

# Automotive Fuel and Emissions Control Systems 4/E

## Chapter 5 GASOLINE


### Opening Your Class











KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of <b>Automotive Fuel and Emissions Control Systems</b> . 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. <ol style="list-style-type: none"><li>1. Discuss the chemical composition and the process of refining gasoline.</li><li>2. Explain how driveability is affected by volatility.</li><li>3. Understand the process of gasoline combustion and the means of avoiding abnormal combustion.</li><li>4. Describe gasoline additives, reformulated gasoline, and gasoline blending.</li><li>5. Discuss how to test gasoline for alcohol content and the general gasoline purchase and use recommendations.</li></ol>
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.











**NOTE: This lesson plan is based on Fuel & Emission Control 4<sup>th</sup> Edition Chapter Images found on Jim's web site @**











**[www.jameshalderman.com](http://www.jameshalderman.com)**









**LINK CHP 5: [Chapter Images](#)**

ICONS	Ch05 GASOLINE
	<p><b>1. SLIDE 1 CH5 GASOLINE</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b>  @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a>  <b>WEB SITE REGULARLY UPDATED</b></p> <p><b><u>DISCUSSION:</u> DISCUSS <u>GASOLINE</u> CHEMICAL COMPOSITION. HOW MANY CARBON ATOMS DO HYDROCARBONS IN GASOLINE HAVE?</b></p> <p><b><u>Videos</u></b></p> <p>At the beginning of this class, you can download the crossword puzzle &amp; Word Search from the links below to familiarize your class with the terms in this chapter &amp; then discuss them</p> <p><b><u>Crossword Puzzle (Microsoft Word) (PDF)</u></b>  <b><u>Word Search Puzzle (Microsoft Word) (PDF)</u></b></p> <p><b><u>DISCUSSION:</u> DISCUSS DANGERS OF <u>HYDROCARBONS</u>. IS A HYDROCARBON HARMFUL AS A LIQUID? IS IT HARMFUL AS A GAS? WHAT SAFETY PRECAUTIONS SHOULD BE TAKEN WHEN HANDLING HYDROCARBONS?</b></p> <p><b>2. SLIDE 2 EXPLAIN Figure 5-1</b> crude oil refining process showing most of the major steps and processes &amp; SHIPPING</p> <p><b>HAVING DIFFERENT GRADES OF GASOLINE, DIFFERENT BLENDS, &amp; VARYING FRESHNESS ON HAND AS YOU DISCUSS GASOLINE WILL OFFER VARIETY OF FUELS TO OBSERVE &amp; TEST.</b></p> <p><b><u>DISCUSSION:</u> HAVE THE STUDENTS DISCUSS CRACKING PROCESS. WHAT IS DIFFERENCE BETWEEN THERMAL CRACKING, CATALYTIC CRACKING, &amp; HYDROCRACKING? <u>FIGURE 5-1</u></b></p>

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   	<p><b>HANDS-ON TASK: STUDENTS COMPLETE AN MSDS REVIEW OF HYDROCARBONS TO DETERMINE WHETHER THEY UNDERSTAND HAZARDS OF HYDROCARBONS</b></p> <p><b>DISCUSSION: DISTILLATION PROCESS. IN ADDITION TO FUEL, WHAT OTHER PRODUCTS ARE PRODUCED THROUGH DISTILLATION PROCESS?</b></p> <p><b>DEMONSTRATION: LOCATE A VIDEO THAT DEMONSTRATES DISTILLATION PROCESS. HAVE STUDENTS WATCH IT &amp; DISCUSS PROCESS. NATIONAL GEOGRAPHIC CHANNEL OR DISCOVERY CHANNEL ARE POSSIBLE VIDEO SOURCES.</b></p> <p>3. SLIDE 3 EXPLAIN FIGURE 5-2 gasoline testing kit, including an insulated container where water at 100° F is used to heat a container holding a small sample of gasoline. The reading on the pressure gauge is the Reid vapor pressure (RVP)</p> <p>4. SLIDE 4 EXPLAIN FIGURE 5-3 A typical distillation curve. Heavier molecules evaporate at higher temperatures and contain more heat energy for power, whereas lighter molecules evaporate easier for starting.</p>
     	<p><b>DEMONSTRATION: SHOW THE STUDENTS HOW TO TEST GASOLINE, EMPHASIZING RVP READING AS A CLASSIFICATION FOR USAGE. FIGURE 5-2</b></p> <p><b>HANDS ON-TASK: CHECK FUEL RVP BASED ON DEMO</b></p> <p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p> <p><b>DISCUSSION: DISCUSS COLD START PROBLEMS RELATED TO FUEL ISSUES. WHY IS IT IMPORTANT FOR FUEL TO HAVE SPECIFIC RVP READING?</b></p> <p>5. SLIDE 5 EXPLAIN Figure 5-4 engine will not run if the air-fuel mixture is either too rich or too lean.</p> <p>6. SLIDE 6 EXPLAIN Figure 5-5 With a three-way catalytic converter, emission control is most efficient with an air-fuel ratio between 14.65 to 1 and 14.75 to 1.</p>

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  <p>QUESTION</p>  <p>DEMO</p>	<p><b><u>DISCUSSION:</u> DISCUSS HOW AIR-FUEL RATIOS ARE STATED. WHY IS RATIO USUALLY MEASURED BY WEIGHT AND NOT VOLUME?</b></p> <p><b><u>DEMONSTRATION:</u> SHOW HOW FUEL INJECTOR SPRAYS FUEL INTO COMBUSTION CHAMBER BY CREATING AN EXTERNAL FUEL SYSTEM IN WHICH STUDENTS CAN VIEW AN INJECTOR SPRAYING FUEL INTO VISIBLE CONTAINER. FOR SAFETY REASONS, YOU CAN PERFORM THIS DEMO WITH WATER INSTEAD OF FUEL, KEEPING IN MIND THAT INJECTORS AND PUMP SUSTAIN DAMAGE FROM WATER AFTER LONG-TERM USE.</b></p>
  <p>QUESTION</p>	<p><b><u>DISCUSSION:</u> HAVE THE STUDENTS DISCUSS AIR-FUEL RATIOS. WHAT MAKES AN AIR-FUEL MIXTURE TOO RICH OR TOO LEAN?</b></p>
  <p>QUESTION</p>	<p><b><u>DISCUSSION:</u> HAVE THE STUDENTS REFER TO <u>FIGURE 5-5</u> AND DISCUSS WHAT HAPPENS TO NO<sub>x</sub>, CO, AND HC IN THREE-WAY CATALYTIC CONVERTER. WHY DOES <u>STOICHIOMETRIC RATIO</u> WORK BEST TO CONTROL THESE MIXTURES? ANS: <u>STOICHIOMETRIC</u> IS CONCERNED WITH, INVOLVING, OR HAVING THE EXACT PROPORTIONS FOR A PARTICULAR CHEMICAL REACTION.</b></p>
	<p>7. SLIDE 7 EXPLAIN NORMAL &amp; ABNORMAL COMBUSTION &amp; Figure 5-6 Normal combustion is a smooth, controlled burning of the air-fuel mixture.</p> <p>8. SLIDE 8 EXPLAIN Figure 5-7 Detonation is a secondary ignition of the air-fuel mixture. It is also called spark knock or pinging.</p>
 <p>DEMO</p>	<p><b><u>DEMONSTRATION:</u> HAVE STUDENTS LISTEN TO A VEHICLE MAKING KNOCKING SOUND DUE TO DETONATION. ASK THEM TO DESCRIBE WHAT THIS SOUNDS LIKE TO THEM. THIS CAN BE DONE ON AN OLDER VEHICLE BY ADVANCING TIMING OR DISCONNECTING EGR: <u>FIGURE 5-7</u></b></p>
	<p><b><u>HANDS-ON TASK:</u> HAVE STUDENTS USE <u>5-GAS ANALYZER ON VEHICLE</u>. ASK THEM TO RECORD READINGS AND INTERPRET THEIR FINDINGS.</b></p>

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	<p>9. SLIDE 9 EXPLAIN Octane Rating &amp; EXPLAIN Figure 5-8 pump showing regular with pump octane of 87, plus rated at 89, and premium rated at 93. These ratings can vary with brand as well as in different parts of the country.</p>
	<p><b>DISCUSSION: DISCUSS GRADES OF GASOLINE. IS IT ALWAYS BETTER TO USE PREMIUM GAS? POINT OUT THE PROBLEMS OF HARD START AND ROUGH IDLE USING <u>PREMIUM-GRADE GASOLINE</u> DURING COLD WEATHER</b></p>
	<p><b>DISCUSSION: HAVE THE STUDENTS TALK ABOUT INJECTOR FLOW RATE. WHAT IS THE RELATION OF INJECTOR FLOW RATE TO HORSEPOWER?</b></p>
	<p><b>DISCUSSION: DISCUSS OCTANE RATING. HOW IS ISOCTANE USED IN OCTANE RATING? WHAT ARE THE METHODS USED TO RATE GASOLINE FOR ANTIKNOCK PROPERTIES? <u>FIGURE 5-8</u></b></p>
	<p><b>HANDS-ON TASK: LOCATE A <u>KNOCK SENSOR</u> ON A VEHICLE. ASK THEM TO REVIEW OEM INFORMATION ABOUT SENSOR. HAVE STUDENTS USE A <u>SCAN TOOL</u> TO COMPARE IT TO LIVE DATA FROM SENSOR. IS KNOCK SENSOR ACCURATE?</b></p>
	<p><b>EXPLAIN TECH-TIP</b></p>
	<p><b>DISACUSS FREQUENTLY ASKED QUESTION</b></p>
	<p>10. SLIDE 10 EXPLAIN Figure 5-9 posted octane rating in most high-altitude areas shows regular at 85 instead of the usual 87.</p>
	<p><b>DISCUSSION: HAVE STUDENTS DISCUSS <u>HIGH-ALTITUDE</u> OCTANE REQUIREMENTS. WHAT HAPPENS TO AIR WHEN ATMOSPHERIC PRESSURE DROPS? HOW DOES LOWERED ATMOSPHERIC PRESSURE AFFECT OCTANE RATING?</b></p>
	<p>11. SLIDE 11 EXPLAIN Gasoline Additives &amp; EXPLAIN Figure 5-10 This refueling pump indicates that the gasoline is blended with 10% ethanol (ethyl alcohol) and can be used in any gasoline vehicle. E85 contains 85%</p>

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	<p>ethanol and can be used only in vehicles specifically designed to use it.</p> <p><b>DISCUSSION: DISCUSS GASOLINE ADDITIVES. WHAT PROBLEMS CAN BE CAUSED BY ADDITIVES?</b></p>
	<p><b>DISCUSSION: DISCUSS ADDING ETHANOL TO BASE GASOLINE. WHY ARE THERE DIFFERENT METHODS FOR ADDING ADDITIVES TO CREATE AN E10 FUEL MIXTURE? FIGURE 5-10</b></p>
	<p><b>12. SLIDE 12 EXPLAIN Figure 5-11</b> A container with gasoline containing alcohol. Notice the separation line where the alcohol–water mixture separated from the gasoline and sank to the bottom.</p>
	<p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p>
	<p><b>DEMONSTRATION: PLACE SOME GAS AND WATER IN A CLEAR CONTAINER FOR VIEWING. HAVE STUDENTS TALK ABOUT PHASE SEPARATION. DISCUSS WHAT HAPPENS WHEN AN ENGINE COMBUSTS A LITTLE WATER. WHAT WILL HAPPEN TO CYLINDER TEMPERATURE IF THIS HAPPENS?</b></p>
	<p><b>DISCUSSION: HAVE STUDENTS TALK ABOUT REFORMULATED GASOLINE. WILL REFORMULATED GAS WORK WELL IN COLD WEATHER CONDITIONS? HAVE STUDENTS DISCUSS CHANGES MADE TO REFORMULATE GASOLINE. WHAT HAS BEEN RESULT IN AREAS WHERE REFORMULATED GAS IS BEING USED?</b></p>
	<p><a href="#">Fuel Blending In-Line (View) (Download)</a>  <a href="#">Fuel Blending Sequential (View) (Download)</a>  <a href="#">Fuel Blending Splash (View) (Download)</a>  <a href="#">Fuel Mileage, Gas (View) (Download)</a>  <a href="#">Fuel Mileage, Hybrid (View) (Download)</a></p>
	<p><b>13. SLIDE 13 EXPLAIN BLENDING &amp; Figure 5-12</b> In-line blending is the most accurate method for blending ethanol with gasoline because computers are used to calculate the correct ratio.</p> <p><b>14. SLIDE 14 EXPLAIN Figure 5-13</b> Sequential blending uses a computer to calculate correct ratio as well as the prescribed order in which the products are loaded.</p>

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15. SLIDE 15 EXPLAIN Figure 5-14 Splash blending occurs when ethanol is added to a tanker with gasoline and is mixed as truck travels to retail outlet

**DISCUSS FREQUENTLY ASKED QUESTION**

**DISCUSSION: HAVE THE STUDENTS TALK ABOUT OXYGENATED FUEL ADDITIVES. UNDER WHAT CONDITIONS CAN ADDITIVES BE USED TO IMPROVE DRIVEABILITY?**

**EXPLAIN WARNING**

16. SLIDE 16 EXPLAIN Figure 5-15 Checking gasoline for alcohol involves using a graduated cylinder and adding water to check if the alcohol absorbs the water.








**DEMONSTRATION: SHOW THE STUDENTS HOW TO CHECK FOR ALCOHOL CONTENT IN GAS. REMIND THEM OF SAFETY PRECAUTIONS TO TAKE WHEN TESTING GASOLINE. FIGURE 5-15 ON-VEHICLE NATEF TASK CHECK FUEL FOR CONTAMINANTS AND QUALITY; DETERMINE NECESSARY ACTION.**

**DISCUSSION: REMIND STUDENTS OF IMPORTANCE OF TESTING FUEL FOR ALCOHOL & WATER. HOW CAN NOT TESTING FUEL FOR ALCOHOL AND WATER AFFECT REPAIR OF DRIVEABILITY PROBLEMS ASSOCIATED WITH FUEL MIXTURE?**

**DISCUSS FREQUENTLY ASKED QUESTION**

17. SLIDE 17 EXPLAIN FIGURE 5-16 The gas cap on a Ford vehicle notes that BP fuel is recommended.

18. SLIDE 18 EXPLAIN Figure 5-17 Many gasoline service stations have signs posted warning customers to place plastic fuel containers on the ground while filling. If placed in a trunk or pickup truck bed equipped with a

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       	<p>plastic liner, static electricity could build up during fueling and discharge from the container to the metal nozzle, creating a spark and possible explosion. Some service stations have warning signs not to use cell phones while fueling to help avoid the possibility of an accidental spark creating a fire hazard.</p> <p><b>EXPLAIN TECH-TIP</b></p> <p><b><u>DEMONSTRATION: DEMONSTRATE A SNIFF TEST ON STALE GASOLINE. TALK ABOUT WHAT GASOLINE STABILIZER IS, WHEN TO USE IT, AND WHERE TO FIND IT.</u></b></p> <p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p> <p><b>51. SLIDES 51-52 EXPLAIN TECH-TIPS</b></p> <p><b><u>DISCUSSION: HAVE STUDENTS DISCUSS KEEPING FUEL LEVEL ABOVE ¼ TANK. WHY SHOULD FUEL LEVEL BE KEPT ABOVE THAT LEVEL?</u></b></p> <p><b>WHEN A RICH MIXTURE IS DETECTED &amp; FUEL GAUGE READS FULL, REMIND THE STUDENTS TO CHECK CHARCOAL CANISTER OUTLET TO THE ENGINE. VERIFY TO SEE WHETHER LIQUID GAS IS BEING SUCKED INTO THE ENGINE. TEMPORARY BLOCKAGE OF LINE AND REPEATED CHECKING OF O<sub>2</sub> SENSOR READINGS COULD VERIFY CONDITION.</b></p> <p><b><u>DISCUSSION: HAVE THE STUDENTS TALK ABOUT USING A FUEL COMPOSITION TESTER TO TEST FOR ALCOHOL CONTENT IN GASOLINE. WHAT IS THE FIRST STEP TO USING TESTER?</u></b></p>