















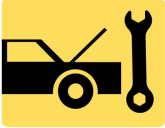





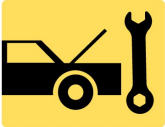
Automotive Maintenance and Light Repair, 1ST Edition








Chapter 42 Emission Control Devices




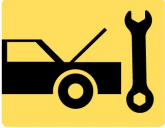






Opening Your Class

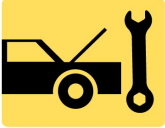







KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers Automotive Maintenance and Light Repair . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure 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. <ul style="list-style-type: none">— Prepare for the ASE Engine Performance (A8) certification test content area “D” (Emission Control Systems).— Describe the purpose and function of the exhaust gas recirculation (EGR) system.— Describe the purpose and function of the positive crankcase ventilation (PCV).— Describe the purpose and function of the secondary air-injection (SAI) reaction system.— Describe the purpose and function of the catalytic converter.— Describe the purpose and function of the evaporative emission control system.
Establish the Mood or Climate	Provide a <i>WELCOME</i> , 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.

ICONS	Ch42 Emission Control Devices
       <p data-bbox="354 995 457 1020">QUESTION</p>    	<p data-bbox="626 302 1364 382"> 1. SLIDE 1 CH42 Emission Control Devices 2. SLIDES 2-3 EXPLAIN OBJECTIVES </p> <p data-bbox="626 432 1390 550"> Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE REGULARLY UPDATED </p> <p data-bbox="626 575 1416 688"> 4. SLIDE 4 EXPLAIN SMOG 5. SLIDE 5 EXPLAIN FIGURE 42-1 Nitrogen oxides (NOx) create red-brown haze often hangs over major cities </p> <p data-bbox="587 709 1399 781"> 6. SLIDE 6 EXPLAIN Exhaust Gas Recirculation Systems <u>EXHAUST GAS RECIRCULATION, EGR</u> </p> <p data-bbox="587 890 1406 1176"> <u>DISCUSSION: HAVE THE STUDENTS TALK ABOUT HOW EGR SYSTEMS ARE DESIGNED TO RECIRCULATE EXHAUST INTO THE COMBUSTION CHAMBER. WHAT CONDITIONS MUST BE PRESENT TO ALLOW PROPER ENGINE OPERATION WHILE EXHAUST IS RECIRCULATED? FIGURE 42-1</u> </p> <p data-bbox="626 1192 1383 1297"> 7. SLIDE 7 EXPLAIN Figure 42-2 When the EGR valve opens, the exhaust gases flow through the valve and into passages in the intake manifold </p> <p data-bbox="587 1323 1419 1646"> <u>DEMONSTRATION: WHILE APPLYING VACUUM USING A HAND-HELD PUMP, OPEN & CLOSE A STANDARD EGR VALVE SO STUDENTS CAN SEE DIAPHRAGM & VALVE OPERATION. FIGURE 42-2</u> <u>DEMONSTRATION: PASS AROUND VARIOUS EGR VALVES TO THE STUDENTS. POINT OUT POSITIVE AND NEGATIVE FIGURE 42-2 BACKPRESSURE STYLES AND HOW THEY VARY.</u> </p> <p data-bbox="587 1654 1354 1797"> EGR VALVES CAN BE TESTED FOR LEAKAGE BY INVERTING AND SPRAYING CARBURETOR CLEANER INTO THE PINTLE VALVE. IF CLEANER LEAKS PAST PINTLE, VALVE IS DEFECTIVE. </p>

ICONS	Ch42 Emission Control Devices
	<p><u>DEMONSTRATION:</u> PASS AROUND BOTH DIGITAL & LINEAR EGR VALVES FOR THE STUDENTS TO SEE.</p>
	<p><u>DEMONSTRATION:</u> PASS AROUND <u>VARIOUS TYPES OF EGR VALVE POSITION SENSORS</u> FOR THE STUDENTS TO SEE</p>
	<p>8. SLIDE 8 EXPLAIN Figure 42-3 GM ELECTRONIC EGR valve</p>
	<p><u>HANDS-ON TASK:</u> HAVE STUDENTS <u>GRADUALLY OPEN EGR VALVE</u> WITH A HAND OPERATED VACUUM PUMP. HAVE THEM USE AN <u>OHMMETER</u> TO CHECK VALVE POSITION SENSOR RESISTANCE AT VARIOUS VALVE OPENINGS.</p>
	<p><u>DISCUSSION:</u> DISCUSS THE DIFFERENCE BETWEEN <u>LINEAR AND DIGITAL EGR VALVES.</u> WHAT IS THE DIFFERENCE?</p>
	<p><u>DISCUSSION:</u> ASK STUDENTS TO DISCUSS & LIST POSSIBLE SYMPTOMS OF A MALFUNCTIONING EGR SYSTEM. WHAT DRIVEABILITY ISSUES COULD BE CAUSED BY TOO MUCH, OR INCORRECT, EGR FLOW OR TIMING? WHAT PROBLEMS CAN BE CAUSED BY NO, TOO LITTLE, EGR FLOW?</p>
	<p>9. SLIDE 9 EXPLAIN OBD-II EGR Monitoring</p>
	<p><u>DISCUSSION:</u> HAVE THE STUDENTS TALK ABOUT THE VARIOUS TYPES OF WARNING LIGHTS THAT OEMS USE & SIGNIFICANCE OF THE AMBER COLOR. WHAT IS <u>MIL</u> & WHAT IS ITS COLOR?</p>
	<p><u>DISCUSSION:</u> DISCUSS <u>OBD II EGR MONITORS.</u> HOW ARE THEY USED IN DIAGNOSIS?</p>
	<p><u>HANDS-ON TASK:</u> HAVE STUDENTS DISCONNECT EGR VACUUM HOSE ON A CAR AND DRIVE IT UNTIL IT MEETS ENABLING CRITERIA FOR <u>EGR MONITOR</u> TO RUN. CONNECT A SCAN TOOL &</p>

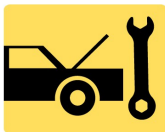
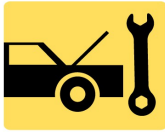
ICONS	Ch42 Emission Control Devices
	<p>RETRIEVE DTC. IF MONITOR RUNS ONLY ONCE, DTC WILL BE STORED AS A PENDING CODE. IF THE MONITOR RUNS TWICE AND FAILS, A MATURED DTC WILL SET, AND THE MIL WILL BE ILLUMINATED.</p> <p>DISCUSSION: HAVE THE STUDENTS DISCUSS <u>DETONATION</u>. WHAT IS DETONATION AND HOW IS IT CAUSED? WHAT ARE ITS EFFECTS? WHAT KIND OF MECHANICAL DAMAGE CAN DETONATION CAUSE TO THE ENGINE?</p>
	<p>HANDS-ON TASK: HAVE THE STUDENTS LOOK UP <u>OEM PROCEDURES FOR TESTING EGR SYSTEM</u> ON THEIR OWN VEHICLES.</p>
	<p>SPEED-DENSITY FUEL SYSTEM MEASURES INTAKE MAP (VACUUM) CAN BE FOOLED BY A STUCK OPEN EGR VALVE. OPEN EGR VALVE ADMITS EXHAUST PRESSURE INTO INTAKE MANIFOLD, WHICH PCM MISINTERPRETS AS AN INCREASE IN ENGINE LOAD, DRIVING FUEL SYSTEM VERY RICH. ADDITIONAL FUEL WILL KEEP ENGINE RUNNING, ALTHOUGH POORLY DUE TO EXCESS EXHAUST. BLACK EXHAUST SMOKE CAUSED BY THIS OVERLY RICH CONDITION CAN CAUSE TECHNICIAN TO MISTAKENLY LOOK FOR FUEL SYSTEM PROBLEM</p>
	<p>DEMONSTRATION: ON A RUNNING ENGINE, APPLY VACUUM INCREMENTALLY TO THE EGR VALVE USING A HAND-HELD VACUUM PUMP. SHOW EFFECT OF INCREASED VACUUM ON ENGINE OPERATION AS EGR VALVE OPENS UP. APPLY ENOUGH VACUUM TO STALL THE ENGINE.</p>
	<p>DEMONSTRATION: ON A VEHICLE WITH EITHER A <u>DIGITAL OR LINEAR EGR VALVE</u>, OPEN THE VALVE INCREMENTALLY WITH A BIDIRECTIONAL <u>SCAN TOOL</u> TO SHOW STUDENTS ITS EFFECTS</p>
	<p>10. SLIDE 10 EXPLAIN Positive Crankcase Ventilation</p>
	<p>ANIMATION: <u>PCV OPERATION</u> <u>WWW.MYAUTOMOTIVELAB.COM</u> <small>HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A1_ANIMATION/CHAPTER19_FIG_19_12&13/INDEX.HTM</small></p>

ICONS	Ch42 Emission Control Devices
 	<p><u>DEMONSTRATION: PASS AROUND VARIOUS PCV VALVES FOR THE STUDENTS TO SEE. STUDENTS SHOULD UNDERSTAND WHERE THE PCV VALVE CAN BE LOCATED ON AN ENGINE</u></p> <ol style="list-style-type: none"> 11. SLIDE 11 EXPLAIN FIGURE 42-4 PCV valve and hose on a Ford 5.0-liter V-8. Many are hard to see as they are hidden from view under plastic covers. 12. SLIDE 12 EXPLAIN Figure 42-5 Spring force, crankcase pressure, and intake manifold vacuum work together to regulate the flow rate through the PCV valve
 	<p><u>DEMONSTRATION: SHOW THE STUDENTS HOW TO CHECK VALVE OPERATION BY SHAKING THE VALVE.</u></p> <p><u>HANDS-ON TASK: HAVE THE STUDENTS LOCATE PCV SYSTEM COMPONENTS ON THEIR OWN VEHICLES. ASK THEM TO EXPLAIN HOW AIR FLOWS THROUGH THE SYSTEM.</u></p>
  <p>QUESTION</p>	<p><u>DISCUSSION: DISCUSS WHAT CAN HAPPEN TO A PCV SYSTEM FROM A VEHICLE OWNER WHO NEGLECTS OR EXTENDS NORMAL OIL AND FILTER REPLACEMENTS. WHAT PROBLEMS CAN RESTRICTED AIRFLOW CAUSE?</u></p>
 	<p><u>DEMONSTRATION: SHOW STUDENTS EXAMPLES OF PLUGGED, DIRTY, OR STUCK PCV VALVES.</u></p> <p><u>DON'T OVERLOOK MALFUNCTIONING PCV SYSTEM WHEN DIAGNOSING EXCESSIVE OIL LEAKS. PLUGGED PCV SYSTEM CAN CREATE EXCESS PRESSURE IN CRANKCASE DUE TO ACCUMULATION OF COMBUSTION VAPORS. THIS EXCESS PRESSURE CAN FORCE OIL OUT OF CRANKCASE THROUGH ENGINE SEALS & GASKETS</u></p>
 	<p><u>DEMONSTRATION: SHOW HOW TO CHECK FOR A SLIGHT VACUUM ON A RUNNING ENGINE BY USING A 3 X 5 INDEX CARD. PINCH VACUUM LINE BETWEEN INTAKE MANIFOLD AND PCV VALVE TO ILLUSTRATE PLUGGED OR OBSTRUCTED SYSTEM WITH NO VACUUM.</u></p>

ICONS	Ch42 Emission Control Devices
	<p>HANDS-ON TASK: PERFORM THE SNAP-BACK TEST ON A PCV VALVE ON A RUNNING ENGINE BY PLACING THEIR FINGER OVER VALVE INLET. STUDENTS SHOULD LISTEN & FEEL FOR CLICK WHEN THEY REMOVE THEIR FINGER INDICATING THE VALVE IS FUNCTIONING PROPERLY.</p>
	<p>NATEF MLR TASK A8D1 INSPECT, TEST, AND SERVICE POSITIVE CRANKCASE VENTILATION (PCV) FILTER/BREATHER CAP, VALVE, TUBES, ORIFICES, AND HOSES; PERFORM NECESSARY ACTION.</p>
	<p>13. SLIDE 13 EXPLAIN Secondary Air-Injection System 14. SLIDE 14 EXPLAIN Figure 42-6 typical belt-driven AIR pump. Air enters through revolving fins behind the drive pulley. The fins act as an air filter because dirt is heavier than air, and therefore the dirt is deflected off of the fins at the same time air is being drawn into the pump</p>
	<p><u>DEMONSTRATION: SHOW AIR INJECTION PUMPS. MOST BELT-DRIVEN PUMPS CAN BE EASILY DISASSEMBLED TO SHOW THEIR INTERNAL COMPONENTS. FIGURE 42-6</u></p>
	<p>15. SLIDE 15 EXPLAIN Secondary Air-Injection System 16. SLIDE 16 EXPLAIN Figure 42-7 external air manifold and exhaust check valve on a restored muscle car engine</p>
	<p><u>DEMONSTRATION: SHOW VARIOUS AIR DISTRIBUTION MANIFOLDS & EXHAUST CHECK VALVES. DEMO CHECK VALVE OPERATION BY ATTEMPTING TO BLOW AIR THROUGH EACH SIDE. IF VALVE IS GOOD, AIR SHOULD PASS THROUGH ONLY ONE SIDE</u></p>
	<p>17. SLIDE 17 EXPLAIN Figure 42-8 typical electric motor-driven SAI pump. This unit is on a Chevrolet Corvette and only works when the engine is cold</p>
	<p><u>DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE VARIOUS CONDITIONS THAT REQUIRE AIR INJECTION & AREAS THAT WILL RECEIVE AIR INJECTION. UNDER WHAT CONDITIONS DOES THE SAI SYSTEM OPERATE, AND WHERE DOES IT INJECT AIR?</u></p>

ICONS

Ch42 Emission Control Devices



ANIMATION: CATALYTIC CONVERTER OP **WWW.MYAUTOMOTIVELAB.COM**

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A16 ANIMATION/CHAPTER62 FIG 62 22/INDEX.HTM](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/a16_animation/chapter62_fig_62_22/index.htm)

18. **SLIDE 18 EXPLAIN** Catalytic Converters
19. **SLIDE 19 EXPLAIN** **Figure 42-9** Most catalytic converters are located as close to the exhaust manifold as possible, as seen in this display of a Chevrolet Corvette
20. **SLIDE 20 EXPLAIN** **Figure 42-10** three-way catalytic converter first separates the NO_x into nitrogen and oxygen and then converts the HC and CO into harmless water (H_2O) and carbon dioxide (CO_2). The nitrogen (N) passes through the converter and exits the tailpipe and enters the atmosphere which is about 78% nitrogen.

DEMONSTRATION: WITH A VEHICLE ON LIFT, SHOW INSTALLED CATALYTIC CONVERTERS & THEIR LOCATIONS. POINT OUT THE REDUCTION CATALYST & OXIDIZING CATALYST.

BECAUSE PRICES OF PRECIOUS METALS USED IN CATALYTIC CONVERTERS HAVE RISEN STEEPLY IN THE PAST FEW YEARS, THESE COMPONENTS HAVE BECOME POPULAR AMONG THIEVES. OWNERS OF TRUCKS & 4WD VEHICLES HAVE RETURNED TO THEIR PARKED VEHICLES TO FIND THAT THIEVES HAVE STOLEN THEIR CATALYTIC CONVERTERS WITH BATTERY-POWERED RECIPROCATING SAW. REPLACEMENTS CAN RUN AS HIGH AS \$2,500.

DISCUSSION: DISCUSS HOW OFTEN PCM TESTS CATALYTIC CONVERTER. HOW IS CATALYTIC CONVERTER MONITOR CLASSIFIED? WHEN WILL MONITOR CHECK EFFICIENCY OF CONVERTER? WHAT WILL HAPPEN IF TEST FAILS?

DEMONSTRATION: TALK ABOUT DIAGNOSING CATALYTIC CONVERTERS. HOW ARE CATALYTIC CONVERTERS TESTED?

DEMONSTRATION: CONNECT A DIGITAL STORAGE OSCILLOSCOPE (DSO) TO AN UPSTREAM OXYGEN SENSOR & OPERATE ENGINE AT NORMAL OPERATING TEMPERATURE. SHOW WAVEFORM OF AN UPSTREAM OXYGEN SENSOR IN OPERATION.

ICONS

Ch42 Emission Control Devices

DEMO



DEMONSTRATION: INSTALL EXHAUST BACK PRESSURE GAUGE IN PLACE OF AN OXYGEN SENSOR, LEAVE OXYGEN SENSOR CONNECTED WHILE IT IS REMOVED AND OPERATE ENGINE, SHOWING STUDENTS NORMAL BACK PRESSURE. INSTALL EXPANDABLE PLUG IN TAILPIPE TO SIMULATE A PLUGGED CONVERTER AND HAVE STUDENTS WATCH BACK PRESSURE INCREASE.



**ANIMATION: CATALYTIC CONVERTER
DIAG:WWW.MYAUTOMOTIVELAB.COM**

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A1_ANIMATION/CHAPTER19 FIG_19_27/INDEX.HTM](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/a1_animation/chapter19_fig_19_27/index.htm)



QUESTION

DISCUSSION: DISCUSS WITH THE STUDENTS THAT AN OVERLY RICH MIXTURE OR ANY MALFUNCTION SUCH AS MISFIRE CAN ALLOW UNBURNED HYDROCARBONS TO ENTER CATALYTIC CONVERTER. HOW DOES THIS AFFECT THE CATALYTIC CONVERTER? (POINT OUT THAT THIS CAN CAUSE THE CONVERTER TO MELT INTERNALLY AND CAN EVEN SET ON FIRE)

DEMO



DEMONSTRATION: WITH VEHICLE ON A LIFT, CREATE A MISFIRE; FOR EXAMPLE, CLOSE ELECTRODES ON A SPARK PLUG. OPERATE AT 2,500 RPM UNTIL THE CONVERTER BEGINS TO OVERHEAT AND STUDENTS OBSERVE THE SMELL OF ROTTEN EGGS. CONTINUE OPERATING VEHICLE FOR A FEW MORE MINUTES, CHECK CONVERTER TEMPERATURE WITH INFRARED THERMOMETER TO SHOW STUDENTS EXTREME OVERHEAT CONDITION.










DEMO


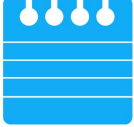






DEMONSTRATION: DEMONSTRATE CATALYTIC CONVERTER OPERATION BY TESTING EXHAUST EMISSIONS WITH 5-GAS ANALYZER BEFORE AND AFTER CONVERTER RUNS. REMOVE THE UPSTREAM OXYGEN SENSOR AFTER THE ENGINE HAS WARMED UP, THEN OPERATE ENGINE WITH SENSOR CONNECTED AND INSERT ANALYZER PROBE INTO SENSOR BOSS WHILE SAMPLING.



21. SLIDE 21 EXPLAIN Evaporative Emission Control System

ICONS	Ch42 Emission Control Devices
	<p>22. SLIDE 22 EXPLAIN FIGURE 42-11 charcoal canister can be located under the hood or underneath the vehicle.</p>
	<p>23. SLIDE 23 EXPLAIN FIGURE 42-12 enhanced EVAP system is able to perform system and leak detection diagnosis.</p> <p>DISCUSSION: HAVE THE STUDENTS LIST AND DESCRIBE MAIN FUNCTIONS OF THE EVAPORATIVE SYSTEM & POTENTIAL PROBLEMS. WHAT IS THE SYSTEM DESIGNED TO DO WITH FUEL VAPORS (HYDROCARBONS)? WHAT ARE POTENTIAL PROBLEMS WITH THE SYSTEM?</p>
	<p>24. SLIDE 24 EXPLAIN Evaporative Emission Control System.</p>
	<p>DEMONSTRATION: PASS AROUND EXAMPLES OF EVAPORATIVE PURGE & VENT SOLENOIDS. SHOW HOW TO LOCATE PURGE AND VENT SOLENOIDS ON A VEHICLE USING ELECTRICAL COMPONENT LOCATOR.</p>
	<p>25. SLIDE 25 EXPLAIN FIGURE 42-13 Some vehicles will display a message if an evaporative control system leak is detected that could be the result of a loose gas cap.</p>
	<p>Pressure conversions. <i>NOTE: 1 PSI = 28 in. H₂O, 0.25 PSI = 7 in. H₂O</i></p> <p>HANDS-ON TASK: STUDENTS CUT OPEN A USED EVAPORATIVE CANISTER TO SHOW THE STUDENTS WHAT ACTIVATED CHARCOAL GRANULES LOOK LIKE.</p>
	<p><u>SAFETY</u> REMIND THE STUDENTS OF <u>EXTREME FIRE HAZARD</u> OF WORKING AROUND & SERVICING EVAPORATIVE EMISSION SYSTEM ON A VEHICLE. <u>FUEL VAPORS ARE EXTREMELY EXPLOSIVE.</u></p>
	<p>DEMONSTRATION: SHOW THE STUDENTS HOW TO USE A VEHICLE UNDERHOOD ECS LABEL & WIRING DIAGRAM AND/OR VACUUM DIAGRAM TO DETERMINE WHETHER THE VEHICLE HAS AN ENHANCED OR NON-ENHANCED SYSTEM</p>
	

ICONS	Ch42 Emission Control Devices
     	<p>HANDS-ON TASK: ASK THE STUDENTS TO IDENTIFY AND LOCATE PURGE SOLENOID & EVAPORATIVE CANISTERS ON THEIR OWN CARS USING OEM SERVICE INFORMATION.</p> <p>STUDENTS CAN EASILY REMEMBER REST POSITION OF BOTH PURGE & VENT SOLENOIDS (NORMALLY CLOSED & NORMALLY OPEN, RESPECTIVELY) BY USING ANALOGY OF A HOME'S FRONT & BACK DOORS. FRONT DOOR IS USUALLY CLOSED, WHEREAS BACK DOOR IS FREQUENTLY LEFT OPEN.</p> <p><u>SAFETY</u> REMIND STUDENTS THAT IT IS IMPERATIVE TO USE AN INERT GAS SUCH AS <u>NITROGEN</u> TO PREVENT POSSIBLE EXPLOSIONS WHEN PRESSURE-CHECKING EVAPORATIVE EMISSION SYSTEM FOR LEAKS. USING COMPRESSED AIR COULD PRODUCE A <u>FLAMMABLE MIXTURE OF FUEL VAPORS AND OXYGEN.</u></p> <p><u>NATEF MLR TASK A8B2</u> DESCRIBE THE IMPORTANCE OF OPERATING ALL OBDII MONITORS FOR REPAIR VERIFICATION.</p>