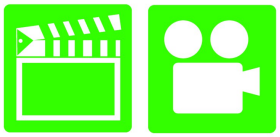
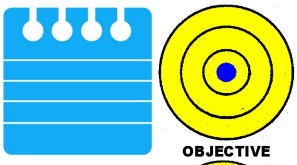
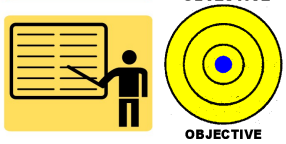
A8 Engine Performance 4th Edition

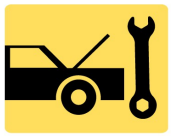
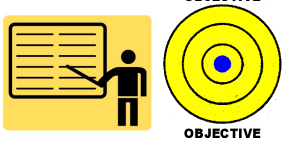
Chapter 32 Emission Control Devices Operation & Testing

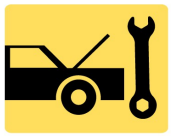
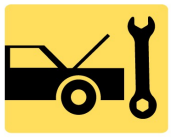
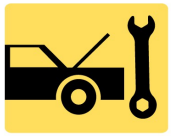
Opening Your Class

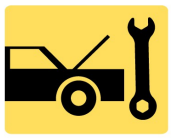
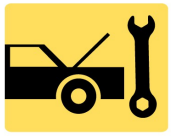
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Engine Performance.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge 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. 1. Prepare for ASE Engine Performance (A8) certification test content area "D" (emission Control Systems). 2. Describe the purpose and function of the exhaust gas recirculation system. 3. Explain methods for diagnosing and testing for faults in the exhaust gas recirculation system. 4. Describe the purpose and function of the positive crankcase ventilation and the air injection reaction system. 5. Explain methods for diagnosing and testing faults in the PCV and AIR systems. 6. Describe the purpose and function of the catalytic converter. 7. Explain the method for diagnosing and testing the catalytic converter. 8. Describe the purpose and function of the evaporative emission control system. 9. Discuss how the evaporative emission control system is tested under OBD-II regulations. 10. Explain methods for diagnosing and testing faults in the evaporative emission control system.
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.

ICONS	Ch32 Emission Control Devices
	1. SLIDE 1 CH32 Emission Control Devices Operation & Testing
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE REGULARLY UPDATED
	POWER POINTS DONE BY INDIVIDUAL LEARNING OBJECTIVES, SO THERE IS POWER POINT FILE FOR EACH LEARNING OBJECTIVE
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO1 3. SLIDE 3 EXPLAIN SMOG
	4. SLIDE 4 EXPLAIN FIGURE 32-1 Notice the haze caused by nitrogen oxides that is often over many major cities.
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO2 3. SLIDE 3 EXPLAIN FIGURE 32-1 Notice the haze caused by nitrogen oxides that is often over many major cities. 4. SLIDE 4 EXPLAIN Exhaust Gas Recirculation Systems: NOx Formation 5. SLIDES 5-6 EXPLAIN Exhaust Gas Recirculation Systems: Controlling NOx
	EXHAUST GAS RECIRULATION, EGR
	DISCUSSION: DISCUSS 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 32-1
	7. SLIDE 7 EXPLAIN Figure 32-2 When the EGR valve opens, the exhaust gases flow through the valve and into passages in the intake manifold

ICONS	Ch32 Emission Control Devices
DEMO	**DEMONSTRATION: WHILE APPLYING VACUUM USING A HAND-HELD PUMP, OPEN & CLOSE A STANDARD EGR VALVE SO STUDENTS CAN SEE DIAPHRAGM & VALVE OPERATION. FIGURE 32-2**
DEMO	**DEMONSTRATION: PASS AROUND VARIOUS EGR VALVES TO THE STUDENTS. POINT OUT POSITIVE AND NEGATIVE FIGURE 32-2 BACKPRESSURE STYLES AND HOW THEY VARY.**
	8. **SLIDE 8 EXPLAIN Figure 32-3** Back pressure in the exhaust system is used to close the control valve, allowing engine vacuum to open the EGR valve.
	9. **SLIDES 9-13 EXPLAIN** Exhaust Gas Recirculation Systems
	14. **SLIDE 14 EXPLAIN Figure 32-4** Typical vacuum-operated EGR valve. The operation of the valve is controlled by the PCM by pulsing the EGR control solenoid on and off.
	15. **SLIDE 15 EXPLAIN Computer Controlled** Exhaust Gas Recirculation Systems Digital EGR Valves
	**EGR VALVES CAN BE TESTED FOR LEAKAGE BY INVERTING AND SPRAYING CARBURETOR CLEANER INTO THE PINTLE VALVE. IF THE CARBURETOR CLEANER LEAKS PAST PINTLE, VALVE IS DEFECTIVE.**
	16. **SLIDE 16 EXPLAIN Figure 32-5** An EGR valve position sensor on top of an EGR valve
DEMO	**DEMONSTRATION: PASS AROUND BOTH DIGITAL & LINEAR EGR VALVES FOR THE STUDENTS TO SEE. FIGURES 32-3, 4, & 5**
DEMO	**DEMONSTRATION: PASS AROUND VARIOUS TYPES OF EGR VALVE POSITION SENSORS FOR THE STUDENTS TO SEE. FIG 32-3, 4, & 5**
	17. **SLIDE 17 EXPLAIN Figure 32-6** Digital EGR valve as used on some older General Motors engines.
	23. **SLIDE 23 EXPLAIN Figure 32-7** GM linear EGR valve

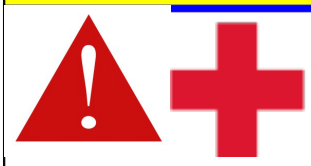
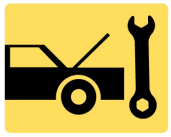
ICONS	Ch32 Emission Control Devices
	**HANDS-ON TASK: HAVE STUDENTS GRADUALLY OPEN EGR VALVE WITH A HAND OPERATED VACUUM PUMP. HAVE THEM USE AN OHMMETER TO CHECK VALVE POSITION SENSOR RESISTANCE AT VARIOUS VALVE OPENINGS.**
	**DISCUSSION: DISCUSS THE DIFFERENCE BETWEEN LINEAR AND DIGITAL EGR VALVES. WHAT IS THE DIFFERENCE? FIG 32-6, 7, & 8**
	**DISCUSSION: 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?**
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO3** **REPEAT SLIDES 3 to 23 FROM AEP_LO2**
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO4** 3. SLIDES 3-4 EXPLAIN PCV DIAGNOSIS
	**ANIMATION: PCV OPERATION WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A1_ANIMATION/CHAPTER19_FIG_19_12&13/INDEX.HTM
	**DEMONSTRATION: PASS AROUND VARIOUS PCV VALVES FOR THE STUDENTS TO SEE. STUDENTS SHOULD UNDERSTAND WHERE THE PCV VALVE CAN BE LOCATED ON AN ENGINE**
	5. SLIDE 5 EXPLAIN FIGURE 32-15 PCV valve operation in the event of a backfire 6. SLIDE 6 EXPLAIN FIGURE 32-16 Most PCV valves used on newer vehicles are secured with fasteners, which makes it more difficult to disconnect and thereby less likely to increase emissions.
	**DEMONSTRATION: SHOW HOW TO CHECK VALVE OPERATION BY SHAKING THE VALVE.**

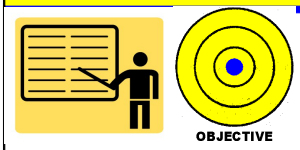
ICONS	Ch32 Emission Control Devices
	HANDS-ON TASK: HAVE THE STUDENTS LOCATE PCV SYSTEM COMPONENTS ON THEIR OWN VEHICLES. ASK THEM TO EXPLAIN HOW AIR FLOWS THROUGH THE SYSTEM.
	DISCUSSION: HAVE THE STUDENTS TALK ABOUT WHAT CAN HAPPEN TO A PCV SYSTEM FROM A VEHICLE OWNER WHO NEGLECTS OR EXTENDS NORMAL OIL AND FILTER REPLACEMENTS. WHAT PROBLEMS CAN RESTRICTED AIRFLOW CAUSE?
	DEMONSTRATION: SHOW STUDENTS EXAMPLES OF PLUGGED, DIRTY, OR STUCK PCV VALVES.
	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.
	HANDS-ON TASK: SHOW THE STUDENTS AN ORIFICE-CONTROLLED CRANKCASE VENTILATION SYSTEM. HAVE THEM LOCATE & LABEL MAIN COMPONENTS & EXPLAIN AIRFLOW THROUGH THE SYSTEM.
	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.
	HANDS-ON TASK: HAVE STUDENTS 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.
	DISCUSSION: HAVE THE STUDENTS TALK ABOUT WHY OBD-II SYSTEM CHECKS OR MONITORS PCV SYSTEM. HOW DO CRANKCASE EMISSIONS

ICONS	Ch32 Emission Control Devices
	AFFECT ATMOSPHERE? WHAT DOES PCV SYSTEM DO TO PREVENT POLLUTION?
	HANDS-ON TASK: HAVE THE STUDENTS RESEARCH A PCV SYSTEM FAILURE DTC. STUDENTS SHOULD BE ABLE TO DETERMINE CONDITIONS THAT CAUSED DTC & OEM TROUBLESHOOTING PROCEDURE FOR DTC.
	ON-VEHICLE NATEF TASK: DIAGNOSE OIL LEAKS, EMISSIONS, AND DRIVEABILITY CONCERNS CAUSED BY THE POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM; DETERMINE NECESSARY ACTION.
	ON-VEHICLE NATEF TASK: INSPECT, TEST AND SERVICE POSITIVE CRANKCASE VENTILATION (PCV) FILTER/BREATHER CAP, VALVE, TUBES, ORIFICES, AND HOSES; PERFORM NECESSARY ACTION.
	7. SLIDE 7 EXPLAIN FIGURE 32-17 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
	DEMONSTRATION: SHOW THE STUDENTS VARIOUS TYPES OF AIR INJECTION PUMPS. MOST BELT-DRIVEN PUMPS CAN BE EASILY DISASSEMBLED TO SHOW THEIR INTERNAL COMPONENTS. FIGURE 32-17
	HANDS-ON TASK: HAVE THE STUDENTS USE ELECTRONIC SERVICE INFORMATION COMPONENT LOCATOR TO LOCATE THE SECONDARY AIR-INJECTION COMPONENTS ON THEIR OWN CARS. STUDENTS SHOULD BE ABLE TO IDENTIFY COMPONENTS AND EXPLAIN THEIR OPERATION AND PURPOSES.
	7. SLIDE 7 EXPLAIN FIGURE 32-18 (a) When the engine is cold and before the oxygen sensor is hot enough to reach closed loop, the air flow is directed to the exhaust manifold(s) through one-way check valve(s). These valves keep exhaust gases from entering the switching solenoids and the air pump itself. (b) When the engine achieves closed loop, the air flows through the pump, is directed to the catalytic converter, and then moves through a check

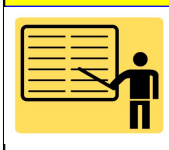
ICONS	Ch32 Emission Control Devices
	valve. 8. **SLIDES 8-11 EXPLAIN Air Distribution Manifolds and Nozzles** 12. **SLIDE 12 EXPLAIN FIGURE 32-19** A typical electric motor-driven AIR pump. This unit is on a Chevrolet Corvette and only works when the engine is cold.
DEMO	**DEMONSTRATION: SHOW VARIOUS AIR DISTRIBUTION MANIFOLDS & EXHAUST CHECK VALVES. DEMONSTRATE CHECK VALVE OPERATION BY ATTEMPTING TO BLOW AIR THROUGH EACH SIDE. IF VALVE IS GOOD, AIR SHOULD PASS THROUGH ONLY ONE SIDE**
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO5** 3. **SLIDE 3 EXPLAIN Crankcase Ventilation**
	4. **SLIDE 4 EXPLAIN FIGURE 32-10** A PCV valve shown in a cutaway valve cover showing the baffles that prevent liquid oil from being drawn into the intake manifold. 5. **SLIDE 5 EXPLAIN FIGURE 32-11** PCV valve in a cutaway valve cover, showing the baffles that prevent liquid oil from being drawn into the intake manifold. 6. **SLIDE 6 EXPLAIN FIGURE 32-12** Spring force, crankcase pressure, and intake manifold vacuum work together to regulate the flow rate through the PCV valve & **EXPLAIN FIGURE 32-13** Air flows through the PCV valve during idle, cruising, and light-load conditions 7. **SLIDE 7 EXPLAIN FIGURE 32-14** Air flows through PCV valve during acceleration & when engine is under a heavy load.
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO6** 3. **SLIDE 3 EXPLAIN Figure 32-28** EVAP system includes all of the lines, hoses, and valves, plus charcoal canister.
	**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?**

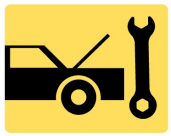
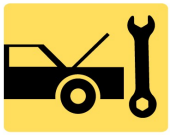
ICONS	Ch32 Emission Control Devices
	4. **SLIDE 4 EXPLAIN Figure 32-29** typical EVAP system. Note that when the computer turns on the canister purge solenoid valve, manifold vacuum draws any stored vapors from the canister into the engine. Manifold vacuum also is applied to the pressure control valve. When this valve opens, fumes from the fuel tank are drawn into the charcoal canister and eventually into the engine. When the solenoid valve is turned off (or the engine stops and there is no manifold vacuum), pressure control valve is spring-loaded shut to keep vapors inside the fuel tank from escaping to atmosphere.
DEMO	**DEMONSTRATION: PASS AROUND EXAMPLES OF EVAPORATIVE PURGE & VENT SOLENOIDS. SHOW HOW TO LOCATE PURGE AND VENT SOLENOIDS ON A VEHICLE USING ELECTRICAL COMPONENT LOCATOR.**
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO7** **REPEAT OF AEP_LO6**
	3. **SLIDE 3 EXPLAIN Figure 32-28** EVAP system includes all of the lines, hoses, and valves, plus charcoal canister. 4. **SLIDE 4 EXPLAIN Figure 32-29** typical EVAP system. Note that when the computer turns on the canister purge solenoid valve, manifold vacuum draws any stored vapors from the canister into the engine. Manifold vacuum also is applied to the pressure control valve. When this valve opens, fumes from the fuel tank are drawn into the charcoal canister and eventually into the engine. When the solenoid valve is turned off (or the engine stops and there is no manifold vacuum), pressure control valve is spring-loaded shut to keep vapors inside the fuel tank from escaping to atmosphere. 5. **SLIDES 5-6 EXPLAIN** Enhanced Evaporative Control System
	2. SLIDE 2 EXPLAIN **OBJECTIVE CH32 AEP_LO8** **REPEAT OF AEP_LO7 SLIDES 5-6**
	3. **SLIDES 3-4 EXPLAIN** Enhanced Evaporative Control System
	HANDS-ON TASK: STUDENTS CUT OPEN A USED EVAPORATIVE CANISTER TO SHOW THE STUDENTS WHAT ACTIVATED CHARCOAL GRANULES LOOK LIKE.

ICONS	Ch32 Emission Control Devices
	**SAFETY** REMIND THE STUDENTS OF **EXTREME FIRE HAZARD** OF WORKING AROUND & SERVICING EVAPORATIVE EMISSION SYSTEM ON A VEHICLE. **FUEL VAPORS ARE EXTREMELY EXPLOSIVE.**
	**DISCUSSION:** HAVE THE STUDENTS TALK ABOUT **FUEL EVAPORATION RATES.** WHAT FACTORS (E.G., ALCOHOL CONTENT, TEMPERATURE, ATMOSPHERIC PRESSURE, ETC.) INFLUENCE FUEL EVAPORATION RATES?
	**DEMONSTRATION:** SHOW HOW TO USE AN **ALCOHOL TEST KIT** TO OBTAIN A SAMPLE OF FUEL FROM A VEHICLE & TEST FOR ALCOHOL CONTENT.
	**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
	**HANDS-ON TASK:** ASK THE STUDENTS TO IDENTIFY AND LOCATE PURGE SOLENOID & EVAPORATIVE CANISTERS ON THEIR OWN CARS USING OEM SERVICE INFORMATION.
	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**. EXPLAIN HOW VENT SOLENOIDS CAN BE TESTED USING JUMPER WIRES AND A 12 V SOURCE TO ALLOW SYSTEM TESTING. REMEMBER, THE VENT SOLENOID IS NORMALLY OPEN AND SHOULD BE ENERGIZED FOR ONLY SHORT PERIODS (5 MINUTES OR LESS) TO PREVENT DAMAGE.
	
	**DEMONSTRATION:** PASS AROUND VARIOUS **LEAK DETECTION PUMPS**. SHOW LOCATION OF THE PUMP ON VEHICLE.

ICONS	Ch32 Emission Control Devices
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO9 3. SLIDE 3-5 EXPLAIN Secondary Air Injection System
	**DEMONSTRATION: USING SMALL DRILL BITS FOR AUTOMATIC TRANSMISSION SERVICE, DRILL TWO .020" & 0.040" HOLES IN A SMALL ALUMINUM PLATE. HAVE STUDENTS OBSERVE DRILLED PLATE SO THEY CAN VISUALIZE SIZE OF LEAK THAT AN ENHANCED SYSTEM MUST DETECT.**
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT LEAK DETECTION PUMP SYSTEMS. WHAT OTHER POSSIBLE METHODS MIGHT MANUFACTURERS USE TO LEAK TEST AN EVAPORATIVE SYSTEM WITHOUT USING A PUMP?**
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO10 3. SLIDE 3-4 EXPLAIN Secondary Air Injection System
	5. SLIDE 5-7 EXPLAIN Inspections
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO11 3. SLIDE 3-5 EXPLAIN Catalytic Converter
	**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
	6. SLIDE 6 EXPLAIN FIGURE 32-18 (a) When the engine is cold and before the oxygen sensor is hot enough to reach closed loop, the air flow is directed to the exhaust manifold(s) through one-way check valve(s). These valves keep exhaust gases from entering the switching solenoids and the air pump itself. (b) When the engine achieves closed loop, the air flows through the pump, is directed to the catalytic converter, and then moves through a check valve. 7. SLIDE 7 EXPLAIN FIGURE 32-20 Most catalytic converters are located as close to the exhaust manifold as possible, as seen in this display of a Chevrolet Corvette 8. SLIDE 8 EXPLAIN FIGURE 32-21 A typical catalytic

ICONS	Ch32 Emission Control Devices
	converter with a monolithic substrate. 9. **SLIDE 9 EXPLAIN FIGURE 32-22** 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.**
	10. **SLIDE 10 EXPLAIN FIGURE 32-23** OBD-II catalytic converter monitor compares signals of upstream and downstream oxygen sensors to determine converter efficiency.
 	**DISCUSSION: HAVE THE STUDENTS DISCUSS HOW OFTEN A PCM TESTS A CATALYTIC CONVERTER. HOW IS CATALYTIC CONVERTER MONITOR CLASSIFIED? WHEN WILL THE MONITOR CHECK THE EFFICIENCY OF CONVERTER? WHAT WILL HAPPEN IF THE 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	Ch32 Emission Control Devices
	2. SLIDE 2 EXPLAIN OBJECTIVE CH32 AEP_LO12 3. SLIDE 3-6 EXPLAIN Inspecting and Testing
	**DEMONSTRATION:** AFTER SHOWING STUDENTS A WAVEFORM OF UPSTREAM OXYGEN SENSOR, CONNECT DSO TO **DOWNSTREAM OXYGEN SENSOR** TO SHOW STUDENTS DIFFERENCE BETWEEN SENSORS. OBD-II USES DOWNSTREAM SENSOR TO CHECK THE EFFICIENCY OF THE CATALYTIC CONVERTER
	**DEMONSTRATION:** SIMULATE A PLUGGED OR MELTED CONVERTER BY INSTALLING AN **EXPANDABLE PLUG** INTO A VEHICLE EXHAUST PIPE. OPERATE VEHICLE ON DYNAMOMETER OR ON A TEST DRIVE WITH VACUUM GAUGE TAPED TO WINDSHIELD. SHOW STUDENTS HOW VACUUM DROPS AS EXHAUST BACK PRESSURE INCREASES, CAUSING A SUBSTANTIAL DROP IN ENGINE PERFORMANCE. REMOVE PLUG AND OPERATE VEHICLE NORMALLY TO SHOW PROPER VACUUM READINGS.
	**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.
	**ON-VEHICLE NATEF TASK:** PERFORM EXHAUST SYSTEM **BACK-PRESSURE TEST**; DETERMINE NECESSARY ACTION.
	**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
	**DISCUSSION:** HAVE THE STUDENTS TALK ABOUT **CATALYTIC CONVERTER EFFICIENCY TESTS**. HOW ARE RESULTS OF AN OXYGEN LEVEL TEST INTERPRETED?

ICONS	Ch32 Emission Control Devices
	HANDS-ON TASK: HAVE STUDENTS OPERATE AN ENGINE AT 2,500 RPM UNTIL NORMAL OPERATING TEMPERATURE IS ACHIEVED, THEN MEASURE INLET & OUTLET TEMPERATURES OF CATALYTIC CONVERTER WITH AN INFRARED THERMOMETER.
	ON-VEHICLE NATEF TASK: INSPECT AND TEST CATALYTIC CONVERTER EFFICIENCY.
	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)
	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.
	BECAUSE HEAT IS SO CRITICAL FOR CONVERTER OPERATION, AND UNDERHOOD SPACE IS LIMITED, MANY OEMS LOCATE CATALYST IN EXHAUST MANIFOLD.
	HANDS-ON TASK: HAVE THE STUDENTS LOOK UP CATALYST EFFICIENCY DTCS FOR THEIR OWN VEHICLES. STUDENTS SHOULD BE ABLE TO FIND CONDITIONS THAT MUST BE MET FOR DTC TO SET AND FIND OEM TROUBLESHOOTING PROCEDURE TO DIAGNOSE DTC.
	DEMONSTRATION: DEMONSTRATE CATALYTIC CONVERTER OPERATION BY TESTING EXHAUST EMISSIONS WITH 5-GAS ANALYZER BEFORE AND AFTER CONVERTER RUNS. REMOVE THE UPSTREAM

ICONS	Ch32 Emission Control Devices
DEMO	OXYGEN SENSOR AFTER THE ENGINE HAS WARMED UP, THEN OPERATE ENGINE WITH SENSOR CONNECTED AND INSERT ANALYZER PROBE INTO SENSOR BOSS WHILE SAMPLING. **DEMONSTRATION:** PERFORM A **CONVERTER SNAP-THROTTLE TEST** WHILE SAMPLING EXHAUST EMISSIONS. HAVE STUDENTS PAY ATTENTION TO O2 READINGS TO DETERMINE CONVERTER EFFICIENCY.
	**ON-VEHICLE NATEF TASK:** CATALYTIC CONVERTER RATTLE TEST
	**ON-VEHICLE NATEF TASK: CATALYTIC CONVERTER PERFORMANCE TEST**
	2. SLIDE 2 EXPLAIN OBJECTIVE **CH32 AEP_LO13**
	3. SLIDE 3 EXPLAIN TECH-TIP
	4. SLIDE 4-6 EXPLAIN INSPECTIONS