

# Introduction to Automotive Service

## Chapter 27 Heating & Air-Conditioning Systems

### Opening Your Class

KEY ELEMENT	EXAMPLES
<b>Introduce Content</b>	This course or class serves as an introduction to the world of automotive service. It correlates material to task lists specified by ASE and NATEF.
<b>Motivate Learners</b>	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.
<b>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.</b>	<p>Explain learning objectives to students.</p> <ol style="list-style-type: none"> <li>1. Prepare for ASE Heating and Air-conditioning (A7) certification test content area "A" (Air Conditioning System Diagnosis and Repair) and content area "C" (Heating and Engine Cooling Systems Diagnosis and Repair).</li> <li>2. Describe how the heater functions.</li> <li>3. Describe how the refrigeration cycle functions.</li> <li>4. List the parts of a typical air-conditioning system.</li> <li>5. Explain how the air-conditioning system removes heat from the passenger compartment.</li> <li>6. Describe how to check for refrigerant leaks.</li> <li>7. Check for proper heater operation.</li> <li>8. Describe how to measure air conditioning outlet temperature.</li> </ol>
<b>Establish the Mood or Climate</b>	Provide a <b>WELCOME</b> , Avoid put downs and bad jokes.
<b>Complete Essentials</b>	Restrooms, breaks, registration, tests, etc.
<b>Clarify and Establish Knowledge Base</b>	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



## Ch27 Heating & Air-Conditioning Systems

### 1. SLIDE 1 Ch27 HEATING & AIR-CONDITIONING

Check for **ADDITIONAL VIDEOS & ANIMATIONS @**  
<http://www.jameshalderman.com/>  
**WEB SITE IS UPDATED REGULARLY**

2. **SLIDE 2 EXPLAIN** Heating, Ventilation, and Air Conditioning System
3. **SLIDE 3 EXPLAIN** Heating System
4. **SLIDE 4 EXPLAIN FIGURE 27-1** Typical flow of air through an automotive heat, ventilation, and air conditioning system when placed in the heat position
5. **SLIDE 5 EXPLAIN FIGURE 27-2** A typical blower motor assembly with attached squirrel-cage blower is used to move air into passenger compartment through ducts, hoses, and vents located under the dashboard

### Heat Transfer SHOW ANIMATION

<http://www.jameshalderman.com/>

**DEMONSTRATION: Borrow either a hygrometer or a psychrometer (**FIGURE 62-4**) from your school's science lab, and show students how they are used to measure relative humidity.**

6. **SLIDE 6 EXPLAIN** Heater Operation Diagnosis
7. **SLIDE 7 EXPLAIN FIGURE 27-3** Heater hoses are the smaller coolant hoses that run from and back to the engine
8. **SLIDE 8 EXPLAIN** Heater Operation Diagnosis

### Blower SHOW ANIMATION

<http://www.jameshalderman.com/>

### Air Conditioning (79 Links) **VIDEOS**

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9. SLIDE 9 **EXPLAIN** Air Conditioning System
10. SLIDE 10 **EXPLAIN** FIGURE 27-4 Water is a substance that can be found naturally in solid, liquid, and vapor states

### A/C System Operation

SHOW ANIMATION

<http://www.jameshalderman.com/>

**DISCUSSION:** Ask students to discuss the three states of water and how they relate to automotive heating and air-conditioning systems. Explain how molecules of water are moving at different states. Ask why there has to be an unbalanced force for the molecules to transfer heat.

Show ANIMATION: Latent Heat of Evaporation [www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/A77\\_Animation/Chapter48\\_Fig\\_48\\_2/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A77_Animation/Chapter48_Fig_48_2/index.htm)

11. SLIDE 11 **EXPLAIN** Air Conditioning Refrigeration Cycle

### A/C System Operation

SHOW ANIMATION

<http://www.jameshalderman.com/>

### Conduction SHOW ANIMATION

<http://www.jameshalderman.com/>

### Convection SHOW ANIMATION

<http://www.jameshalderman.com/>

**DISCUSSION:** Ask students to talk about the differences between kinetic and potential energy. Have them give examples of each in both automotive and non-automotive applications.

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**DISCUSSION:** Ask students to discuss why aerosol cans become cold when sprayed continuously and why a can of nonflammable refrigerant can explode when heated by fire.

**Hint:** Have them focus on relationship between pressure and temperature for a vapor.

**DISCUSSION:** Asks students to discuss the relationships between pressure and temperature in an HVAC system.

12. **SLIDE 12 EXPLAIN** Figure 27-5 evaporator serves to allow the liquid refrigerant to evaporate and absorb heat from the passenger compartment. The evaporator is located inside the passenger compartment in the dash area usually behind the glove compartment
13. **SLIDE 13 EXPLAIN FIGURE 27-6** A typical air conditioning compressor that is belt driven
14. **SLIDE 14 EXPLAIN FIGURE 27-7** evaporator serves the same function for both the orifice-tube and the expansion valve-type air conditioning system and that is to allow the liquid refrigerant to evaporate and absorb heat from the passenger compartment

**DEMONSTRATION:** Show students an A/C compressor electromagnetic clutch & describe its purpose & function. Show clutch engaging. Explain how diode prevents a voltage spike that could cause damage to PCM.

15. **SLIDE 15 EXPLAIN FIGURE 27-8** Air flows through the vent to the passenger compartment. Above this vent on the driver's side is another smaller vent used to demist the driver's door glass

**DEMONSTRATION: USE LAB VEHICLE** Show students the parts of an automotive heating system, including heater hoses & heater core. Also show them blower motor that sends heated air into passenger compartment. Use an infrared thermometer to show temperature differences on high and low sides of AC system & heating system.

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Some DMMs come with a temperature probe for checking temperatures. Use this on the radiator hoses to check for a thermostat opening. Also, INFRARED temperature guns are available to check temperatures.

**DEMONSTRATION:** Show students the parts of an automotive cooling system. Point out the compressor and explain how it works.

**DISCUSSION:** Ask students to talk about how heat is absorbed by an automotive A/C system

Show ANIMATION: Refrigerant Flow  
[www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/A77\\_Animation/Chapter48\\_Fig\\_48\\_22/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A77_Animation/Chapter48_Fig_48_22/index.htm)

**DEMONSTRATION:** Show students an expansion valve, describe its purpose, and explain how it works

Show ANIMATION: Expansion Valve OP  
[www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/A77\\_Animation/Chapter48\\_Fig\\_48\\_29/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A77_Animation/Chapter48_Fig_48_29/index.htm)

**DISCUSSION:** Ask students to discuss how thermostatic control is used to prevent the temperature of the evaporator from dropping below 32°F (0°C). What would be the result if it did fall below this temperature?

16. SLIDE 16 **EXPLAIN** Refrigerants & Refrigerant oils
17. SLIDE 17 **EXPLAIN** FIGURE 27-9 R-134a is available in 12-oz cans as well as larger 30-lb containers
18. SLIDE 18 **EXPLAIN** FIGURE 27-10 label on a Toyota Fuel Cell Hybrid Vehicle (FCHV) showing that CO<sub>2</sub> is being used as refrigerant

**DISCUSSION:** Ask students to talk about the requirements of automotive technicians stemming from Section 609 of the Clean Air Act of 1990

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DEMO



DEMO



DEMO

DEMO



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**DEMONSTRATION:** Show students an **orifice tube**, describe its purpose, and explain how it works. Show them special tool required to remove orifice tube from system

All cars since 1990s use HFC-134a as a refrigerant because it is less harmful to ozone layer than its predecessor, CFC-12. Ask students to **DISCUSS** why this is so important.

Show **ANIMATION: OZONE DEPLETION**  
[www.myautomotivelab.com](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A77_Animation/Chapter48_Fig_48_15/index.htm)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/A77\\_Animation/Chapter48\\_Fig\\_48\\_15/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A77_Animation/Chapter48_Fig_48_15/index.htm)

**DEMONSTRATION:** Show students the tester for identifying refrigerant gases

**DISCUSSION:** Ask students to talk about the types of refrigerants that have been used in automotive systems and in residential home AC systems. How do these refrigerants work? Why is CFC-12 no longer used?

Residential home refrigerants can't be used in automotive systems, **EXCEPT IN BUSES.**

**DEMONSTRATION:** Show students a **Condenser** & explain its purpose and function. Use a condenser that has a cut-through area to show that the tubes are hollow

**DEMONSTRATION:** Show students' evaporator in an automotive A/C system. Describe its purpose and how it works

19. **SLIDE 19 EXPLAIN** Receiver-Drier; Refrigerant Lines and Hoses
20. **SLIDE 20 EXPLAIN FIGURE 27-11** Some systems store excess refrigerant in a receiver-drier, which is



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located in high-side liquid section of the system, whereas other systems (orifice-tube systems) store excess refrigerant in an accumulator located in low-side vapor section of system

**DEMONSTRATION:** Show students **Receiver-Drier** in an automotive A/C system and describe its purpose and function

**DISCUSSION:** Ask students to talk about the role of the desiccant in the drier. What would happen if it were omitted?

**DEMONSTRATION:** Show students the **Accumulator** on an orifice tube system (**FIGURE 62-22**). Describe its purpose and how it works

21. **SLIDE 21 EXPLAIN** FIGURE 27-12 Aluminum tubing lines and accumulator have service valves that are used to test system pressures and to evacuate & recharge system using a recovery and recharging machine

**DISCUSSION:** Ask students to discuss how refrigerant lines and hoses differ from radiator cooling system hoses?

22. **SLIDE 22 EXPLAIN** Air Conditioning System Checks
23. **SLIDE 23 EXPLAIN** FIGURE 27-13 An air conditioning thermometer being used to check the discharge temperature at the center vents
24. **SLIDE 24 EXPLAIN** Air Conditioning System Checks
25. **SLIDE 25 EXPLAIN** FIGURE 27-14 An electronic leak detector being used to check for leaks at the hoses and connections of an air conditioning system

**ON-VEHICLE NATEF TASK (A7-A-4)** Locate and interpret vehicle and major component identification numbers. **(P-1) Page 184**

**Homework:** complete Ch27 crossword puzzle:  
[http://www.jameshalderman.com/links/book\\_intro/cw/crossword\\_ch\\_27.pdf](http://www.jameshalderman.com/links/book_intro/cw/crossword_ch_27.pdf)