from the master cylinder during a caliper removal operation?
   a. All of it.
   b. About two thirds.
   c. Four fifths.
   d. None of it.

5. What is the "C" clamp used for during a caliper removal job?
   a. To force the piston back into the bore of the caliper.
   b. To free the caliper from it's mounting place.
   c. To bleed air from the caliper.
   d. To remove the brake pads holding down the spring.

6. In operation, where is the disc brake caliper supported?
   a. On the upper control arm of the front end.
   b. On the lower control arm of the front end.
   c. On the steering knuckle support arm.
   d. None of the above.
7. How is the piston removed from its bore in the caliper housing?
   a. By hitting the caliper housing with a hammer.
   b. By blowing "light" air pressure into the cylinder bore of the caliper.
   c. By using light mouth pressure.
   d. All of the above.

8. What is the best way to "clean-up" a cylinder bore during a caliper overhaul?
   a. By sanding it with emery cloth.
   b. By honing it light abrasive stones.
   c. By washing it with gasoline.
   d. By rubbing it with engine oil.

9. How much tolerance is allowed between the piston and its bore in the caliper housing?
   a. .002.
   b. .008.
   c. .015.
   d. .025.

10. The following is a list of ways to install a piston down into its bore of the caliper. Which is the correct way?
    a. Tap it down lightly with a steel ballpeen hammer.
    b. Tap it down lightly with a rubber mallet.
    c. Tap it down with a plastic driver and a soft mallet.
    d. Hit it down with a soft piece of wood and a steel hammer.

11. What should you do if the clearance between a piston and its bore exceeded the allowable limits on a disc brake caliper?
    a. Replace the piston with a larger one.
    b. Install oversize seals.
    c. Install a sleeve in the bore to make up the difference.
    d. Replace it with a new caliper.
12. Which is the correct procedure for the installation of a new caliper?
   a. Fasten caliper to support arm, bleed brakes, and connect flex brake line to steel line.
   b. Fasten caliper to support arm, connect flex brake line to steel line, and bleed brakes.
   c. Bleed brakes, connect flex brake line to steel line, fasten caliper to support arm.
   d. Any of the above.

13. One of the following is a recommended method of bleeding disc brakes. Which one is it?
    a. Pressure bleeding.
    c. Combination, manual, and pressure bleeding.
    d. None of the above.

14. How much air pressure is required to operate a hydraulic brake pressure bleeder?
    a. 10 pounds.
    b. 30 pounds.
    c. 60 pounds.
    d. 90 pounds.

15. What is the trade practice for servicing the combination valve on disc brakes?
    a. Replace it with a rebuilt one, if faulty.
    b. Rebuild it with new parts, if faulty.
    c. Renew it, if faulty.
    d. All of the above.

16. The brake warning light on the dash board suddenly goes on. What is wrong?
    a. There is a hydraulic pressure drop in the rear brake circuit.
    b. There is a hydraulic pressure drop in the front brake circuit.
    c. There is a hydraulic pressure drop in the front and rear brake circuit.
    d. All of the above.
17. A vehicle equipped with disc brakes in the front and drum in the rear, requires more hydraulic pressure at the rear brakes. Why?
   a. Because of the action of the retracting springs.
   b. Because drum brakes are more efficient.
   c. Because more is required of a set of rear brakes than of the front brakes.
   d. All of the above.

18. The metering function of the combination valve provides the braking system with:
   a. Less hydraulic pressure at low speeds.
   b. More hydraulic pressure at high speeds.
   c. Balanced braking.
   d. None of the above.

19. Which part of the disc brake system helps prevent premature rear wheel slide?
   a. The brake discs.
   b. The master cylinder.
   c. The combination valve.
   d. The calipers.

20. The combination valve features a by-pass. What is its function?
   a. It's another chamber for extra brake fluid storage.
   b. It's a by-pass connection for use on recreational vehicles.
   c. Its function is to operate the stop light switch.
   d. None of the above.
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STUDENT PERFORMANCE OBJECTIVE:

Given an assignment sheet from the student automotive workbook. Students will perform the workbook assignment.

LEARNING ACTIVITIES:

1. Students will complete the assignment on page 146 of the Auto Mechanics Fundamentals workbook.
2. Students will be provided with Info sheet #17.

EVALUATION:

Students will perform the workbook assignment with a minimum competency of 90%.
As you read the textbook, complete the statements and define the terms on disc brakes.

Identify the following parts using the illustrations in your textbook. Study each part carefully.

DISC BRAKES

1. During braking, there is a transfer of weight to the _______ of the car. This forces the _______ more tightly against the road and reduces downward pressure on the _______.

2. To compensate for this shifting of weight during braking, the front brakes are usually designed to _______.

3. An average braking ratio would be _______.

4. Disc brake (define) _______.

5. The brake caliper is bolted to the _______ and contains the hydraulic _______.

6. When hydraulic pressure is built up behind the caliper pistons, the brake friction _______ will be forced against the _______ to stop the car.

7. The emergency brake uses a foot pedal or dash mounted handle which pulls on _______ or _______ that go to both _______.

8. Brake lights are operated by _______.

---

STUDENT WORKSHEET PAGE 146

BRAKE SYSTEM SERVICE
DISC BRAKES, page 146:

1. Front, front tires, rear tires.
2. Produce more stopping action than the rear.
3. Front brakes -.55 to 60 percent. Rear brakes - 40 to 45 percent of stopping force.
4. They use a caliper wheel cylinder to clamp and slow or stop the rotation of a disc fastened to the wheel.

5. Spindle, piston.
6. Pads, disc.
7. Linkage, cables, rear brake assemblies.
8. A hydraulic or mechanical switch actuated by the brake pedal.

A. Brake lining pad.  L. Piston.
B. Braking disc.  M. Piston spring.
C. Outer caliper housing.  N. Friction lining or pad.
D. Hub.  O. Dust boot.
E. Bearing.  P. bleeder screw.
F. Nut lock.  Q. Brake lining.
G. Cotter pin.  R. Brake shoe.
H. Ventilating louvers.  S. Outer caliper half.
I. Splash shield.  T. Ventilated disc or rotor.
J. Brake fluid tube (inlet).  U. Seal ring.
K. Piston seal.  V. Inner caliper half.

132
DISC BRAKES

PISTON SEAL
CALIPER HALF
LINING
PISTON
FRICION
PAD PLATE
DUST BOOT
DISC
(ROTOR)

CALIPER
PADS
PISTON
HYDRAULIC SEAL
DUST
BOOT
ROTOR

VENTILATED DISC OR ROTOR

BRAKE PLATE
(SHOE) AND
LINING ASSEMBLY

BRAKE PLATE AND
LINING (PAD)
ASSEMBLY

BRAKE PAD
(LINING) WEAR
INDICATOR

SLIDING CALIPER

FIXED CALIPER
STUDENT PERFORMANCE OBJECTIVE:

Given a demonstration lecture by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R of disc brake pads.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Disc Brake Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake System Service to verify the students ability to perform the demonstrated manipulative skills.
Disc Brake Diagnosis and Repair

1. Diagnose poor stopping, pulling, or dragging caused by problems in the disc brake caliper assembly; determine needed repairs. (HP)

2. Diagnose poor stopping, noise, pulling, grabbing, dragging, or pedal pulsation caused by problems in the disc brake mechanical assembly; determine needed repairs. (HP)

3. Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing. (HP)

4. Clean and inspect caliper mountings and slides for wear and damage. (HP)

5. Remove, clean, and inspect pads and retaining hardware; determine needed repairs, adjustments, and replacements. (HP)

6. Remove, disassemble and clean caliper assembly; inspect parts for wear, rust, scoring, and damage; replace all seals, boots, and any damaged or worn parts.

7. Reassemble caliper; reinstall.

8. Clean, inspect, and measure rotor with a dial indicator and a micrometer. (HP)

9. Remove rotor, mount on lathe, and machine. (HP)

10. Determine correct brake pad application. (HP)

11. Install pads, calipers, and related attaching hardware. (HP)

12. Adjust calipers with integrated parking brakes.

13. Fill master cylinder with recommended fluid to proper level and seat pads by depressing pedal; inspect caliper for leaks. (HP)

14. Reinstall wheel, torque lug nuts, and make final checks and adjustments. (HP)

(HP) - NATEF Recommended High Priority Tasks.

135
INSTRUCTOR CHECKLIST

Automotive Brake System Service

Standard 3: The student will repair different brake designs, both drum and disc, in conformance with industrial standards.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R brake shoes. ______
2. R&R self adjusters and springs. ______
3. R&R disc brake pads. ______

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
UNIT FOUR

AUTOMOTIVE POWER BRAKES

UNIT 4 GOAL:

The student will be able to diagnose problems with power brakes and will make repairs consistent with industrial standards.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. R&R hydraulic power brake unit.
2. Service power brake unit.
3. R&R hydro-brake booster unit.
4. Service hydro-brake booster unit.
STUDENT PERFORMANCE OBJECTIVE:

Given the assignment sheet from the student automotive workbook. Students will perform the workbook assignment.

LEARNING ACTIVITIES:

1. Students will complete the assignment on page 147 of the Auto Mechanics Fundamentals workbook.

2. Students will be provided with Info sheets # 18, 19, and 20.

EVALUATION:

Students will perform the workbook assignment with a minimum competency of 90%.
■ While reading the textbook, complete the following statements. Write the missing words into the blanks.

1. Power brakes are designed to reduce the amount of __________ necessary to stop the car.

2. Another feature of power brakes is that __________

3. Usually, the power brake unit is built to take advantage of the __________ produced by the car's __________

4. A brake booster is a __________ with a __________ inside.

5. One side of the power brake or booster is connected to the __________ piston and the other side is connected to the __________

6. The power brake has three stages of operation __________

7. In the event the booster or vacuum fails, the brakes may still be applied by __________

8. The anti-skid brake system permits __________
POWER BRAKES, page 147:

1. Pedal pressure.
2. Pedal travel can be shortened.
4. Closed cylinder, piston.
5. Master cylinder, brake pedal.
6. Brakes released, applied brakes, and holding constant apply pressure.
7. Foot pressure alone.
8. Rapid straight line stops by preventing rear wheel lockup.

A. Vacuum inlet.  K. Master cylinder.
B. Brake line.  L. Vacuum check valve.
C. Master cylinder.  M. Diaphragm.
D. Push rod.  N. Dust boot.
E. Vacuum.  O. Valve operating rod.
F. Booster cylinder.  P. Diaphragm.
G. Piston.  Q. Front shell.
H. Brake pedal.  R. Cylinder-to-shell seal.
I. Atmospheric pressure.  S. Hydraulic push rod.
J. Linkage.  T. Adjusting screw.
VACUUM BRAKE BOOSTER
VACUUM BRAKE BOOSTER OPERATION

- Plate and valve body floating control valve
- Atmospheric pressure
- Valve rod and plunger
- Air valve return spring
- Vacuum
- Atmospheric

- Diaphragm
- Vacuum check valve
- Engine manifold
- Control vacuum chamber (full vacuum)
- Poppet valve
- Plunger
- Poppet valve return spring
- Vacuum port (closed)
- Atmospheric port (open)
- Valve operating rod
- Valve rod & plunger return spring
- Constant vacuum chamber (full vacuum)

Auto Mechanics Fundamentals
Goodheart-Willcox Co., Inc.
HYDRAULIC BRAKE BOOSTER

SPOOL

PLUG

SPOOL

POWER PISTON

LEVER

INPUT ROD END

INPUT ROD

SEALS

SPOOL MOVED FORWARD

HYDRAULIC PRESSURE BUILDS IN THIS SPACE

POWER PISTON

PISTON, PUSH ROD, AND END MOVED FORWARD
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor.

Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R and service of hydraulic power brake units.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Power Assist Units Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Power Brakes to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Power Assist Units Diagnosis and Repair.

1. Test pedal free travel with and without engine running to check power booster operation. (HP)

2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster with a vacuum gauge. (HP)

3. Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; repair or replace parts as necessary. (HP)

4. Inspect and test hydro-boost system and accumulator for leaks and proper operation; repair and replace parts as necessary.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Power Brakes

Standard 4: The student will diagnose problems with power brakes and will make repairs consistent with industrial standards.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R hydraulic power brake unit.
2. Service power brake unit.
3. R&R hydro-brake power brake unit.
4. Service hydro-brake booster unit.

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lectures by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R and service of hydro-brake booster units.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Power Assist Units Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Power Brakes to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Power Assist Units Diagnosis and Repair.

1. Test pedal free travel with and without engine running to check power booster operation. (HP)

2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster with a vacuum gauge. (HP)

3. Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; repair or replace parts as necessary. (HP)

4. Inspect and test hydro-boost system and accumulator for leaks and proper operation; repair and replace parts as necessary.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Power Brakes

Standard 4: The student will diagnose problems with power brakes and will make repairs consistent with industrial standards.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. R&R hydraulic power brake unit.
2. Service power brake unit.
3. R&R hydro-brake power brake unit.
4. Service hydro-brake booster unit.

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
UNIT FIVE

AUTOMOTIVE BRAKE PROBLEMS AND DIAGNOSIS

UNIT 5 GOAL:

The student will be able to recognize, diagnose, and effectively repair identified brake system problems consistent with industrial standards.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. Cam (arc) grind brake shoes.
2. Recondition brake backing plate.
3. R&R brake drum.
4. R&R disc brake rotor.
5. Bleed hydraulic brake system.
6. Torque wheel lug nuts.
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for cam grinding brake shoes and reconditioning brake backing plate assemblies.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Miscellaneous Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Problems and Diagnosis to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Miscellaneous (wheel bearing, parking brakes, electrical, etc.) Diagnosis and Repair.

1. Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs. (HP)

2. Remove, clean, inspect, repack, or replace and pack wheel bearings, replace seals and adjust wheel bearings. (HP)

3. Check parking brake system; inspect cables and parts for wear, rusting, binding and corrosion; clean or replace parts as necessary; lubricate assembly. (HP)

4. Adjust parking brake assembly; check operation. (HP)

5. Test parking brake indicator light, switch, and wiring. (HP)

6. Test, adjust, repair or replace brake stop light switch and wiring.

7. Check operation of anti-skid braking systems; adjust or repair according to manufacturers' recommendations.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Problems and Diagnosis

Standard 5: The student will recognize, diagnose, and effectively repair identified brake system problems.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Cam (arc) grind brake shoes. ______
2. Recondition brake backing plate. ______
3. R&R brake drum. ______
4. R&R disc brake rotor. ______
5. Bleed hydraulic brake system. ______
6. Torque wheel lug nuts. ______

STUDENT PERFORMING TASKS: __________________________

DATE TASKS COMPLETED: __________________________

INSTRUCTOR SIGNATURE: __________________________
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor.
Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for R&R of brake drums and disc brake rotors.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Miscellaneous Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Problems and Diagnosis to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Miscellaneous (wheel bearing, parking brakes, electrical, etc.) Diagnosis and Repair.

1. Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs. (HP)

2. Remove, clean, inspect, repack, or replace and pack wheel bearings, replace seals and adjust wheel bearings. (HP)

3. Check parking brake system; inspect cables and parts for wear, rusting, binding and corrosion; clean or replace parts as necessary; lubricate assembly. (HP)

4. Adjust parking brake assembly; check operation. (HP)

5. Test parking brake indicator light, switch, and wiring. (HP)

6. Test, adjust, repair or replace brake stop light switch and wiring.

7. Check operation of anti-skid braking systems; adjust or repair according to manufacturers' recommendations.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Problems and Diagnosis

Standard 5: The student will recognize, diagnose, and effectively repair identified brake system problems.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Cam (arc) grind brake shoes.
2. Recondition brake backing plate.
3. R&R brake drum.
4. R&R disc brake rotor.
5. Bleed hydraulic brake system.
6. Torque wheel lug nuts.

STUDENT PERFORMING TASKS: __________________________

DATE TASKS COMPLETED: __________________________

INSTRUCTOR SIGNATURE: __________________________
LESSON PLAN 3

AUTOMOTIVE BRAKE PROBLEMS AND DIAGNOSIS

STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor. Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for bleeding the hydraulic brake system and torqueing of wheel lug nuts.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Miscellaneous Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Problems and Diagnosis to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Miscellaneous (wheel bearing, parking brakes, electrical, etc.) Diagnosis and Repair.

1. Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs. (HP)

2. Remove, clean, inspect, repack, or replace and pack wheel bearings, replace seals and adjust wheel bearings. (HP)

3. Check parking brake system; inspect cables and parts for wear, rusting, binding and corrosion; clean or replace parts as necessary; lubricate assembly. (HP)

4. Adjust parking brake assembly; check operation. (HP)

5. Test parking brake indicator light, switch, and wiring. (HP)

6. Test, adjust, repair or replace brake stop light switch and wiring.

7. Check operation of anti-skid braking systems; adjust or repair according to manufacturers' recommendations.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Problems and Diagnosis

Standard 5: The student will recognize, diagnose, and effectively repair identified brake system problems.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Cam (arc) grind brake shoes.
2. Recondition brake backing plate.
3. R&R brake drum.
4. R&R disc brake rotor.
5. Bleed hydraulic brake system.
6. Torque wheel lug nuts.

STUDENT PERFORMING TASKS: ____________________________

DATE TASKS COMPLETED: ____________________________

INSTRUCTOR SIGNATURE: ____________________________
STUDENT PERFORMANCE OBJECTIVE:

Given a three part quiz by the Instructor. Students will give correct responses to the questions in writing.

LEARNING ACTIVITIES:

1. Students will complete the three part automobile brakes quiz from the Auto Mechanics Fundamentals workbook.

EVALUATION:

Students will demonstrate comprehension of automotive brake systems by scoring a minimum of 90% on the quiz.
Quiz 1
Identify the following brake system parts. Select your answers from the list. Carefully print the correct letter in each illustration blank.

1. 
2. 
3. A. Brake shoe 
4. B. Brake disc 
5. C. Brake drum 
6. D. Emergency brake 
7. E. Emergency brake cable 
8. F. Brake line 
9. 
10. 

A. Brake shoe 
B. Brake disc 
C. Brake drum 
D. Emergency brake 
E. Emergency brake cable 
F. Brake line 
G. Master cylinder 
H. Power booster 
I. Brake caliper 
J. Wheel cylinder 
K. Wheel lug 
L. Backing plate
AUTOMOBILE BRAKES QUIZ

**Quiz 2**

- Complete the statements. Neatly print the correct letter in each statement blank. Select the best answer from the list.

1. Motion and pressure are transmitted from the brake pedal to the wheels by a confined ______.
2. When the wheel cylinder is pushed out, the brake shoes engage the revolving ______ to stop the car.
3. A hydraulic ______ is commonly used to operate a brake warning light.
4. A cast iron housing, two aluminum pistons, two rubber cups, a coil spring, two push rods, and two boots make up a ______ assembly.
5. The brake shoes and wheel cylinders are usually bolted to the brake ______.
6. Air is removed from the brake system by forcing it out one of the ______.
7. The brake shoes are pulled away from the drum by brake ______.
8. When brake linings are overheated, they can lose some of their frictional properties. This is termed ______.
9. Brakes are usually adjusted by turning a ______ affixed to the bottom of the brake shoes.
10. Linkage and steel cables are used to operate the ______.

(A. Star wheel  B. Bleeder screws  C. Brake fluid  D. Pressure switch)

(E. Brake drum  F. Brake drag  G. Backing plate  H. Retracting springs)

(I. Brake fade  J. Emergency brake  K. Wheel cylinder  L. Brake rotor)

**Quiz 3**

- Match the statements and the terms. Neatly print the appropriate letter in each blank. Note! Read one statement; then, read through all of the terms until the correct response is found.

1. Improves safety by helping to prevent complete brake failure, has two independent systems.
   - A. Primary shoe
   - B. Single master cylinder
   - C. Wheel cylinder
   - D. Servo valve
   - E. Disc brakes
   - F. Rubber cups
   - G. Caliper
   - H. Secondary shoe
   - I. Dual master cylinder
   - J. Brake booster
   - K. Brake balancer
   - L. Brake lining

2. Commonly made of asbestos and special fibers, can be bonded or riveted to shoe.

3. Faces front of car and usually has a slightly smaller lining.

4. Produces hydraulic pressure for brake system on early model cars.

5. Uses brake pads and a rotor rather than brake shoes and brake drum.

6. Contains a large hydraulic piston that pushes against brake pads.

7. Utilizes engine vacuum for operation.

8. Located in wheel cylinder, prevents brake fluid leakage past pistons.

9. Applies hydraulic pressure to piston, bolts to backing plate.

10. Trailing brake shoe that faces rear of car, usually has a slightly larger lining.
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UNIT SIX

AUTOMOTIVE BRAKE SERVICE STANDARDS

UNIT 6 GOAL:

The student will demonstrate knowledge of why drums and rotors cannot be machined beyond maximum size. The student will recognize why front drums and rotors must be machined to approximately the same size consistent with industry standards.

STUDENT PERFORMANCE OBJECTIVES:

At the conclusion of this unit of instruction, the student will be able to perform the following tasks with a minimum competency of 95%. It is expected that students will perform all tasks in a safe manner.

1. Reface brake drum.
2. Measure brake drum for proper tolerance.
3. Reface disc brake rotor.
4. Test disc brake rotor parallelism.
5. Test disc brake rotor run-out.
6. Measure disc brake rotor for proper tolerance.
STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor.

Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.
2. Instructor will demonstrate proper procedures for re-facing brake drums and measuring for tolerances.
3. Students will perform the manipulative tasks as demonstrated by the Instructor.
4. Students will be provided with a student performance task list for "Miscellaneous Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor checklist for Automotive Brake Service Standards to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Miscellaneous (wheel bearing, parking brakes, electrical, etc.) Diagnosis and Repair.

1. Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs. (HP)

2. Remove, clean, inspect, repack, or replace and pack wheel bearings, replace seals and adjust wheel bearings. (HP)

3. Check parking brake system; inspect cables and parts for wear, rusting, binding and corrosion; clean or replace parts as necessary; lubricate assembly. (HP)

4. Adjust parking brake assembly; check operation. (HP)

5. Test parking brake indicator light, switch, and wiring. (HP)

6. Test, adjust, repair or replace brake stop light switch and wiring.

7. Check operation of anti-skid braking systems; adjust or repair according to manufacturers' recommendations.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Service Standards

Standard 6: The student will recognize why drums and rotors cannot be turned beyond maximum size. The student will recognize why front drums and rotors must be turned to approximately the same size.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Reface brake drum. __________
2. Measure brake drum for proper tolerance. __________
3. Reface disc brake rotor. __________
4. Test disc brake rotor parallelism. __________
5. Test disc brake rotor run-out. __________
6. Measure disc brake rotor for proper tolerance. __________

STUDENT PERFORMING TASKS: ____________________________________________

DATE TASKS COMPLETED: ________________________________________________

INSTRUCTOR SIGNATURE: ________________________________________________
LESSON PLAN 2

UNIT SIX

AUTOMOTIVE BRAKE SERVICE STANDARDS

STUDENT PERFORMANCE OBJECTIVE:

Given demonstration lecture by the Instructor.

Students will perform the manipulative tasks as demonstrated.

LEARNING ACTIVITIES:

1. Instructor will demonstrate to the students by using mock-up components from actual vehicles.

2. Instructor will demonstrate proper procedures for refacing disc brake rotors, testing rotor run-out and parallelism and measuring for rotor tolerances.

3. Students will perform the manipulative tasks as demonstrated by the Instructor.

4. Students will be provided with a student performance task list for "Miscellaneous Diagnosis and Repair" areas of importance.

EVALUATION:

Instructor will use the Instructor Checklist for Automotive Brake Service Standards to verify the students ability to perform the demonstrated manipulative skills.
NATEF BRAKE SPECIALIST STUDENT PERFORMANCE TASK LIST

Miscellaneous (wheel bearing, parking brakes, electrical, etc.) Diagnosis and Repair.

1. Diagnose wheel bearing noises, wheel shimmy and vibration problems; determine needed repairs. (HP)

2. Remove, clean, inspect, repack, or replace and pack wheel bearings, replace seals and adjust wheel bearings. (HP)

3. Check parking brake system; inspect cables and parts for wear, rusting, binding and corrosion; clean or replace parts as necessary; lubricate assembly. (HP)

4. Adjust parking brake assembly; check operation. (HP)

5. Test parking brake indicator light, switch, and wiring. (HP)

6. Test, adjust, repair or replace brake stop light switch and wiring.

7. Check operation of anti-skid braking systems; adjust or repair according to manufacturers' recommendations.

(HP)-NATEF Recommended High Priority Tasks.
INSTRUCTOR CHECKLIST

Automotive Brake Service Standards

Standard 6: The student will recognize why drums and rotors cannot be turned beyond maximum size. The student will recognize why front drums and rotors must be turned to approximately the same size.

Student will demonstrate to the instructor comprehension of the above competencies by performing the manipulative tasks listed below. The instructor will check off each task as they are successfully accomplished by the student.

1. Reface brake drum.
2. Measure brake drum for proper tolerance.
3. Reface disc brake rotor.
4. Test disc brake rotor parallelism.
5. Test disc brake rotor run-out.
6. Measure disc brake rotor for proper tolerance.

STUDENT PERFORMING TASKS: ________________________________________

DATE TASKS COMPLETED: ________________________________________

INSTRUCTOR SIGNATURE: ________________________________________
STUDENT PERFORMANCE OBJECTIVE:

Given a written final exam by the Instructor. Students will correctly respond to the questions in writing.

LEARNING ACTIVITIES:

1. Students will complete the 45 question final exam for automotive brakes.

EVALUATION:

Students will demonstrate comprehension of automotive brake systems by scoring a minimum of 90% on the final exam.
AUTOMOTIVE BRAKES FINAL EXAM

Directions: Circle the answer that best answers the question.

1. When turning a scored brake drum, the maximum oversize limit for most cars would be:
   a. .060 inch.
   b. .030 inch.
   c. .090 inch.
   d. .110 inch.

2. The most common type of disc brake caliper found on American cars is the:
   a. Single piston sliding.
   b. Two piston fixed.
   c. Two piston sliding.
   d. Four piston fixed.

3. To check rotor parallelism you use a:
   a. Straight edge.
   b. Micrometer.
   c. Dial indicator.
   d. Special service tool.

4. A vehicle is equipped with power disc brakes. The owner says that in order to stop the car excessive brake pedal effort is required.

   Mechanic A says that a master cylinder or power brake malfunction could be the reason.

   Mechanic B says that air in the hydraulic system is probably the cause.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.

5. Swollen cups in the master cylinder would indicate:
   a. Solvent contamination.
   b. Denatured alcohol contamination.
   c. Water contamination.
   d. Both A and C.
6. Drum brake fade could be caused by:
   a. Improper toe-heel clearance.
   b. Bell-mouthed drums.
   c. Heavily glazed lining.
   d. All of the above.

7. The owner of a vehicle with front disc brakes states that the brake pedal pulsates rapidly when he applies the brakes. Which of the following can cause this condition?
   a. A wheel bearing not properly adjusted.
   b. Uneven rotor thickness.
   c. Excessive rotor t.l.r.
   d. All of the above.

8. Dot approved heavy duty brake fluid must have a minimum boiling point of:
   a. 250 degrees of farenheit.
   b. 375 degrees of farenheit.
   c. 550 degrees of farenheit.
   d. 725 degrees of farenheit.

9. In the two-shoe, single-anchor Bendix brake, which of the following is generally true?
   a. The secondary lining is longer than the primary.
   b. The primary and secondary lining are the same color.
   c. Two wheel cylinders are used.
   d. None of the above.

10. The outer bearing race (cup) is spinning (turning) in the front hub. The customer should be sold:
    a. A new cup and bearing.
    b. A new cup only.
    c. A new hub only.
    d. A new cup, bearing, and hub.

11. The drum brake design in wide use today is the:
    a. Duo-servo, fixed anchor.
    b. Uni-servo, fixed anchor.
    c. Non-servo, adjustable anchor
    d. Self-energizing, self-centering, dual anchor.

173
12. When you apply the brakes hard, a car has a pull which is accompanied by a light vibration. Which of the following could cause this condition?
   a. Collapsing strut rod insulators.
   b. Incorrect tire pressure.
   c. Leaky wheel cylinder.
   d. All of the above.

13. When checking disc brake rotor lateral run-out:
   a. Remove the caliper from the steering knuckle.
   b. Use a pair of calipers.
   c. Use a micrometer.
   d. Readjust wheel bearings when through.

14. When holding your foot on the brake, the pedal drops slightly when the engine is started.

   Mechanic A says that this a sign of a faulty power brake booster.

   Mechanic B says that this is normal on a car with power assisted dual master cylinder.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Either A or B.
   d. Neither A nor B.

15. The rubber strap wrapped around the brake drum during turning on the lathe is to:

   a. Cool the drum.
   b. Shield the operator from flying chips.
   c. Prevent drum expansion.
   d. Reduce chatter.

16. The master cylinder maintains residual pressure on a drum brake system in order to:

   a. Keep wheel cylinder cups sealed against the cylinder bores.
   b. Prevent air from entering the system.
   c. Both A and B.
   d. Neither A nor B.
17. Disc brakes normally use no residual pressure check valve because:
   a. Disc brakes use a metering valve.
   b. Residual pressure would cause dragging of brakes.
   c. Residual pressure would delay front brake application.
   d. Disc brakes use a proportioning valve.

18. Prior to replacing disc brake pads, remove some of the brake fluid from the master cylinder reservoir that feeds the disc brakes. This will:
   a. Make bleeding easier.
   b. Prevent fluid overflow when the pistons are pushed back into the calipers.
   c. Allow pressure to the front and rear axles to equalize.
   d. Prevent the brake warning light from coming on.

19. The owner of an American passenger car complains of a pull to the right when stepping on the brakes. 

   Mechanic A says the trouble could be caused by the master cylinder (dual type).

   Mechanic B says the trouble could be a faulty metering or proportioning valve.

   Who is right?
   a. Mechanic A only.
   b. Mechanic B only.
   c. Both A and B.
   d. Neither A nor B.

20. The disc brake reservoir portion of a dual master cylinder is low on fluid.

   Mechanic A says the disc brake pads may be worn.

   Mechanic B says the power brake booster may be faulty.

   Who is right?
   a. A only.
   b. B only.
   c. Both A and B.
   d. Neither A nor B.
Automotive Brake Final (continued).

21. A firm, steady pressure on the brake pedal results in the pedal slowly sinking to the floor. No external fluid leaks can be detected. What is the most likely cause?

   a. Leaking secondary cup.
   b. Defective residual check valve.
   c. Plugged inlet port.
   d. Leaking primary cup.

22. When a brake drum has been turned 0.050" over OEM size, and the brake shoes are standard, which of the following would apply?

   a. The shoes will contact the drum at the ends only.
   b. The shoes will fit the drum properly.
   c. The shoes will contact the drum at the center only.
   d. The shoes should be arc ground only on the ends.

23. When bleeding the brakes, you would normally start with the wheel cylinder or caliper:

   a. Closest to the master cylinder.
   b. Farthest from the master cylinder.
   c. On the same side as the master cylinder.
   d. On the right front side.

24. When using a pressure tank for bleeding drum type brakes, which of the following pressures would you use?

   a. 2 to 8 psi.
   b. 15 to 30 psi.
   c. 40 to 65 psi.
   d. 60 to 80 psi.

25. On drum type brakes, which of the following would cause a rising pedal on successive brake applications?

   a. Insufficient pedal free travel.
   b. Master cylinder piston not returning to its stop.
   c. Both A and B.
   d. Neither A nor B.
Automotive Brake Final (continued).

26. Most combination brake systems use a proportioning valve. Its purpose is to:
   a. Act as a safety valve with the dual type master cylinder.
   b. Reduce pressure at the front brakes.
   c. Reduce pressure at the rear brakes.
   d. Act as a cut-off valve in the event of front or rear system failure.

27. On a slick road condition, what prevents the front disc brakes from locking up at light pedal pressure before the drum brakes develop sufficient stopping force?
   a. Proportioning valve.
   b. By-pass valve.
   c. Residual valve.
   d. Metering valve.

28. When replacing a hydraulic brake line, which of the following is correct procedure?
   a. Use seamless copper tubing with single flared ends.
   b. Cut out bad section, install steel tubing using a union.
   c. Use single length double flared steel or copper tubing.
   d. None of the above.

29. All the brakes drag on a vehicle equipped with hydraulic brakes.

   Mechanic A says that this could be caused by a lack of pedal free travel.

   Mechanic B says that this could be caused by a bad power booster check valve.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.

177
Automotive Brake Final (continued).

30. Which of these should a mechanic use to clean the wheel cylinder bore after honing?
   a. Hot water and soap.
   b. Denatured alcohol.
   c. Cleaning solvent.
   d. An oil saturated rag.

31. The brake pedal is spongy on a car with a disc/drum system. This could be caused by:
   a. Air in the system.
   b. A missing master cylinder cover diaphragm.
   c. Both A and B.
   d. Neither A nor B.

32. An automobile has single piston floating-caliper disc brakes. The R/F pad between the caliper piston and the rotor is badly worn. The other R/F pad shows barely any wear.

   Mechanic A says that too much rotor runout could be the cause.

   Mechanic B says that a stuck caliper piston could be the cause.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.

33. A hydraulic brake system pedal consistently goes to the floor.

   Mechanic A says that this could be caused by the brakes out of adjustment.

   Mechanic B says that this could be caused by too long a master cylinder push rod.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.
Automotive Brake Final (continued).

34. Any of these could cause a parking brake not to hold, EXCEPT:
   a. Rear brakes out of adjustment.
   b. Cables out of adjustment.
   c. Worn linkage.
   d. Leak in brake system.

35. A car is equipped with a disc/drum system. The rear wheels skid prematurely under hard brake application. Which of these is the MOST LIKELY cause?
   a. Plugged compensating port.
   b. Defective proportioning valve.
   c. Defective booster unit.
   d. Trapped air in the hydraulic system.

36. A vehicle is equipped with front and rear drum brakes. The driver complains of a clicking noise upon brake application.

   Mechanic A says that this could be caused by grooved backing plate ledges.

   Mechanic B says that this could be caused by a loose anchor pin.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.

37. A power brake equipped vehicle is losing an excessive amount of fluid. There is no sign of external leakage. What would be the first thing to do?
   a. Remove the check valve and measure vacuum.
   b. Remove the booster vacuum hose and check inside.
   c. Check the compensating port clearance.
   d. Check the brake pedal free travel.
38. The rear brakes grab (lock-up) on a vehicle with hydraulic brakes. Which of these could be the cause?
   a. Grease on the linings.
   b. Out-of-round drums.
   c. Binding parking brake cable.
   d. All of the above.

39. Which of these can cause the brake warning light to come on?
   a. Shorted light circuit.
   b. Worn master cylinder.
   c. Leak in a brake line.
   d. All of the above.

40. A car is losing fluid from the master cylinder. There is brake fluid on the firewall.
    Mechanic A says that this could be caused by a defective secondary cup on the primary piston.
    Mechanic B says that this could be caused by a defective primary cup on the secondary piston.
    Who is right?
    a. Mechanic A.
    b. Mechanic B.
    c. Both A and B.
    d. Neither A nor B.

41. Mechanic A says that vibration should be dampened when machining a rotor.
    Mechanic B says that a rotor should be "swirl" finished.
    Who is right?
    a. Mechanic A.
    b. Mechanic B.
    c. Both A and B.
    d. Neither A nor B.
Automotive Brake Final (continued).

42. A set of good brake linings become soaked with rear axle lubricant. Which of these is the correct procedure in this situation?

   a. Wash the linings in solvent and reuse.
   b. Dry the lining with an oxy-acetylene torch and reuse.
   c. Either a or b.
   d. Neither a nor b.

43. A rotor has excessive thickness variation (parallelism). This would MOST LIKELY cause:

   a. A low brake pedal.
   b. A nervous (pulsating) brake pedal.
   c. Wheel lock-up.
   d. Air to enter the hydraulic system.

44. A car with floating caliper disc brakes pulls to the right.

   Mechanic A says that this could be caused by a frozen caliper piston.

   Mechanic B says that this could be caused by incorrect tire pressure.

   Who is right?
   a. Mechanic A.
   b. Mechanic B.
   c. Both A and B.
   d. Neither A nor B.

45. All of the following could cause the brake lights on a car to not work, EXCEPT:

   a. Bad ground at sockets.
   b. Bad flasher.
   c. Bad directional switch.
   d. Bad wiring.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. A</td>
<td>17. B</td>
<td>32. D</td>
</tr>
<tr>
<td>4. A</td>
<td>19. D</td>
<td>34. D</td>
</tr>
<tr>
<td>5. A</td>
<td>20. C</td>
<td>35. B</td>
</tr>
<tr>
<td>10. D</td>
<td>25. C</td>
<td>40. A</td>
</tr>
<tr>
<td>12. D</td>
<td>27. D</td>
<td>42. D</td>
</tr>
<tr>
<td>English/Language Arts</td>
<td>Automotive Brakes Meets</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>Social Political Issues</td>
<td>EL1</td>
<td></td>
</tr>
<tr>
<td>Reading Program</td>
<td>EL2</td>
<td></td>
</tr>
<tr>
<td>Core Of Literary Works</td>
<td>EL3</td>
<td></td>
</tr>
<tr>
<td>Core Works In Depth</td>
<td>EL4</td>
<td></td>
</tr>
<tr>
<td>Comprehend In Depth</td>
<td>EL5</td>
<td></td>
</tr>
<tr>
<td>Perspectives Of Other Disciplines</td>
<td>EL6</td>
<td></td>
</tr>
<tr>
<td>Write/Speak/Listening Activities</td>
<td>EL7</td>
<td></td>
</tr>
<tr>
<td>Prewrite-editing</td>
<td>EL8</td>
<td></td>
</tr>
<tr>
<td>Discussions, Panels, Debates</td>
<td>EL9</td>
<td></td>
</tr>
<tr>
<td>Oral Presentations</td>
<td>EL10</td>
<td></td>
</tr>
<tr>
<td>Oral/Aural Abilities</td>
<td>EL11</td>
<td></td>
</tr>
<tr>
<td>Listening Skills</td>
<td>EL12</td>
<td></td>
</tr>
<tr>
<td>Analysis, Synthesis</td>
<td>EL13</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>EL14</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Words</td>
<td>EL15</td>
<td></td>
</tr>
<tr>
<td>Vocabulary Comprehension</td>
<td>EL16</td>
<td></td>
</tr>
<tr>
<td>Integrated Skills</td>
<td>EL17</td>
<td></td>
</tr>
<tr>
<td>Substance Contextual</td>
<td>EL17</td>
<td></td>
</tr>
<tr>
<td>History-Social Science</td>
<td>Automotive Brakes Meets</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>Chronological Flow</td>
<td>HS1</td>
<td></td>
</tr>
<tr>
<td>Interest Groups</td>
<td>HS2</td>
<td></td>
</tr>
<tr>
<td>Global Economics</td>
<td>HS3</td>
<td></td>
</tr>
<tr>
<td>Geographical Factors</td>
<td>HS4</td>
<td></td>
</tr>
<tr>
<td>Rise Of Manufacturing</td>
<td>HS5</td>
<td></td>
</tr>
<tr>
<td>Labor Systems And Organizations</td>
<td>HS6</td>
<td></td>
</tr>
<tr>
<td>Transportation Evolution</td>
<td>HS7</td>
<td></td>
</tr>
<tr>
<td>Technological Achievements</td>
<td>HS8</td>
<td></td>
</tr>
<tr>
<td>Environmental Awareness</td>
<td>HS9</td>
<td></td>
</tr>
<tr>
<td>Media Expansion</td>
<td>HS10</td>
<td></td>
</tr>
<tr>
<td>Technology Nuclear Age</td>
<td>HS11</td>
<td></td>
</tr>
<tr>
<td>Social/Cultural Contributions</td>
<td>HS12</td>
<td></td>
</tr>
<tr>
<td>Exploration Discovery</td>
<td>HS13</td>
<td></td>
</tr>
<tr>
<td>Natural Resources</td>
<td>HS14</td>
<td></td>
</tr>
<tr>
<td>Inventiveness, Initiative</td>
<td>HS15</td>
<td></td>
</tr>
<tr>
<td>Living Patterns</td>
<td>HS16</td>
<td></td>
</tr>
<tr>
<td>Informed Citizenry</td>
<td>HS17</td>
<td></td>
</tr>
<tr>
<td>Creative, Critical Thinking</td>
<td>HS18</td>
<td></td>
</tr>
</tbody>
</table>

184
<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Automotive Brakes Meets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signed Numbers</td>
<td>M1</td>
</tr>
<tr>
<td>Measurement</td>
<td>M2</td>
</tr>
<tr>
<td>Definition Of Geometry</td>
<td>M3</td>
</tr>
<tr>
<td>Geometric Construction</td>
<td>M4</td>
</tr>
<tr>
<td>Ratio, Proportion</td>
<td>M5</td>
</tr>
<tr>
<td>Three Dimensional</td>
<td>M6</td>
</tr>
<tr>
<td>Patterns/Functions</td>
<td>M7</td>
</tr>
<tr>
<td>Variables</td>
<td>M8</td>
</tr>
<tr>
<td>Combinatorial Problems</td>
<td>M9</td>
</tr>
<tr>
<td>Probability</td>
<td>M10</td>
</tr>
<tr>
<td>Interpret Data</td>
<td>M11</td>
</tr>
<tr>
<td>Logical Inference</td>
<td>M12</td>
</tr>
<tr>
<td>Algebraic Expressions</td>
<td>M13</td>
</tr>
<tr>
<td>Ratio, Proportion, Percent</td>
<td>M14</td>
</tr>
</tbody>
</table>
### CALIFORNIA STATE MODEL CURRICULUM STANDARDS: MATRIX

<table>
<thead>
<tr>
<th>Science</th>
<th>Automotive Brakes Meets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atoms/Molecules</td>
<td>S1</td>
</tr>
<tr>
<td>Elements And Compounds</td>
<td>S2</td>
</tr>
<tr>
<td>Mass/Weight/Area</td>
<td></td>
</tr>
<tr>
<td>Volume/Temperature</td>
<td>S3</td>
</tr>
<tr>
<td>Chemical Reactions</td>
<td>S4</td>
</tr>
<tr>
<td>Force Effect Matter</td>
<td>S5</td>
</tr>
<tr>
<td>Energy Ability To Do Work</td>
<td>S6</td>
</tr>
<tr>
<td>Force, Mass, Distance</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>S7</td>
</tr>
<tr>
<td>Velocity, Resistance</td>
<td>S8</td>
</tr>
<tr>
<td>Electromagnetic Light, Sound, Fluid</td>
<td>S9</td>
</tr>
<tr>
<td>Electromagnetic Spectrum</td>
<td>S10</td>
</tr>
<tr>
<td>Heat And Temperature</td>
<td>S11</td>
</tr>
<tr>
<td>Electricity/Electronics</td>
<td>S12</td>
</tr>
<tr>
<td>Magnetic Forces</td>
<td></td>
</tr>
<tr>
<td>Electrical Currents</td>
<td>S13</td>
</tr>
<tr>
<td>Space Information</td>
<td>S14</td>
</tr>
</tbody>
</table>
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Uniondale, New York 11553-3695  
Filmstrip and quizzes.

Goodheart-Wilcox Co. Inc.  
123 W. Taft Drive  
South Holland, Illinois 60473  
Textbook and Workbook.

Mary Jo Williams, Counselor  
Phoenix High school  
870 J street  
Lincoln, California 95648  
Language Arts computer program.

National Institute for Automotive Service Excellence  
1920 Association Drive  
Reston, Virginia 22091-1502  
NATEF Task List.

Chris Almeida, Program Manager  
California State Department of Education,  
Vocational Education Division  
721 Capitol Mall  
Sacramento, California 95814  
California State Model Curriculum Standards and Program Framework
October 12, 1988

Goodheart-Wilcox Co. Inc.
123 W. Taft Drive
South Holland, Illinois 60473

Dear Sirs:

I am presently teaching a NATEF certified Automobile training program at Colton High school in Colton, California. Last spring I had the school purchase the automotive text entitled Automechanics Fundamentals by Stockel and Stockel copyright 1985 along with the student workbook and the test masters. I am using this text for my Vocational Automotive course. I am also working on my Masters Degree in Education at California State University San Bernardino. My course work requires that I do a writing project, for that project I have chosen to develop a curriculum for automobile brakes that can be used in the classes that I teach. The purpose for this letter is to request permission to duplicate portions of the text, workbook, and test masters relative to automobile brakes solely for the development of a detailed curriculum package. The curriculum will include detailed lesson plans that will contain all the materials needed to teach each unit of instruction. I will also include a statement to the effect that any material used in the package must be purchased from the respective publishers and not copied from the curriculum package for classroom use. Thank you for your help concerning this matter.

Sincerely,

Manuel Rodriguez
Automotive Instructor
October 18, 1988

Dear Mr. Rodriguez:

In response to your letter of October 12, you have our permission to use selected portions of the copyrighted materials in AUTO MECHANICS FUNDAMENTALS by Stockel. The materials copied should be for your personal use and should not be sold or used in a manner which would compete with any of our copyrighted materials.

Thanks for using our books in your classes. Please don't hesitate to contact us any time we may be of service to you.

Best regards,

Dick Snyder
Sales Manager

DS: cs
October 12, 1988

Bergwall Productions Inc.
106 Charles Lindbergh Blvd.
Uniondale, New York 11553-3695

Dear Sirs:

I am presently teaching a NATEF certified Automobile training program at Colton High School in Colton California. I am currently using your filmstrip programs in my classroom and am considering purchasing some of your new video programs for future use. I am also working on my Master's Degree in Education at California State University San Bernardino. My course work requires that I do a writing project, for that project I have chosen to develop a curriculum for automobile brakes that can be used in the classes that I teach. The purpose for this letter is to request permission to duplicate portions of the text, quizzes and answer key from the filmstrip program for automotive brakes solely for the development of a detailed curriculum package. The curriculum will include detailed lesson plans that will contain all the materials needed to teach each unit of instruction. I will also include a statement to the effect that any material used in the package must be purchased from the respective publishers and not copied from the curriculum package for classroom use. Thank you for your help concerning this matter.

Sincerely,

Manuel Rodriguez
Automotive Instructor
October 21, 1988

Dear Mr. Rodriguez:

We have your letter of October 12, 1988 in which you request permission to copy portions of the text, quizzes and answer key from our Audio Visual program on Automotive Brakes.

You have our permission to copy this material in the context you describe but not for any other purpose, as this would be an infringement of our copyright.

Thank you for your interest in Bergwall.

Sincerely,

[Signature]

Charles Bergwall
President

CB: nm