Automotive Engines
Chapter 29 PISTONS, RINGS, & CONNECTING RODS
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This engine systems course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
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 as listed on the NEXT SLIDE. 1. Prepare for Engine Repair (A1) ASE certification test content area "C" (Engine Block Diagnosis and Repair). 2. Describe the purpose and function of pistons, rings, and connecting rods. 3. Explain how pistons and rods are constructed and what to look for during an inspection. 4. Discuss connecting rod reconditioning procedures. 5. Explain how piston rings operate and how to install them on a piston.
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	Chapter 29 Pistons/Rings/Rods
	1. SLIDE 1 CH29 PISTONS, RINGS, & CONNECTING RODS 2. **SLIDE 2-3 EXPLAIN Objectives & KEY TERMS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS UPDATED REGULARLY**
	4. **SLIDE 4 EXPLAIN Pistons** 5. **SLIDE 5 EXPLAIN FIGURE 29-1** piston seals bottom of combustion chamber & is attached to a connecting rod.
	6. **SLIDE 6 EXPLAIN TECH TIP**
	**Show ANIMATION: PISTON COMPONENTS www.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter29_Fig_29_2/index.htm
	**DEMONSTRATION: Show the students the different parts of piston, including the skirt, pin bore, head valve reliefs, and other components**
	**DISCUSSION: Ask the students to discuss how piston and rod assembly function together and how their reciprocating motion is turned into rotary motion.**
	**DEMONSTRATION: Using a demo engine or animation, show the students the operation of the piston in an engine bore.**
	**DISCUSSION: Have students discuss purpose of different parts of the piston assembly and why they are important to the overall performance of the internal combustion engine (ICE).**
	7. **SLIDE 7 EXPLAIN FIGURE 29-2** All pistons share the same parts in common. 8. **SLIDE 8 EXPLAIN FIGURE 29-3** Piston diameter is measured across the thrust surfaces. 9. **SLIDE 9 EXPLAIN FIGURE 29-4** cast piston showing the sprues which were used to fill the mold with molten aluminum alloy. 10. **SLIDE 10 EXPLAIN FIGURE 29-5** top of the piston

temperature can be 100° F (38° C) lower on a forged piston compared to a cast piston.

Tell your students that hypereutectic pistons are very high in silicone content and are frequently used in new and remanufactured engines

DEMONSTRATION: Using a cutaway engine (if available), show how much clearance there is between piston and valves with engine at TDC.

11. **SLIDE 11** EXPLAIN **FIGURE 29-6** Valve reliefs are used to provide valve clearance.
12. **SLIDE 12** EXPLAIN **FIGURE 29-7** Piston cam shape. The largest diameter is across the thrust surfaces and perpendicular to the piston pin (labeled A).
13. **SLIDE 13** EXPLAIN **FIGURE 29-8** molygraphite coating on this piston from a General Motors 3800 V-6 engine helps to prevent piston scuffing.

Pop-up or domed pistons can create more power, but they will also increase the exhaust emissions.

14. **SLIDE 14** EXPLAIN **FIGURE 29-9** head of the piston is smaller in diameter than the skirt of the piston to allow it to expand when the engine is running.

DISCUSSION: Have the students discuss why it is important for the piston head to be smaller than the rest of piston.

15. **SLIDE 15** EXPLAIN **FIGURE 29-10** Steel struts cast inside the piston help control expansion and add strength to the piston pin area.

DEMONSTRATION: Show examples of pistons with struts

DISCUSSION: Have the students discuss why piston struts are important and what would happen if they were not there.

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	**DEMONSTRATION: Show the proper way to measure piston diameters and inspect the piston for damage.**
	**HANDS-ON TASK: Have the students measure several pistons and inspect them for damage, and report their findings to you.**
	**DISCUSSION: Have the students discuss why pistons in modern engines have to have flat or recessed tops.**
	**ON-VEHICLE NON-NATEF TASK: Determine piston-to-bore clearance.**
	**Show ANIMATION: PISTON & CONNECTING ROD ASSEMBLYwww.myautomotivelab.com** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter29_Fig_29_27/index.htm
	**16. SLIDE 16 EXPLAIN FIGURE 29-11** Most piston pins are hollow to reduce weight and have a straight bore. Some pins have a tapered bore to reinforce the pin.
 http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter29_Fig_29_13/index.htm	**Show ANIMATION: PISTON MAJOR THRUST AREA www.myautomotivelab.com**
	**Connecting rods are not to be mixed during disassembly.**
	**17. SLIDE 17 EXPLAIN FIGURE 29-12** Piston pin offset toward the major thrust surface. **18. SLIDE 18 EXPLAIN FIGURE 29-13** Engine rotation and rod angle during the power stroke cause the piston to press harder against one side of the cylinder, called the major thrust surface.
	**19. SLIDE 19 EXPLAIN FREQUENTLY ASKED QUESTION**

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	**DEMONSTRATION: Show how piston pins are not centered on the piston. MAJOR THRUST AREA, Figures 29-12 & 29-13**
	**DEMONSTRATION: Figure 29-13 & Frequently Asked Question: Show how to apply left-hand rule to determine major thrust side.**
	20. **SLIDE 20** EXPLAIN Piston Pin Retaining Methods & EXPLAIN **FIGURE 29-14** Circlips hold full-floating piston pins in place. 21. **SLIDE 21** EXPLAIN **FIGURE 29-15** typical interference fit piston pin 22. **SLIDE 22** EXPLAIN REAL WORLD FIX
	
	**DEMONSTRATION: Show examples of full-floating and interference fit piston pins.**
 	**DISCUSSION: Discuss differences between full-floating and tolerance (interference) fit piston pins & advantages and disadvantages of both.**
	23. **SLIDE 23** EXPLAIN Piston Rings 24. **SLIDE 24** EXPLAIN **FIGURE 29-16** rings conduct heat from piston to cylinder wall.
	**DEMONSTRATION: Show a set of rings. Explain differences between compression rings and oil control rings and where they go on piston.**
	25. **SLIDE 25** EXPLAIN **Piston Rings & FIGURE 29-17** Combustion chamber pressure forces the ring against the cylinder wall and the bottom of the ring groove to effectively seal the cylinder. 26. **SLIDE 26** EXPLAIN **FIGURE 29-18** side and back clearances must be correct for the compression rings to seal properly. 27. **SLIDE 27** EXPLAIN **FIGURE 29-19** This typical three-piece oil control ring uses a hump-type stainless steel spacer-expander. The expander separates the two steel rails and presses them against the cylinder wall.

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	**DISCUSSION: Ask the students to discuss the function of compression & oil control rings work and why they are important**
	**DISCUSSION: Ask the students why piston ring gap is important and what they think will happen if the gap is too little or too big**
	**28. SLIDE 28** EXPLAIN **FIGURE 29-20** piston ring gaps. **29. SLIDE 29** EXPLAIN **FIGURE 29-21** taper face ring provides oil control by scraping cylinder wall. This style of ring must be installed right side up or the ring will not seal and oil will be drawn into the combustion chamber. **30. SLIDE 30** EXPLAIN **FIGURE 29-22** Torsional twist rings provide better compression sealing and oil control than regular taper rings. **31. SLIDE 31** EXPLAIN **FIGURE 29-23** Scraper-type rings provide improved oil control. **32. SLIDE 32** EXPLAIN **FIGURE 29-24** upper barrel face ring has a line showing contact with the cylinder wall. The second taper face ring shows contact along the lower edge of the ring.
	**33. SLIDE 33** EXPLAIN Piston Ring Construction **34. SLIDE 34** EXPLAIN **FIGURE 29-25** chrome facing on this compression ring is about 0.004 in. (0.10 mm) thick. EXPLAIN **FIGURE 29-26** moly facing on this compression ring is 0.005 in. (0.13 mm) thick. **35. SLIDE 35** EXPLAIN Piston Ring Construction & EXPLAIN **FIGURE 29-27** The connecting rod is the most highly stressed part of any engine because combustion pressure tries to compress it and piston inertia tries to pull it apart.
	**Earliest evidence for a connecting rod comes from the late third century AD in a Roman sawmill.**
	**36. SLIDE 36** EXPLAIN **FIGURE 29-28** The I-beam shape (top rod) is the most common, but the H-beam shape is common in high-performance and racing engine applications. **37. SLIDE 37** EXPLAIN Connecting Rods & EXPLAIN **FIGURE 29-29** Rod bolts are quickly removed using a press.

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	**38. SLIDE 38** EXPLAIN **FIGURE 29-30** Some rods have balancing pads on each end of the connecting rod. **39. SLIDE 39** EXPLAIN **FIGURE 29-31** Some connecting rods have spit holes to help lubricate the cylinder wall or piston pin.
	**DEMONSTRATION: Show the students an example of a connecting rod. Explain the oil hole, the big and small ends, and their functions.**
	**40. SLIDE 40** EXPLAIN **FIGURE 29-32** Some engines, such as this Ford & Duramax diesels, are equipped with oil squirters that spray or stream oil toward the underneath side of the piston head to cool the piston. **41. SLIDE 41** EXPLAIN **FIGURE 29-33** cast connecting rod is found on many stock engines and can be identified by the thin parting line. **42. SLIDE 42** EXPLAIN **FIGURE 29-34** This high-performance connecting rod uses a bronze bushing in the small end of the rod and oil hole to allow oil to reach the full-floating piston pin. **43. SLIDE 43** EXPLAIN **FIGURE 29-35** Powdered metal connecting rods feature a fractured parting line at the big end of the rod.
	**DISCUSSION: Ask the students to discuss the different types of piston and connecting rod oiling systems. Have them discuss as a class the advantages and disadvantages of each.**
	**Shorter connecting rod is, faster it will accelerate near top dead center. This means faster acceleration for the engine. Piston reaches its maximum acceleration at a right angle or 90°, which is why 90° V-8 ENGINES are still choice for racing engines.**
	**Powdered metal (sintered) connecting rod was designed to make a stronger and lighter connecting rod while keeping cost affordable. The combination of light weight and strength helps boost horsepower.**

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	**44. SLIDE 44** EXPLAIN Connecting Rod Service & EXPLAIN **FIGURE 29-36** press used to remove the connecting rod from the piston. **45. SLIDE 45** EXPLAIN **FIGURE 29-37** If the rod is twisted, it will cause diagonal-type wear on the piston skirt. **46. SLIDE 46** EXPLAIN **FIGURE 29-38** rod alignment fixture is used to check a connecting rod for bends or twists. **47. SLIDE 47** EXPLAIN **FIGURE 29-39** Rod bearing bores normally stretch from top to bottom, with most wear concentrated on the rod cap. **48. SLIDE 48** EXPLAIN **FIGURE 29-40** To help ensure that the big ends are honed straight, many experts recommend placing two rods together when performing the honing operation.
 	**DEMONSTRATION: Show the students how to use a rod alignment tool (if you have one) for checking connecting rods for misalignment.** **Connecting rods are numbered at factory during assembly & should take note of these numbers when disassembling an engine**
	**49. SLIDE 49** EXPLAIN Piston and Rod Assembly & EXPLAIN **FIGURE 29-41** small end of the rod is being heated in an electric heater and the piston is positioned properly so the piston pin can be installed as soon as the rod is removed from the heater.
 	**DEMONSTRATION: Show students proper procedure for installing an interference fit piston pin** **Heating rod in an oven and placing piston pin in a freezer will make pin slide in easier due to rod end swelling and pin shrinking**
	**HANDS-ON TASK: Have students install an interference fit piston pin**

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	**50. SLIDE 50** EXPLAIN Piston Ring Service **51. SLIDE 51** EXPLAIN **FIGURE 29-42** side clearance of the piston ring is checked with a feeler gauge. **52. SLIDE 52** EXPLAIN **FIGURE 29-43** ring gap is measured using a feeler gauge. **53. SLIDE 53** EXPLAIN **FIGURE 29-44** hand-operated piston ring end gap grinder being used to increase end gap of a piston ring so that it is within factory specifications. **54. SLIDE 54** EXPLAIN **FIGURE 29-45** A typical ring expander being used to install a piston ring on a piston. **55. SLIDE 55** EXPLAIN **FIGURE 29-46** Identification marks used to indicate the side of the piston ring to be placed toward the head of the piston.
	**DEMONSTRATION: Show proper way to use a feeler gauge to measure piston ring side clearance.**
	**DEMONSTRATION: Show proper way to use a feeler gauge to measure piston ring end gap.**
	**When checking piston ring end gap, should square up the piston ring in the bore by placing piston & rod assembly upside down and pushing ring partway down in bore.**
	**HANDS-ON TASK: Have students measure piston ring gap**
	**DEMONSTRATION: Show proper way of installing compression rings. Emphasize rings should be installed with the mark on ring facing up.**
	**ON-VEHICLE NON-NATEF TASK: Identify piston and bearing wear patterns that connecting rod alignment and main bearing bore problems; determine necessary action.**
	**ON-VEHICLE NON-NATEF TASK: Inspect and measure piston skirts and ring leads; determine necessary action.**

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	**ON-VEHICLE NON-NATEF TASK:** Remove and replace piston pin.
	**ON-VEHICLE NON-NATEF TASK:** Inspect, measure and install piston rings.
	**Tell your students importance of staggering the ring end gaps on the piston to prevent loss of compression and oil consumption. Most OEMs have a specific ring gap pattern listed in their service information**
	**SEARCH INTERNET:** Have the students search Internet and research operation of the piston and rod assembly. Have them work in groups of three or four and have each group do a presentation on different aspects of piston operation (e.g., "How do the pistons seal combustion chamber if they have to move up and down within the cylinder bore?")
	**Talk through SUMMARY and questions**
	**HOMEWORK:** complete Ch29 crossword puzzle: http://www.jameshalderman.com/links/book_engine_theory_serv_7/cw/crossword_ch_29.pdf