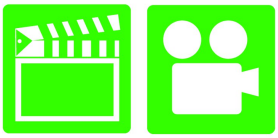
Automotive Maintenance and Light Repair, 1ST Edition

Chapter 54 BRAKE HYDRAULIC SYSTEMS

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. ⁀ Prepare for the Brakes (A54) ASE certification test content area "A" (Hydraulic System Diagnosis and Repair). ⁀ State Pascal's law. ⁀ Describe the function, purpose, and operation of the master cylinder. ⁀ Explain how hydraulic force can be used to supply high pressures to each individual wheel brake. ⁀ Describe the process of troubleshooting master cylinders and related brake hydraulic components. ⁀ Explain how a quick take-up master cylinder work.
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

ICONS	Ch54 BRAKE HYDRAULIC SYSTEMS
	**1. SLIDE 1 CH54 BRAKE HYDRAULIC SYSTEMS** **2. SLIDES 2-3 EXPLAIN OBJECTIVES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED**
	**4. SLIDE 4 EXPLAIN Figure 54-1** Hydraulic brake lines transfer the brake effort to each brake assembly attached to all four wheels. **5. SLIDES 5-6 EXPLAIN MASTER CYLINDERS** **7. SLIDE 7 EXPLAIN Figure 54-2** Because liquids cannot be compressed, they are able to transmit motion in a closed system. **8. SLIDES 8-9 EXPLAIN MASTER CYLINDERS** **10. SLIDE 10 EXPLAIN Figure 54-3** Hydraulic system must be free of air to operate properly. If air is in system, air is compressed when brake pedal is depressed and brake fluid does not transmit the force to wheel brakes.
	**DISCUSSION: DISCUSS PRINCIPLES OF HYDRAULICS/MECHANICAL PROPERTIES OF FLUIDS. DISCUSS PASCAL'S LAW**
	**PASCAL'S LAW, AREA** **PASCAL'S LAW, FORCE** **PASCAL'S LAW, PRESSURE**
	**DEMONSTRATION: SHOW THAT PISTONS CANNOT COMPRESS LIQUIDS IN CLOSED SYSTEM. ASK THEM TO EXPLAIN HOW AIR CAN CONTAMINATE HYDRAULIC SYSTEM & WHAT PROBLEMS RESULT FROM SUCH CONTAMINATION**
	**DEMONSTRATION: show application of Pascal's law by demonstrating that a force applied to a piston in a sealed system displaces equal amounts of force in every direction. Use a single master cylinder & 2 wheel cylinders with different piston area measurements. Ask students to interpret results in accordance with Pascal's law. How does this demonstration correspond to operation of a braking system?**

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	**11. SLIDE 11 EXPLAIN Figure 54-4** Typical master cylinder showing reservoir and associated parts. The reservoir diaphragm lays directly on top of brake fluid, which helps keep air from the surface of brake fluid because brake fluid easily absorbs moisture from air. **12. SLIDE 12 EXPLAIN FIGURE 54–5** The composite master cylinder is made from two different materials—aluminum for the body and plastic materials for the reservoir and reservoir cover. This type of reservoir feeds both primary and secondary chambers, and therefore uses a fluid level switch that activates the red dash warning lamp if the brake fluid level drops. **13. SLIDE 13 EXPLAIN FIGURE 54–6** Note the various names for the vent port (front port) and the replenishing port (rear port). Names vary by vehicle and brake component manufacturer. The names vent port and replenishing port are the terms recommended by SAE **14. SLIDES 14-15 EXPLAIN MASTER CYLINDERS** **16. SLIDE 16 EXPLAIN FIGURE 54–7** vent ports must remain open to allow brake fluid to expand when heated by friction material and transferred to the caliper and/or wheel cylinder. As brake fluid increases in temperature, it expands. The heated brake fluid can expand and flow back into the reservoir through the vent ports. **17. SLIDE 17 EXPLAIN FIGURE 54–8** As brake pedal is depressed, the pushrod moves primary piston forward, closing off the vent port. As soon as the port is blocked, pressure builds in front of the primary sealing cup, which pushes on the secondary piston. The secondary piston also moves forward, blocking the secondary vent port and building pressure in front of the sealing cup. **18. SLIDE 18 EXPLAIN FIGURE 54–9** The purpose of the replenishing port is to keep the volume behind the primary piston filled with brake fluid from the reservoir as the piston moves forward during a brake application **19. SLIDE 19 EXPLAIN FIGURE 54–10** When the brake pedal is released, the master cylinder piston moves rearward. Some of the brake fluid is pushed back up through the replenishing port, but most of the fluid flows past the sealing cup. Therefore, when the driver pumps the brake pedal, the additional fluid in front of the pressure-building sealing cup is available quickly

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	20. **SLIDE 20 EXPLAIN Figure 54-11** Rear-wheel-drive vehicles use a dual split master cylinder. 21. **SLIDE 21 EXPLAIN Figure 54-12** primary outlet is the outlet closest to the pushrod end of the master cylinder and the secondary outlet is closest to the nose end of the master cylinder. 22. **SLIDE 22 EXPLAIN Figure 54-13** In the event of a primary system failure, no hydraulic pressure is available to push the second piston forward. As a result, the primary piston extension rod contacts the secondary piston and pushes on the secondary piston mechanically rather than hydraulically. The loss of pressure in the primary system is usually noticed by the driver by a lower-than-normal brake pedal and the lighting of the red brake warning lamp. 23. **SLIDES 23-24 EXPLAIN** Master Cylinder Designs
	**SHOW ANIMATION: MASTER CYLINDER OP WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/BRAKES/AUTO_ANIMATIONS/05/MASTER_CYL_OPERATION_ANIM/INDEX.HTML
	**DEMONSTRATION: SHOW STUDENTS MASTER CYLINDER OF A VEHICLE, AND ASK THEM TO DESCRIBE HOW IT WORKS. WHY IS THE MASTER CYLINDER THE HEART OF THE BRAKING SYSTEM? SHOW STUDENTS THE SEE-THROUGH RESERVOIR OF A MASTER CYLINDER, AND POINT OUT THE MINIMUM AND MAXIMUM FILL MARKINGS**
	**DISC BRAKE APPLY & RELEASE**
	**ANIMATION: CALIPER OPERATION WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/BRAKES/AUTO_ANIMATIONS/CH12_FIG12_21/INDEX.HTML
	**NEVER FILL THE MASTER CYLINDER HIGHER THAN THE RECOMMENDED FULL MARK TO ALLOW FOR BRAKE-FLUID EXPANSION.**
	**DEMONSTRATION: SHOW MASTER CYLINDER WHEN BRAKES ARE NOT APPLIED, OR IN THE AT-REST POSITION. DISCUSS HOW BRAKE-FLUID EXPANSION AND CONTRACTION CAN OCCUR WITH CHANGES IN TEMPERATURE. SHOW STUDENTS WHAT CHANGES OCCUR WITHIN THE MASTER**

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	CYLINDER WHEN BRAKES ARE APPLIED, AND ASK THEM TO EXPLAIN THE RESULTS. SHOW STUDENTS WHAT CHANGES OCCUR WITHIN MASTER CYLINDER WHEN BRAKES ARE RELEASED & RETURNED TO AT-REST POSITION. WHAT IS IMPACT OF PUMPING BRAKES?
	**IF MINERAL BASED FLUIDS (MOTOR OIL OR HYDRAULIC FLUID) HAVE BEEN INTRODUCED TO THE BRAKE SYSTEM THE RUBBER DIAPHRAGM WILL SWELL OVER SIZED. THIS WILL SHOW THAT THERE ARE EXTENSIVE REPAIRS TO BE MADE.**
	**DISCUSSION: DISCUSS PURPOSE AND FUNCTION OF VENT AND REPLENISHING PORTS IN THE MASTER CYLINDER. HOW IS OUTSIDE AIR AND MOISTURE PROHIBITED FROM ENTERING THE MASTER CYLINDER THROUGH THESE VENTS?**
	25. **SLIDE 25 EXPLAIN Figure 54-14** FWD vehicles use a diagonal split master cylinder. In this design one section of the master cylinder operates the right front and the left rear brake and the other section operates the left front and right rear. In the event of a failure in one section, at least one front brake will still function.
	**DEMONSTRATION: SHOW AN EXAMPLE OF A DIAGONAL-SPLIT MASTER CYLINDER, DISCUSS HOW IT ENABLES FRONT AND REAR BRAKING ACTION IN EVENT OF FAILURE OF ONE CYLINDER**
	**DISCUSSION: WHAT % OF BRAKING THAT WOULD BE SUPPLIED IN EVENT THAT ½ OF A DIAGONALLY SPLIT BRAKE SYSTEM FAILS.**
	**WHEN HYDRAULIC SWITCH TURNS LIGHT ON DURING ½ OF SYSTEM FAILURE LIGHT SWITCH MAY HAVE TO BE RE-CENTERED TO GET LIGHT OFF**
	26. **SLIDES 26-27 EXPLAIN** Master Cylinder Designs 28. **SLIDE 28 EXPLAIN Figure 54-15** Quick take-up master cylinder can be identified by the oversize primary low-pressure chamber. 29. **SLIDE 29 EXPLAIN FIGURE 54–16** brake pedal depressor like this can be used during brake service to block the flow of brake fluid from the master cylinder during service work on the hydraulic system.

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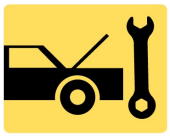
DEMO	**OPTIONAL DEMONSTRATION: SHOW STUDENTS AN EXAMPLE OF A QUICK TAKE-UP MASTER CYLINDER IF ONE IS AVAILABLE.**
	30. **SLIDES 30-31 EXPLAIN** Diagnosing and Troubleshooting Master Cylinders 32. **SLIDE 32 EXPLAIN Figure 54-17** Some seepage is normal when a trace of fluid appears on the vacuum booster shell. Excessive leakage, however, indicates a leaking secondary (end) seal
DEMO	**DEMONSTRATION: SHOW STUDENT HOW TO CHECK FOR PROPER FLUID MOVEMENT IN THE MASTER CYLINDER RESERVOIR.**
	**HANDS-ON TASK: HAVE STUDENTS PERFORM A VISUAL INSPECTION OF A MASTER CYLINDER. HAVE STUDENTS CHECK POSITION & OPERATION OF BRAKE PEDAL FOLLOWING INSPECTION. SELECT A STUDENT TO PRESENT RESULTS OF INSPECTION TO CLASS, IDENTIFYING ANY PROBLEMS & SUGGESTING POSSIBLE CAUSES & SOLUTIONS.**
	**NATEF MLR TASK A5B2 CHECK MASTER CYLINDER FOR INTERNAL/EXTERNAL LEAKS AND PROPER OPERATION; DETERMINE NECESSARY ACTION.**
	33. **SLIDE 33 EXPLAIN Figure 54-18** Pedal height is usually measured from the floor to the top of the brake pedal. Some vehicle manufacturers recommend removing the carpet and measuring from the asphalt matting on the floor for an accurate measurement. Always follow the manufacturer's recommended procedures and measurements. 34. **SLIDE 34 EXPLAIN Figure 54-19** Brake pedal free play is distance between the brake pedal fully released and position of brake pedal when braking resistance is felt. 35. **SLIDE 35 EXPLAIN Figure 5-20** Brake pedal reserve is usually specified as the measurement from the floor to the top of the brake pedal with the brakes applied. A quick-and-easy test of pedal reserve is to try to place your left toe underneath the brake pedal while the brake pedal is depressed with your right foot. If your toe will

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	not fit, then pedal reserve may not be sufficient. **DEMONSTRATION: SHOW STUDENTS HOW TO CHECK BRAKE PEDAL FREE PLAY. EXPLAIN THE IMPORTANCE OF THIS SPECIFICATION.** **NATEF MLR TASK A5B1 MEASURE BRAKE PEDAL HEIGHT, TRAVEL, AND FREE PLAY (AS APPLICABLE); DETERMINE NECESSARY ACTION.** **BRAKE FLUID IS HIGHLY CORROSIVE. ALWAYS USE FENDER COVERS TO PROTECT THE VEHICLE'S FINISH FROM CONTACT WITH BRAKE FLUID.** **DISCUSSION: ask students to discuss how to diagnose and correct spongy brake pedal. Ask how to test & fix a lower-than-normal brake pedal. Ask students to discuss how to diagnose and correct a problem that would cause a brake pedal to go all the way to the floor. Ask students to talk about the phenomenon of bypassing, or internal leak within the master cylinder. How can a technician determine an external leak within braking system versus bypassing within master cylinder?**