Automotive Chassis Systems 7e
Chapter 4 Braking System Principles
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Chassis Systems.** 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. 1. Discuss the energy principles that apply to brakes. 2. Discuss the mechanical principles that apply to brakes. 3. Discuss the friction principles that apply to brakes. 4. Describe how brakes can fade due to excessive heat. 5. Describe how deceleration rate are measured. **This chapter will help prepare for ASE Brakes (A5) certification test**
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.

NOTE: This lesson plan is based on Automotive Chassis Systems 7th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 4: Chapter Images

ICONS	Ch04 Braking System Principles
	**1. SLIDE 1 BRAKING SYSTEM PRINCIPLES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Videos**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them**
	**Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	2. **SLIDE 2 EXPLAIN Figure 4-1** Energy which is the ability to perform work exists in many forms. 3. **SLIDES 3 EXPLAIN Figure 4-2** Kinetic energy increases in direct proportion to the weight of vehicle 4. **SLIDES 4 EXPLAIN Figure 4-3** Kinetic energy increases as the square of any increase in vehicle speed.
	**FOUR ENGINES OF A BOEING 747 PRODUCE 188000 POUNDS OF THRUST, WHILE ONE SOLID ROCKET BOOSTER PRODUCES MORE THAN 17 TIMES AS MUCH THRUST.**
	**DISCUSSION: ASK STUDENTS TO DISCUSS MEANING OF "ENERGY." HOW MANY TYPES OF ENERGY CAN THEY IDENTIFY RELATING TO AUTOMOBILE MANUFACTURE AND OPERATION? ASK STUDENTS TO TALK ABOUT THE PRINCIPLE OF KINETIC ENERGY. WHY IS KINETIC ENERGY THE CENTRAL FOUNDATION OF BRAKE SYSTEM DESIGN AND OPERATION?**
	**DISCUSSION: ASK STUDENTS TO DISCUSS THE PRINCIPLE OF KINETIC ENERGY AND HOW THE RELATIONSHIP BETWEEN WEIGHT AND SPEED INFLUENCES BRAKE DESIGN**

ICONS	Ch04 Braking System Principles
	**DEMONSTRATION:** **USING A SMALL WEIGHT OF A POUND OR LESS PLACE IT ON THE SIDE OF A SODA CAN. NOW TAKE THE SAME WEIGHT AND DROP IT FROM THREE INCHES. THEN DROP WEIGHT FROM A FOOT ABOVE THE CAN. THE WEIGHT NEVER CHANGES BUT THE SPEED DOES.**
	5. **SLIDES 5 EXPLAIN Figure 4-4** Inertia creates weight transfer that requires the front brakes to provide most of the braking force.
	6. **SLIDE 6 EXPLAIN Figure 4-5** Front wheel drive vehicles have most of their weight over the front wheels.
	**DISCUSSION:** **ask students to talk about how the inertia of a moving object is also a factor in brake design. Who first described this physical property? Ask students to discuss how weight is transferred in a vehicle when the brakes are applied and how the vehicle's inertia factors in. Because the front brakes have to shoulder the majority of the load, what types of braking systems would be best suited to this task?**
	**DEMONSTRATION:** **USING 2 LITER BOTTLE FILLED HALF WAY WITH WATER & CAP TIGHTLY SCREWED ON LAY BOTTLE ON ITS SIDE ON BENCH. PUSH THE BOTTLE ACROSS TABLE SLOWLY & THEN STOP IT. DO THIS AGAIN AT A PROGRESSIVELY FASTER RATE. STUDENTS SHOULD OBSERVE HOW WATER MOVES FORWARD, WEIGHT TRANSFER**
	7. **SLIDE 7 EXPLAIN FIGURE 4–6** A first-class lever increases force and changes the direction of the force 8. **SLIDE 8 EXPLAIN FIGURE 4–7** A second-class lever increases the force in the same direction as the applied force. 9. **SLIDE 9 EXPLAIN FIGURE 4–8** A third-class lever reduces force but increases the speed and travel of the resulting work 10. **SLIDE 10 EXPLAIN Figure 4-9** brake pedal assembly is a second-class lever design that provides a 5 to 1 mechanical advantage.

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	**DISCUSSION:** ASK STUDENTS TO TALK ABOUT THE MECHANICAL PRINCIPLE OF LEVERAGE. HOW DOES A BRAKE PEDAL USE A FULCRUM AND THE PRINCIPLE OF LEVERAGE TO CHANGE THE ENERGY APPLIED BY THE DRIVER'S FOOT INTO A MORE USEFUL FORM OF ENERGY?
	**HANDS-ON TASK:** HAVE STUDENTS HOLD A HAMMER NEAR ITS HEAD. THEN MOVE THEIR HANDS OUT TO THE END OF THE HANDLE. THIS WILL DEMONSTRATE TO THEM THE PRINCIPLES OF A THIRD CLASS LEVER.
	**IF IT WAS NOT FOR THE MECHANICAL ADVANTAGE OF LEVERS WE WOULD ALL BE LIVING IN CAVES.**
	**COEFICIENT OF FRICTION (VIEW) (DOWNLOAD)**
	11. **SLIDE 11 EXPLAIN Figure 4-10** coefficient of friction in this example is 0.5. 12. **SLIDE 12 EXPLAIN Figure 4-11** type of friction material affects coefficient of friction which is just 0.05 in this example. 13. **SLIDE 13 EXPLAIN Figure 4-12** static coefficient of friction of an object at rest is higher than the kinetic (dynamic) friction coefficient once in motion.
	**DISCUSSION: ASK STUDENTS TO DISCUSS PRINCIPLE OF FRICTION. INVITE THEM TO PROVIDE EXAMPLES OF FRICTION. HOW DOES A BRAKING SYSTEM USE PRINCIPLE OF FRICTION TO SLOW AND STOP A CAR? ASK STUDENTS TO TALK ABOUT FACTORS THAT DETERMINE COEFFICIENT OF FRICTION IN AN AUTOMOBILE BRAKING SYSTEM. ASK STUDENTS TO DISCUSS ROLE OF FRICTION CONTACT AREA IN DETERMINING COEFFICIENT OF FRICTION. WHY DOES TIRE WIDTH HAVE A DIRECT IMPACT ON COEFFICIENT OF FRICTION BUT BRAKE-PAD SIZE DOES NOT?**

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	**HANDS-ON TASK:** **HAVE THE SAME STUDENT DRAG A HEAVY OBJECT WITH A SMOOTH BOTTOM SURFACE ACROSS THE SHOP FLOOR, AND APPROXIMATE THE FRICTION COEFFICIENT OF THIS OBJECT. WHAT ARE THE IMPLICATIONS FOR DISC AND BRAKE PAD MATERIALS?**
	14. **SLIDE 14 EXPLAIN FIGURE 4–13** Mechanical fade occurs when the brake drums become so hot that they expand away from the brake lining. 15. **SLIDE 15 EXPLAIN FIGURE 4–14** Some heat increases the coefficient of friction, but too much heat can cause it to drop off sharply. 16. **SLIDE 16 EXPLAIN FIGURE 4–15** One cause of GAS brake fade occurs when phenolic resin, a part of friction material, gets so hot that it vaporizes. Vaporized gas from disc brake pads gets between rotor (disc) and the friction pad. Because friction pad is no longer in contact with rotor, no additional braking force is possible.
	**DISCUSSION:** **ask students to talk about amount of heat converted from kinetic energy during braking. What are factors that determine increase in brake temperature? Where is heat absorbed? Ask students to talk about mechanical brake fade and what causes it. How can the driver restore some brake power? Why is mechanical fade not an issue for disc brakes? Ask students to discuss the causes of lining fade. How can partial brake power be restored, and what are the possible consequences?**
	**USE A LOWER GEAR WHEN DESCENDING HILLS TO REDUCE THE POSSIBILITY OF BRAKE FADE.**
	**ON-VEHICLE NATEF TASK** **RESEARCH APPLICABLE VEHICLE AND SERVICE INFORMATION, SUCH AS BRAKE SYSTEM OPERATION, ETC.**
	**HAVE STUDENTS INTERVIEW A LOCAL SHOP OWNER VIA TELEPHONE. ASK THE OWNER WHAT PROCEDURES ARE IN PLACE AT THEIR SHOP TO INSURE BRAKE REPAIRS THAT MEET STATE LAWS AND REGULATIONS. HAVE THEM REPORT THEIR FINDINGS DURING THE NEXT CLASS**