Automotive Technology 6th Edition
Chapter 24 Intake & Exhaust Systems
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 the chapter learning objectives to the students as listed: 1. Explain air intake filtration. 2. Discuss the throttle-body injection intake manifolds and port fuel-injection intake manifolds. 3. Discuss exhaust gas recirculation passages and exhaust manifolds. 4. Describe the purpose and function of mufflers.
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 the 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 24 Chapter Images: From http://www.jameshalderman.com/automotive_principles.htmlNOTE: You can use Chapter Images or possibly Power Point files:

ICONS	CH24 Intake & Exhaust Sys.
	**1. SLIDE 1 CH24 INTAKE & EXHAUST SYSTEMS**
	**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**
	**INTAKE & SYSTEM Videos**
	2. **SLIDE 2 EXPLAIN Figure 24-1** Downward movement of the piston lowers the air pressure inside the combustion chamber. The pressure differential between the atmosphere and the inside of the engine forces air into the engine. 3. **SLIDE 3 EXPLAIN Figure 24-2** Dust and dirt in the air are trapped in the air filter so they do not enter the engine. 4. **SLIDE 4 EXPLAIN Figure 24-3** Most air filter housings are located on the side of the engine compartment and use flexible rubber hose to direct the airflow into the throttle body of the engine.
	**DISCUSSION: Have your students discuss the pros and cons of not using an air filter on a racing engine.**
	**DEMONSTRATION: Show students a variety of air filters and point out the differences between those used on a carbureted or throttle used for port fuel injection.**

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	**Reusable filters that are coated with an oil film can damage some engine sensors and lead to Diagnostic Trouble Codes (DTC).**
	5. **SLIDE 5 EXPLAIN Figure 24-4** typical air filter restriction indicator used on a GM truck DIESEL engine. The indicator turns red when it detects enough restriction to require a filter replacement.
	**HANDS-ON TASK: Have your students apply vacuum to the back of a restriction indicator to observe its operation.**
	**EXPLAIN TECH TIP: Always Check the Air Filter Always inspect the air filter and the air intake system carefully during routine service. Debris or objects deposited by animals can cause a restriction to the airflow and can reduce engine performance. • SEE FIGURE 24–5.**
	6. **SLIDE 6 EXPLAIN Figure 24-5 (a)** Note the discovery as the air filter housing was opened during service. The nuts were obviously deposited by squirrels (or some other animal). 7. **SLIDE 7 EXPLAIN Figure 24-5 (b)** Not only was the housing filled with nuts, but also this air filter was extremely dirty, indicating that this vehicle had not been serviced for a long time. 8. **SLIDE 8 EXPLAIN Figure 24-6** A resonance tube, called a Helmholtz resonator, is used on the intake duct between the air filter and the throttle body to reduce air intake noise during engine acceleration.

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	**DISCUSS FREQUENTLY ASKED QUESTION: What Does This Tube Do? What is the purpose of the odd-shape tube attached to inlet duct between the air filter and the throttle body, as seen in • FIGURE 24–6? The tube shape is designed to dampen out certain resonant frequencies that can occur at specific engine speeds. The length and shape of this tube are designed to absorb shock waves that are created in the air intake System and to provide a reservoir for the air that will then be released into the airstream during cycles of lower pressure. This resonance tube is often called a Helmholtz resonator, named for the discoverer of the relationship between shape and value of frequency, Herman L. F. von Helmholtz (1821–1894) of the University of Hönizsberg in East Prussia. The overall effect of these resonance tubes is to reduce the noise of the air entering the engine.**
	**Installing an aftermarket air intake without a resonance tube can lead to an increase in induction noise**
	9. **SLIDE 9 EXPLAIN FIGURE 24–7** The graph shows the effect of sonic tuning of the intake manifold runners. The longer runners increase the torque peak and move it to a lower RPM. The 600 mm intake runner is about 24 inches long. 10. **SLIDE 10 EXPLAIN FIGURE 24–8** Airflow through the large-diameter upper intake manifold is distributed to smaller-diameter individual runners in the lower manifold in this two-piece manifold design.

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	**DISCUSSION:** **Throttle-body injection relies on a manifold with unequal-length runners to distribute fuel from a central location. Have students discuss how this might affect cold-engine drivability and fuel balance between cylinders**
	11. **SLIDE 11 EXPLAIN FIGURE 24–9** The air flowing into the engine can be directed through long or short runners for best performance and fuel economy**.**
	12. **SLIDE 12 EXPLAIN FIGURE 24–10** Many plastic intake manifolds are constructed using many parts glued together to form complex passages for airflow into the engine. 13. **SLIDE 13 EXPLAIN FIGURE 24–11** A typical variable intake manifold where the length of the intake passage is changed using a valve to change the direction of the airflow. 14. **SLIDE 14 EXPLAIN FIGURE 24–12** A typical long exhaust gas line used to cool the exhaust gases before being recirculated back into the intake manifold.
	**DEMONSTRATION: Show students examples of cast iron, aluminum, and plastic intake manifolds. Be sure to point out differences between TBI & port fuel-injection manifolds.**
	**DISCUSSION: Ask students to discuss how smooth finish of a plastic manifold can help engine performance.**
	**Plastic manifolds are fragile and care must be taken to follow correct tightening sequence and torque specifications. EGR coolers are frequently used on diesel motors.**
	**ON-VEHICLE TASK: Replace intake manifold gasket**

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	**DEMONSTRATION: Demonstrate use of propane to diagnose an intake leak**
	**Many "cold-air" intakes sold through performance companies can actually draw in engine compartment heat if the air box is replaced with an open filter element.**
	15. **SLIDE 15 EXPLAIN Figure 24-13** exhaust gases are pushed out of cylinder by piston on exhaust stroke. 16. **SLIDE 16 EXPLAIN Figure 24-14** This exhaust manifold (red area) is equipped with a heat shield to help retain heat and reduce exhaust emissions**.** 17. **SLIDE 17 EXPLAIN Figure 24-15** Many exhaust manifolds are constructed of steel tubing and are free flowing to improve engine performance.
	**DISCUSSION: Discuss advantages of using stainless steel for exhaust systems**

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	**DISCUSS FREQUENTLY ASKED QUESTION: How Can a Cracked Exhaust Manifold Affect Engine Performance? Cracks in an exhaust manifold will not only allow exhaust gases to escape and cause noise, but also allow air to enter exhaust manifold. • SEE FIGURE 24–16. Exhaust flows from the cylinders as individual puffs or pressure pulses. Behind each of these pressure pulses, a low pressure (below atmospheric pressure) is created. Outside air at atmospheric pressure is then drawn into the exhaust manifold through the crack. This outside air contains 21% oxygen and is measured by the oxygen sensor (O2S). The air passing the O2S signals the engine computer that the engine is operating too lean (excess oxygen) and the computer, not knowing that the lean indicator is false, adds additional fuel to the engine. The result is that the engine will be operating richer (more fuel than normal) and spark plugs could become fouled by fuel, causing poor engine operation.**
	18. **SLIDE 18 EXPLAIN Figure 24-16** crack in an exhaust manifold is often not visible because a heat shield usually covers the area. 19. **SLIDE 19 EXPLAIN Figure 24-17** Typical exhaust manifold gaskets. Note how they are laminated to allow the exhaust manifold to expand and contract due to heating and cooling. 20. **SLIDE 20 EXPLAIN Figure 24-18** exhaust manifold spreader tool is absolutely necessary when reinstalling exhaust manifolds. When they are removed from the engine, the manifolds tend to warp slightly even though the engine is allowed to cool before being removed. The spreader tool allows the technician to line up the bolt holes without harming the manifold.

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	**EXPLAIN TECH TIP:** Using the Correct Tool Saves Time: When cast-iron exhaust manifolds are removed, the stresses built up in the manifolds often cause the manifolds to twist or bend. This distortion even occurs when the exhaust manifolds have been allowed to cool before removal. Attempting to reinstall distorted exhaust manifolds is often a time-consuming and frustrating exercise. However, special spreading jacks can be used to force the manifold back into position so that the fasteners can be lined up with the cylinder head. • SEE FIGURE 24–18.
	**HANDS-ON TASK:** Have students remove and install an exhaust manifold.
	**DEMONSTRATION:** Show students correct use of an exhaust manifold spreader
	**HANDS-ON TASK:** Have students practice using a manifold spreader, noting change in port position with a Vernier Caliper.
	**ON-VEHICLE TASK:** EXHAUST SYSTEM INSPECTION

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	21. **SLIDE 21 EXPLAIN FIGURE 24–19** The “exhaust manifold” on this Honda is actually part of cylinder head and not a separate part. The catalytic converter is attached directly to the cylinder head using four studs. 22. **SLIDE 22 EXPLAIN FIGURE 24–20** A typical exhaust system showing the heat shields and hangers used to isolate exhaust system vibrations from the vehicle body, and to control the movement as the exhaust system changes in length due to heat.. 23. **SLIDE 23 EXPLAIN FIGURE 24–21** Exhaust gases expand and cool as they travel through passages in the muffler. 24. **SLIDE 24 EXPLAIN FIGURE 24–22** A hole in the muffler allows condensed water to escape.
	**DISCUSS FREQUENTLY ASKED QUESTION: Why Is There a Hole in My Muffler? Many mufflers are equipped with a small hole in the lower rear part to drain accumulated water. About 1 gallon of water is produced in the form of steam for each gallon of gasoline burned. The water is formed when gasoline is burned in the cylinder. Water consists of two molecules of hydrogen and one of oxygen (H_2O). The hydrogen (H) comes from the fuel and the oxygen (O) comes from the air. During combustion, the hydrogen from the fuel combines with some of the oxygen in the air to form water vapor. The water vapor condenses on the cooler surfaces of the exhaust system, especially in the muffler, until the vehicle has been driven long enough to fully warm the exhaust above the boiling point of water (212°F [100°C]). • SEE FIGURE 24–22.**

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	**EXPLAIN TECH TIP:** Perform an Exhaust System Tap Test: The condition of an exhaust system is often hard to determine by visual inspection only. Many professional service technicians use a rubber mallet and tap the each section of the exhaust system. This test often finds broken heat shields that rattle when the system is tapped, or a loose hanger, or even a section of the exhaust that has corroded from the inside out and the weak area could not be seen. To perform an exhaust tap test, start at the front of the vehicle and lightly tap on each section using a small rubber mallet. Continue taping each section to the rear. If any rattles are heard, then further inspection is needed in that area to find the root cause. Fix or repair as needed.
	**HOMEWORK: SEARCH INTERNET:** Have students research the use of tuned intakes for racing use. Students should pick a specific application and present their findings to the class.