Automotive Technology 6th Edition
Chapter 96 BRAKING SYSTEM PRINCIPLES
Opening Your Class

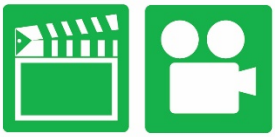
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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 learning objectives to students as listed below: 1. Discuss the energy principles that apply to brakes. 2. Discuss the friction principles that apply to brakes. 3. Describe how brakes can fade due to excessive heat. 4. Describe how deceleration rates are measured. 5. Discuss friction materials used in brake systems.
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: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 93 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	CH93 Braking System Principles
	**1. SLIDE 1 CH93 BRAKING SYSTEM PRINCIPLES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF**
	
	**Videos**
	**2. SLIDE 2 EXPLAIN Figure 93-1** Energy which is the ability to perform work exists in many forms. **3. SLIDES 3 EXPLAIN Figure 93-2** Kinetic energy increases in direct proportion to the weight of vehicle. **4. SLIDES 4 EXPLAIN Figure 93-3** Kinetic energy increases as the square of any increase in vehicle speed.
	**EXPLAIN TECH TIP: *Brakes Stop Wheels, Not the Vehicle:* Brakes are used to slow and stop rotation of wheels. The tires are attached to wheels and the friction between tire tread and pavement is what actually stops vehicle. If vehicle is on a slippery surface, such as gravel or snow, wheels may be stopped by brakes, but vehicle can continue without slowing if there is a lack of traction between tires and the ground.**
	**The 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?**

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	**DISCUSSION:** Ask students to discuss the principle of kinetic energy and how the relationship between weight and speed influences brake design
	**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 93-4** Inertia creates weight transfer that requires the front brakes to provide most of the braking force. 6. **SLIDE 6 EXPLAIN Figure 93-5** Front wheel drive vehicles have most of their weight over the front wheels.
	**DISCUSSION:** discuss inertia of a moving object is also a factor in brake design. Who first described this physical property? 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 a two liter bottle filled half way with water & cap tightly screwed on lay bottle on its side on bench. Push the bottle across the table slowly and then stop it. Do this again at a progressively faster rate. Students should observe how the water moves forward, weight transfer
	7. **SLIDE 7 EXPLAIN FIGURE 97–6** static coefficient of friction of an object at rest is higher than the kinetic (dynamic) friction coefficient once in motion..
	**Brake Pedal Force (View) (Download)** **Brake Pedal Travel (View) (Download)** **Brake Swept Area (View) (Download)**
	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?

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      	**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.** 8. **SLIDE 8 EXPLAIN FIGURE 97–7** Some heat increases the coefficient of friction, but too much heat can cause it to drop off sharply. 9. **SLIDE 9 EXPLAIN FIGURE 97–8** One cause of brake fade occurs when the phenolic resin, a part of friction material, gets so hot that it vaporizes. The vaporized gas from the disc brake pads gets between rotor (disc) and the friction pad. Because the friction pad is no longer in contact with rotor, no additional braking force is possible. **EXPLAIN TECH TIP:** ***How to Reduce Possible Brake Fade*** **To help prevent possible brake fade while descending long hills, place the gear selector into a lower drive range, such as "2," or even "1," if going slowly enough. This action allows for additional engine braking and takes the load off of the wheel brakes. • SEE FIGURE 97–9.** 10. **SLIDE 10 EXPLAIN FIGURE 97–9** gear selector is often called the "PRNDL," pronounced "prindle," regardless of the actual letters or numbers used. 11. **SLIDE 11 EXPLAIN FIGURE 97–10** Rapid braking causes the brake friction material to wear more compared to gentle, less aggressive, braking. **Use a lower gear when descending hills to reduce the possibility of brake fade.** **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**

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    	direct impact on coefficient of friction but brake-pad size does not? **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? **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? **Show ANIMATION: Coefficient of Friction (View) (Download)** **EXPLAIN TECH TIP:** ***Competitively Priced Brakes*** **DISCUSS FREQUENTLY ASKED QUESTION:** ***What Do D3EA and BEEP Mean?*** Original equipment brake pads and shoes are required to comply with FMVSS 135, which specifies maximum stopping distances. There is also a requirement for fade resistance, but no standard for noise or wear. Aftermarket (replacement) brake pads and shoes are not required to meet FMVSS standard. However, several manufacturers of replacement brake pads and shoes are using a standardized test that closely matches the FMVSS standard and is called the **"Dual Dynamometer Differential Effectiveness Analysis" or D3EA**. This test is currently voluntary and linings that pass test can have a "D3EA certified" seal placed on product package. BEEP stands for "Brake

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    Education Foundation	**Effectiveness Evaluation Procedure" and is a series of tests on aftermarket brake components that is similar to FMVSS tests and SAE J2430 standards.** 12. **SLIDE 12 EXPLAIN FIGURE 97–11** All boxes of brake linings and pads should be labeled with leaf mark, which gives a visual clue as to standard under which the brake friction materials meet certain state laws regarding the amount of copper.. 13. **SLIDE 13 EXPLAIN FIGURE 97–12** edge codes include a lot of information about brake friction material. 14. **SLIDE 14 EXPLAIN FIGURE 97–13** "edge codes" are now printed on the backing of brake pad because there is so much required information that it often does not fit on the edge of brake pad or shoe**.** 15. **SLIDE 15 EXPLAIN FIGURE 97–14** Typical drum brake lining edge codes, showing coefficient of friction codes for cold and hot circled. **DISCUSS FREQUENTLY ASKED QUESTION:** ***WHAT ARE CERMAIC PADS*** **EXPLAIN TECH TIP:** ***Edge Codes Do Not Represent Quality*** **ON-VEHICLE ASEEDUCATION TASK: Research applicable vehicle and service information, such as brake system operation, etc.**