Automotive Technology 6th Edition
Chapter 66 HVAC DIAGNOSIS
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. List the steps to diagnose HVAC problems. 2. Explain how to diagnose a heating system problem. 3. Describe how to check the performance of the A/C system. 4. Explain the procedures to measure temperature and pressure in A/C 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

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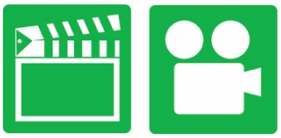
NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	Chapter 66 HVAC System Diagnosis
	1. SLIDE 1 Chapter 66 HEATING & AIR-CONDITIONING SYSTEM DIAGNOSIS
	**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**
	**Heater Operation (View) (Download)**
	**DISCUSSION: Ask students to discuss HVAC diagnostic procedures. Have them explain why all the steps are necessary.**
	**DEMONSTRATION: Show heater core and plenum assembly and discuss how each functions.**
	2. **SLIDE 2 EXPLAIN Figure 66-1** heater core is mounted inside a heater plenum chamber where air passes over it to absorb heat from warmed engine coolant.
	**EXPLAIN TECH TIP: *Water on the Carpet? Check the Evaporator Water Drain"* If evaporator water drip tube becomes clogged with mud, leaves, or debris, water will build up inside evaporator housing and spill out onto carpet on passenger side. Customers often think that windshield or door seals are leaking. Most evaporator water drains are not visible unless the vehicle is hoisted.**

ICONS	Chapter 66 HVAC System Diagnosis
	3. **SLIDE 3 EXPLAIN Figure 66-2** A cable controlled heater control valve. This valve is normally open, allowing engine coolant to flow through the heater core. When the air conditioning is switched to maximum cooling, the valve shuts off the flow of coolant to the heater 4. **SLIDE 4 EXPLAIN FIGURE 66-3** Many engines are equipped with bleeder valve to permit a technician to bleed any trapped air from the cooling system.
	**EXPLAIN TECH TIP: *Defrost All the Time*? Check the Vacuum: A common problem involves airflow from the defroster ducts, even though the selector lever is in other positions. The defrost setting is the default position in the event of a failure with the vacuum supply. The defrost position is used because it is the safest position. For safety, the windshield must remain free from frost. Heat is also supplied to the passenger compartments, not only through defrost ducts, but also through the heater vents at floor level. If the airflow is mostly directed to the windshield, check under the hood for a broken, disconnected, or missing vacuum hose. Check the vacuum reserve container for cracks or rust (if metal) that could prevent the container from holding vacuum. Check all vacuum hose connections at the intake manifold and trace each carefully, inspecting for cracks, splits, or softened areas that may indicate a problem. Hint: This problem of incorrect airflow inside vehicle often occurs after another service procedure has been performed, such as spark plug replacement. The movement of the technician's body and arms can cause a hose to be pulled loose or a vacuum fitting to break without the service technician being aware that anything wrong has occurred.**
	**DISCUSS FREQUENTLY ASKED QUESTION: *How Can You Easily Burp Air from the Cooling System?* The first step in being certain there is no air in the cooling system is to try to avoid getting air into the system in the first place during cooling system service. If the engine is**

ICONS	Chapter 66 HVAC System Diagnosis
	equipped with bleeder valves near the high spots of the cooling system, these valves should be open when refilling the radiator. • **SEE FIGURE 66–3**. Any trapped air always travels to highest portion of cooling system and escapes out of these bleeder openings. Close the valves as soon as coolant is observed coming out of the valve opening. If the cooling system is not equipped with bleeder valves, fill cooling system as full as possible and then start the engine. With the radiator cap removed, coolant level often rises as the trapped air is expanding, then drop down as the trapped air escapes out of the radiator neck opening. Air can still remain trapped. To help speed up the process, try installing the radiator cap just to the first notch. (In this position radiator cap is closed, but does not seal enough to allow pressure to build in the cooling system.) To help force any trapped air from the cooling system, simply drive the vehicle normally for several miles. By driving the vehicle under load, the engine warms up faster and the thermostat opens, allowing the coolant to flow from engine and through the radiator. Any trapped air is then released into the radiator where it can easily escape through the unsealed radiator cap. After filling the radiator, securely tighten radiator cap and test-drive the vehicle to verify proper operation. Always check service information for exact procedure to follow when replacing coolant. **EXPLAIN TECH TIP:** ***The Hand Test*** **To check a radiator or condenser for possible clogged or restricted areas, simply touch the outside of the unit with your hand. Any cool spots indicate that**

ICONS	Chapter 66 HVAC System Diagnosis
	the radiator or condenser is clogged in that cool area. **EXPLAIN TECH TIP:** ***Hot/Cold/Hot/Cold Heater*** Diagnosis A common customer complaint is a lack of heat from the heater, but only while driving, even though there seems to be plenty of heat when the engine is at idle speed and vehicle is stopped. This ***is a classic symptom of low coolant level***. The lower than normal coolant level in the radiator prevents enough flow to supply the heater core. When engine speed is reduced, the water pump turns slower and coolant can more easily flow through the heater core resulting in heat from the heater. As the engine speed increases, the water pump speed also increases. Because there is less than the proper amount of coolant in system, water pump is only able to supply coolant through the engine (a path of lower resistance).
	**DEMONSTRATION:** Show examples of a heater control and a bleeder valve and explain how they work: **FIGURE 66-3**
	**HANDS-ON TASK:** Students studied operation of the thermostat. Ask them to review relevant reading as it applies here to heater problem diagnosis.
	**HANDS-ON TASK:** Have students follow steps to **diagnose a heater problem** and report conclusions.
	**If water appears on passenger-side carpet, check for clogged evaporator drip tube.**
	**SAFETY** Remind students never to remove the radiator cap when the **engine** is **hot**.
	**DEMONSTRATION:** Show how to perform hand test to check a radiator or condenser for possible clogged or restricted areas.

ICONS	Chapter 66 HVAC System Diagnosis
	**HANDS-ON TASK: Have students perform a visual inspection of a heater problem and report their results.**
	**Most A/C Problems relate to a low charge due to a leak.**
	5. **SLIDE 5 EXPLAIN Figure 66-4** Many older CFC-12 systems are equipped with a sight glass either on or near the receiver-drier. A fully-charged (or completely empty) system is indicated by a clear sight glass. Bubbles or foam indicate that the system is not fully charged. An empty system may have oil streaks on the sight glass being moved by the vapor remaining in the system.
	**DEMONSTRATION: Show Sight Glass On A Receiver-Drier on CFC-12 System and discuss how it was used to check condition of the cooling system refrigerant: FIGURE 66-4**
	6. **SLIDE 6 EXPLAIN Figure 66-5** A typical refrigerant identification machine. The readout indicates what kind of refrigerant is in the system. If a blend or some other contaminated refrigerant is discovered, it should be recovered and stored in a separate container to keep it from contaminating fresh refrigerant.
	**DEMONSTRATION: Point out high-pressure & low-pressure hoses and lines in a HVAC system and discuss their significance.**
	7. **SLIDE 7 EXPLAIN Figure 66-6 (a)** Both high-pressure (red) and low-pressure (blue) hoses have been attached to the vehicle. Before starting the engine, both the high and low pressure reading should be the same. (b) High-side pressure can be compared to the temperature of the outlet from the compressor. Here a service technician is using an infrared pyrometer to measure the temperature
	8. **SLIDE 8 EXPLAIN Figure 66-7** Hot refrigerant condenses in the condenser when it loses its heat to the outside air. Note how the level of the liquid line changes when undercharged or overcharged.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What's Wrong When the A/C Compressor Clutch***

ICONS	Chapter 66 HVAC System Diagnosis
	Cycles On and Off Rapidly? **This is a common occurrence on a vehicle equipped with a cycling clutch orifice tube (CCOT) system that is low on refrigerant charge. With a normal charge, the low-side pressure should be 15 to 35 psi and the clutch should be on for 45 to 90 seconds and be off for only about 15 to 30 seconds.**
	**EXPLAIN TECH TIP:** ***High-Side Pressure Tip*** **A quick and easy way to determine the correct high-side pressure is to add 100 to the ambient air temperature in Fahrenheit. For example: 85°F outside air temperature +100/185 PSI = typical normal high-side pressure**
	**DEMONSTRATION: Demo Below NATEF TASKS**
 	**ON-VEHICLE ASEEDUCATION TASK A1. Identify and interpret heating and air conditioning problems; determine needed action.**
 	**ON-VEHICLE ASEEDUCATION TASK D2. Diagnose A/C compressor clutch control systems; determine needed action.**
 	**ON-VEHICLE ASEEDUCATION TASK A3 Performance test the A/C system and diagnose using principles of refrigeration**
 	**ON-VEHICLE ASEEDUCATION TASK A4 Identify abnormal operating noises in the A/C system; determine needed action.**

ICONS	Chapter 66 HVAC System Diagnosis
 	**ON-VEHICLE ASEEDUCATION TASK A9. Using a scan tool, observe and record related HVAC data and trouble codes.**
 	**ON-VEHICLE ASEEDUCATION TASK C1. Inspect engine cooling and heater systems hoses and pipes; perform needed action.** **ON-VEHICLE ASEEDUCATION TASK C2. Inspect and test heater control valve(s); perform needed action.**
 	**ON-VEHICLE ASEEDUCATION TASK C3. Diagnose temperature control problems in the HVAC system; determine needed**
 	**ON-VEHICLE ASEEDUCATION TASK C4. Determine procedure to remove, inspect, reinstall, and/or replace heater core.**
	**DEMONSTRATION: Show students how to use a pyrometer to measure temperature of upper radiator hose & area around thermostat housing.**
	9. **SLIDE 9 EXPLAIN Figure 66-8** The average R-134a pressure–temperature readings during a performance test. The high-side pressure of R-12 systems will be lower at higher temperatures.
	10. **SLIDE 10 EXPLAIN Figure 66-9** When both low- and high-side pressures are low, the system is undercharged with refrigerant.
	11. **SLIDE 11 EXPLAIN Figure 66-10** Both low- and high-side pressures higher than normal indicate that the system is overcharged with refrigerant.
	12. **SLIDE 12 EXPLAIN Figure 66-11** Lack of proper airflow across the condenser is usually the cause of this condition

ICONS	Chapter 66 HVAC System Diagnosis

ON-VEHICLE ASEEDUCATION TASK A5.

Identify refrigerant type; select and connect proper gauge set/test equipment; record temperature and pressure readings.

DISCUSSION: Ask students to discuss cause of low readings for both Low Side & High-Side pressure? What about high readings for both Low-Side & High-Side pressure?

FIGURES 66-9, 10, 11

OPTIONAL HANDS-ON TASK: Have students create a chart for symptoms of Low Side & High-Side pressure

Low-Side Pressure	High-Side Pressure	Causes
25-35 psi	170 - 200	Normal
LOW	LOW	Low refrigerant charge
LOW	LOW	Obstruction in the suction line
LOW	LOW	Clogged orifice tube
LOW	LOW	TXV valve stuck closed
LOW	LOW	Restricted line from condenser to evaporator
LOW	HIGH	Restricted evaporator airflow
HIGH	LOW	Internal compressor damage
HIGH	HIGH	Refrigerant overcharge
HIGH	HIGH	Restricted condenser airflow
HIGH	HIGH	High engine coolant temperature
HIGH	HIGH	TXV valve stuck open
HIGH	HIGH	Air or moisture in the refrigerant

DISCUSSION: Ask students to talk about how to repair most common refrigerant leaks. What parts should always be replaced?

EXPLAIN TECH TIP: *Clogged Orifice Tube Test* A clogged orifice tube is a common air-conditioning system failure. When orifice tube becomes clogged, it blocks the flow of refrigerant through the evaporator, which causes a reduced cooling of the passenger compartment. To check for a possible restriction in the system, follow these easy steps:

STEP 1 Connect the A/C pressure gauge to both low- and high-side pressure fittings.

STEP 2 Operate the A/C system for 5 to 10 minutes.

STEP 3 Shut off the A/C system and watch the pressure gauges. If the pressures do not equalize

ICONS	Chapter 66 HVAC System Diagnosis
 	quickly, then there is a restriction in the system. • SEE FIGURES 66–12 AND 66–13. NOTE: To locate a restriction anywhere in the system, feel along the system lines. The restriction exists at the point of greatest temperature difference. "Frosting" 13. **SLIDE 13 EXPLAIN Figure 66.12** clogged orifice tube. 14. **SLIDE 14 EXPLAIN Figure 66-13** Assortment of orifice tubes. **DISCUSS CASE STUDY *The Clogged Evaporator Problem*** The owner of an older Buick complained that the blower motor must be defective because the air no longer flowed from the air-conditioning vents as it should. A check of the blower motor circuit revealed that the blower motor was working. To confirm the operation of blower, the resistor pack was removed and air flowed out of the opening. Then the technician discovered cause of the lack of airflow—the evaporator was covered with oily dirt. The technician recovered the refrigerant and removed the evaporator. Apparently, the evaporator had a small refrigerant leak that allowed the refrigerant oil to coat the fins of the evaporator. Any dirt in the air stuck to evaporator until the dirt almost completely blocked airflow. Replacing evaporator and recharging system fixed blower motor problem. • SEE FIGURE 66–14. **Summary:** • Complaint—Vehicle owner complained of a lack of airflow from the A/C vents • Cause—evaporator was covered with oily dirt. • Correction—evaporator was replaced and system was recharged.

ICONS	Chapter 66 HVAC System Diagnosis
	**15. SLIDE 15 EXPLAIN Figure 66-14** A partially clogged evaporator.
	**EXPLAIN TECH TIP:** ***The Smell Test:*** **Many air-conditioning systems form mildew inside the evaporator housing due to the moist condition that exists in this area. If a "wet" smell is noticed, the mold and mildew may be the cause and a biocide needs to be used to correct problem.**
	**EXPLAIN TECH TIP:** ***The Touch, Feel Test*** **A quick-and-easy test to check the state of charge of an orifice tube system is to use one hand and touch the evaporator side of the orifice tube. Touch your other hand to the inlet to the accumulator. The following conditions can be determined by noticing the temperature of these two locations. • SEE FIGURE 66–15.** **Normal operation —both temperatures about same Undercharged condition —accumulator temperature higher (warmer) than the orifice tube temperature just remember: High pressure means that the temperature of the component or line is also high (hot). Low pressure means that the temperature of the component or line is also low (cold). For example, the inlet to the compressor (low pressure) should always be cool, whereas outlet of the compressor (high pressure) should always be hot.**
	**16. SLIDE 16 EXPLAIN FIGURE 66–15** If system is fully charged, the outlet temperature of line leaving the evaporator should be about same as temperature of the line entering the evaporator after expansion valve..
	17. FIGURE 66–16 EXPLAIN Typical electronic refrigerant leak detector. Many are capable of detecting either CFC-12 or HFC-134a.
	18. SLIDE 18 EXPLAIN Figure 66-17 black light being used to look for refrigerant leaks after a fluorescent dye was installed in the system.

ICONS	Chapter 66 HVAC System Diagnosis
	**DISCUSSION:** Ask students to discuss methods for detecting leaks in an A/C system.
	**HANDS-ON TASK:** Have students use fluorescent dye and a black light to detect refrigerant leaks. **FIGURES 66-17**
	**OPTIONAL HANDS-ON TASK:** Have students use a **soap-and-water solution** to detect a refrigerant **leak** in an air-conditioning system.
	**HANDS-ON TASK:** Have students perform a **refrigerant leak test on evaporator** by removing blower motor resistor pack and using a leak detector in open area.
	**ON-VEHICLE ASEEDUCATION TASK A6** Leak test the air conditioning system; determine necessary action.
	
	**ON-VEHICLE ASEEDUCATION TASK A7.** Inspect for proper A/C condenser airflow; determine needed action.
	
	**ON-VEHICLE ASEEDUCATION TASK B11.** Diagnose A/C system conditions that cause the protection devices (pressure, thermal, and/or control module) to interrupt system operation; determine needed action.