Automotive Technology 6th Edition
Chapter 68 GASOLINE
Opening Your Class

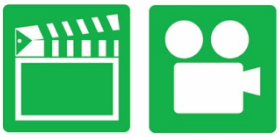
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features 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. Explain the chemical composition of gasoline and the process of refining gasoline. 2. Discuss how volatility affects driveability. 3. Describe the gasoline combustion process, normal versus abnormal combustion, and octane ratings and requirements. 4. Discuss the benefits of using gasoline additives, blending gasoline, and reformulating gasoline. 5. Describe the procedure to test gasoline for alcohol content. 6. List gasoline recommendations for maintaining proper engine operation and minimizing fuel costs. 7. This chapter will help prepare for Engine Repair (A8) ASE certification test content area "A" (General Engine Diagnosis).
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

DOWNLOAD Chapter 68 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

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

ICONS	Chapter 68 Gasoline
	**1. SLIDE 1 Chapter 66 GASOLINE**
	**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**
	**DISCUSSION: Have the students talk about chemical composition of gasoline. How many carbon atoms do the hydrocarbons in gasoline have?**
	**DISCUSSION: Have the students talk about the dangers of hydrocarbons. Is a hydrocarbon harmful as a liquid? Is it harmful as a gas? What safety precautions should be taken when handling hydrocarbons?**
	**2. SLIDE 2 EXPLAIN Figure 68-1** crude oil refining process showing most of the major steps and processes
	**Having different grades of gasoline, different blends, and varying freshness on hand as you discuss gasoline will offer students a variety of fuels to observe & test.**
	**HANDS-ON TASK: Have the students complete an MSDS review of hydrocarbons to determine whether they understand hazards of hydrocarbons**
	**DISCUSSION: Have the students talk about Distillation process. In addition to fuel, what other products are produced through distillation process?**

ICONS	Chapter 68 Gasoline
	**DEMONSTRATION:** Locate a **video** that **demonstrates distillation process**. Have students watch it & discuss process. National Geographic Channel or Discovery Channel are possible video sources. **LRC** may have this video
	**DISCUSSION:** Have the students discuss cracking process. What is difference between thermal cracking, catalytic cracking, & hydrocracking?
	**FIGURE 66-1** **3. SLIDE 3 EXPLAIN Figure 68-2** A 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).
	**DEMONSTRATION:** Show the students how to test gasoline, emphasizing RVP reading as a classification for usage. **FIGURE 68-2**
	**DISCUSSION:** Have students discuss cold start problems that are related to fuel issues. Why is it important for fuel to have a specific **RVP** reading?
	**Fuel Blending In-Line (View) (Download)** **Fuel Blending Sequential (View) (Download)** **Fuel Blending Splash (View) (Download)** **Fuel Mileage, Gas (View) (Download)** **Fuel Mileage, Hybrid (View) (Download)**
	**4. SLIDE 4 EXPLAIN Figure 68-3** A typical distillation curve. Heavier molecules evaporate at higher temperatures and contain more heat energy for power, whereas lighter molecules evaporate easier for starting.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***Why Do I Get Lower Gas Mileage in Winter?*** **Several factors cause the engine to use more fuel in winter than in summer, including:** • **Gasoline that is blended for use in cold climates is designed for ease of starting and contains fewer heavy molecules, which contribute to fuel economy. The**

ICONS	Chapter 68 Gasoline
	heat content of winter gasoline is lower than summer blended gasoline. • In cold temperatures, all lubricants are stiff, causing more resistance. These lubricants include the engine oil, as well as transmission and differential gear lubricants. • Heat from the engine is radiated into the outside air more rapidly when the temperature is cold, resulting in longer run time until the engine has reached normal operating temperature. • • Road conditions, such as ice and snow, can cause tire slippage or additional drag on the vehicle.
	5. **SLIDE 5 EXPLAIN Figure 68-4** An engine will not run if the air-fuel mixture is either too rich or too lean. 6. **SLIDE 6 EXPLAIN Figure 68-5** 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.
	**HANDS ON-TASK: Check fuel RVP BASED ON DEMO**
	**DISCUSSION: Have the students talk about how air-fuel ratios are stated. Why is the ratio usually measured by weight and not volume?**
	**DEMONSTRATION: 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 demonstration with water instead of fuel, keeping in mind that injectors and pump sustain damage from water after long-term use.**
	**DISCUSSION: Have the students discuss air-fuel ratios. What makes an air-fuel mixture too rich or too lean?**

ICONS	Chapter 68 Gasoline
	**DISCUSSION:** Have the students talk about the gasoline combustion process. Will a contaminated atmosphere have an effect on combustion process? **FIGURES 68-3 & 4**
	**DISCUSSION:** Have the students refer to **FIGURE 68–5** and discuss what happens to NO_x, CO, and HC in three-way catalytic converter. Why does **stoichiometric ratio** work best to control these mixtures? ANS: **STOICHIOMETRIC** IS concerned with, involving, or having the exact proportions for a particular chemical reaction.
	7. **SLIDE 7 EXPLAIN Figure 68-6** Normal combustion is a smooth, controlled burning of the air-fuel mixture. 8. **SLIDE 8 EXPLAIN Figure 68-7** Detonation is a secondary ignition of the air-fuel mixture. It is also called spark knock or pinging.
	**DEMONSTRATION:** 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: **FIGURE 68-7**
	**HANDS-ON TASK:** Have students use a **5-gas analyzer on a vehicle**. Ask them to record readings and interpret their findings. Grade them on their understanding of by-products of combustion process and their awareness of what is required to reduce harmful emissions.
	9. **SLIDE 9 EXPLAIN Figure 68-8** A pump showing regular with a 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.
	**DISCUSSION:** Have the students talk about grades of gasoline. Is it always better to use premium gas? Point out the problems of hard start and rough idle using **premium-grade gasoline** during cold weather conditions.
	**DISCUSSION:** Have the students talk about injector flow rate. What is the relation of injector flow rate to horsepower?

ICONS	Chapter 68 Gasoline
	**DISCUSSION:** Have the students talk about octane rating. How is isooctane used in octane rating? What are the methods used to rate gasoline for antiknock properties? **FIGURE 68-8**
	**HANDS-ON TASK:** Have the students locate a **Knock Sensor** on a vehicle. Ask them to review OEM information about sensor. Have students use a **scan tool** to compare it to live data from Sensor. Is knock sensor accurate?
	**DISCUSSION:** Have students discuss **high-altitude** octane requirements. What happens to air when atmospheric pressure drops? How does lowered atmospheric pressure affect octane rating?
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Grade of Gasoline Does the EPA Use When Testing Engines?*** Due to the various grades and additives used in commercial fuel, government (EPA) uses a liquid called indolene. Indolene has a research octane number of 96.5 and a motor method octane rating of 88, which results in an (R + M) , 2 rating of 92.25.
	**EXPLAIN TECH TIP:** ***Horsepower and Fuel Flow*** To produce 1 hp, the engine must be supplied with 0.50 pounds of fuel per hour (lb/hr). Fuel injectors are rated in pounds per hour. For example, a volt-8 engine equipped with 25 lb/hr fuel injectors could produce 50 hp per cylinder (per injector) or 400 hp. Even if the cylinder head or block is modified to produce more horsepower, limiting factor may be the injector flow rate. The following are flow rates and resulting horsepower for a V-8 engine: • 30 lb/hr: 60 hp per cylinder or 480 hp • 35 lb/hr: 70 hp per cylinder or 560 hp • 40 lb/hr: 80 hp per cylinder or 640 hp Of course, injector flow rate is only one of many variables that affect power output. Installing larger injectors without other major engine modifications could decrease engine output and drastically increase exhaust emissions.

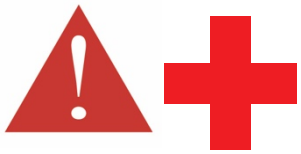
ICONS	Chapter 68 Gasoline
   	**DISCUSS CHART 68-1** **Typical octane ratings for gasoline in most parts of the country.** 10. **SLIDE 10 EXPLAIN Figure 68-9** The posted octane rating in most high-altitude areas shows regular at 85 instead of the usual 87. **DISCUSSION: Have students discuss gasoline additives. What problems can be caused by additives?** **DISCUSS FREQUENTLY ASKED QUESTION:** ***Can Regular-Grade Gasoline Be Used If Premium Is Recommended Grade?*** ***Maybe.*** **It is possible to use regular-grade or midgrade (plus) gasoline in most new vehicles without danger of damage to the engine. Most vehicles built since 1990s are equipped with at least one knock sensor. If a lower-octane gasoline than specified is used, the engine ignition timing setting usually causes the engine to spark knock, also called detonation or ping. This spark knock is detected by knock sensor(s), which sends a signal to computer. Computer then retards ignition timing until spark knock stops.** **NOTE: Some scan tools show the "estimated Octane rating" of the fuel being used, which is based on knock sensor activity. As a result of this spark timing retardation, the engine torque is reduced. While this reduction in power is seldom noticed, it reduces fuel economy, often by four to five miles per gallon. If premium gasoline is then used, the PCM gradually permits the engine to operate at more advanced ignition timing setting. Therefore, it may take several tanks of premium gasoline to restore normal fuel economy. For best overall**

ICONS	Chapter 68 Gasoline
	performance, use the grade of gasoline recommended by the OEM
	11. **SLIDE 11 EXPLAIN Figure 68-10** 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% ethanol and can be used only in vehicles specifically designed to use it. 12. **SLIDE 12 EXPLAIN Figure 68-11** A container with gasoline containing alcohol. Notice the separation line where the alcohol–water mixture separated from the gasoline and sank to the bottom.
	**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?**
	**DISCUSSION: Have the students talk about adding ethanol to base gasoline. Why are there different methods for adding additives to create an E10 fuel mixture? FIGURE 68-10**
	**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?**
	13. **SLIDE 13 EXPLAIN Figure 68-12** In-line blending is the most accurate method for blending ethanol with gasoline because computers are used to calculate the correct ratio. 14. **SLIDE 14 EXPLAIN Figure 68-13** Sequential blending uses a computer to calculate correct ratio as well as the prescribed order in which the products are loaded. 15. **SLIDE 15 EXPLAIN Figure 68-14** 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:** ***What Is Meant by "Phase Separation"?*** **All alcohols absorb water, and the alcohol-water mixture can separate from gasoline and sink to bottom of fuel tank. This process is**

ICONS	Chapter 68 Gasoline
     	called phase separation. To help avoid engine performance problems, try to keep at least a quarter tank of fuel at all times, especially during seasons when there is a wide temperature span between daytime highs and nighttime lows. These conditions can cause moisture to accumulate in fuel tank as a result of condensation of moisture in air. **DISCUSSION:** Have the students talk about oxygenated fuel additives. Under what conditions can additives be used to improve driveability? **DEMONSTRATION:** Show how to check for alcohol content in gas. Remind them of safety precautions to take when testing gasoline. **FIGURE 68-15** **WARNING: Do not smoke or run FUEL tests around sources of ignition!** 16. **SLIDE 16 EXPLAIN Figure 68-15** Checking gasoline for alcohol involves using a graduated cylinder and adding water to check if the alcohol absorbs the water. 17. **SLIDE 17 EXPLAIN FIGURE 68-16** Many vehicle manufacturers include warning Labels to avoid E15 (15% ethanol and 85% gasoline) as well as E85 (85% ethanol and 15% gasoline). **DISCUSS FREQUENTLY ASKED QUESTION:** ***Is Water Heavier than Gasoline? Yes.*** **Water weighs about 8 pounds per gallon, whereas gasoline weighs about 6 pounds per gallon. The density as measured by specific gravity includes: Water = 1.000 (the baseline for specific gravity) Gasoline = 0.730 to 0.760 This means that any water that gets into the fuel tank sinks to bottom.**

ICONS	Chapter 68 Gasoline
     	**ON-VEHICLE ASEEDUCATION 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:** ***How Does Alcohol Content in the Gasoline Affect Engine Operation?*** In most cases, use of gasoline containing 10% or less of ethanol (ethyl alcohol) has little or no effect on engine operation. However, because addition of 10% ethanol raises volatility of fuel slightly, occasional rough idle or stalling may be noticed, especially during warm weather. The rough idle and stalling may also be noticeable after engine is started, driven, then stopped for a short time. Engine heat can vaporize alcohol enhanced fuel causing bubbles to form in the fuel system. These bubbles in the fuel prevent the proper operation of fuel injection system and result in a hesitation during acceleration, rough idle, or, in severe cases, repeated stalling until all the bubbles have been forced through fuel system, replaced by cooler fuel from the fuel tank. **DISCUSS FREQUENTLY ASKED QUESTION:** What Is "Top-Tier" Gasoline? Top-tier gasoline is gasoline that has specific standards for quality, including enough detergent to keep all intake valves clean. Four automobile manufacturers—BMW, General Motors, Honda, and Toyota—developed standards. Top-tier gasoline exceeds quality standards developed by World Wide Fuel Charter (WWFC) that was

ICONS	Chapter 68 Gasoline
	established in 2002 by vehicle and engine manufacturers. The gasoline companies that agreed to make fuel that matches or exceeds standards as a top-tier fuel include ChevronTexaco, Shell, and ConocoPhillips. For additional information and a list of all stations that are top tier gas stations, visit www.toptiergas.com. • SEE FIGURE 68–16.
	17. SLIDE 17 EXPLAIN FIGURE 68–16 Not all top-tier gas stations mention that they are top-tier like this station. For more information and the list of top-tier gasoline stations, visit www.toptiergas.com.
	18. SLIDE 18 EXPLAIN Figure 68-17 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 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.
	DEMONSTRATION: Demonstrate a sniff test on stale gasoline. Talk about what gasoline stabilizer is, when to use it, and where to find it.
	EXPLAIN TECH TIP: *The Sniff Test:* Problems can occur with stale gasoline from which the lighter parts of the gasoline have evaporated. Stale gasoline usually results in a no-start situation. If stale gasoline is suspected, sniff it. If it smells rancid, replace it with fresh gasoline. NOTE: If storing a vehicle, boat, or lawnmower over the winter, put some gasoline stabilizer into the gasoline to reduce the evaporation and separation that can occur during storage. Gasoline stabilizer is frequently available at lawnmower repair shops or marinas.
	DISCUSSION: discuss keeping fuel level above ¼ tank. Why should fuel level be kept above that level?

ICONS	Chapter 68 Gasoline
	**DISCUSS FREQUENTLY ASKED QUESTION: *Why Should I Keep the Fuel Gauge Above One-Quarter Tank?*** **Fuel pickup inside fuel tank can help keep water from being drawn into fuel system unless water is all that is left at bottom of tank. Over time, moisture in air inside fuel tank can condense, causing liquid water to drop to bottom of fuel tank (water is heavier than gasoline—about 8 lb per gallon for water and about 6 lb per gallon for). If alcohol blended gasoline is used, alcohol can absorb water and alcohol-water combination can be burned inside engine. However, when water combines with alcohol, a separation layer occurs between the gasoline at top of tank and alcohol-water combination at bottom. When the fuel level is low, fuel pump draws from this concentrated level of alcohol and water. Because alcohol and water do not burn as well as pure gasoline, severe driveability problems can occur, such as stalling, rough idle, hard starting, and missing.**
	**When a rich mixture is detected & 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_2 sensor readings could verify condition.**
	**SAFETY** **Discuss importance of having a fire extinguisher available when working with fuel, and of wearing PPE including safety glasses, a respirator, and gloves.**
	**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?** **SLIDE SHOW ON GASOLINE TESTING**

ICONS	Chapter 68 Gasoline
	**EXPLAIN TECH TIP:** ***Do Not Overfill the Fuel Tank*** **Gasoline fuel tanks have an expansion volume area at the top. The volume of this expansion area is equal to 10% to 15% of volume of tank. This area is normally not filled with gasoline, but rather is designed to provide a place for the gasoline to expand into, if vehicle is parked in hot sun and gasoline expands. This prevents raw gasoline from escaping from fuel system. A small restriction is usually present to control amount of air and vapors that can escape tank and flow to charcoal canister. This volume area could be filled with gasoline if fuel is slowly pumped into tank. Since it can hold an extra 10% (2 gallons in a 20-gallon tank), some people deliberately try to fill tank completely. When this expansion volume is filled, liquid fuel (rather than vapors) can be drawn into charcoal canister. When purge valve opens, liquid fuel can be drawn into engine, causing an excessively rich air–fuel mixture. Not only can this liquid fuel harm vapor recovery parts, but overfilling gas tank could also cause vehicle to fail an exhaust emission test, particularly during an enhanced test when tank could be purged while on the rollers.**
	19. SLIDES 19-24 EXPLAIN OPTIONAL TESTING FOR ALCOHOL CONTENT IN GASOLINE