

Automotive Technology 5th Edition

ATE4 Chapter 32 CAMSHAFTS & VALVE TRAINS

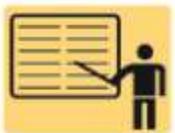
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 5th text provides complete coverage of automotive 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: <ol style="list-style-type: none"> 1. Describe the purpose and function of camshafts. 2. Discuss camshaft drives and camshaft movement. 3. Discuss rocker arms and pushrods. 4. Explain overhead camshaft valve trains and camshaft specifications. 5. Explain lifters or tappets, valve train lubrication, and valve train problem diagnosis. 6. Explain the procedure for camshaft removal, measuring camshafts, and selecting a camshaft. 7. Explain variable valve timing, and variable lift and cylinder deactivation systems.
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: This lesson plan is based on the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 32: [ATE5 Chapter Images](#)

ICONS



Ch32 Camshaft/Valve Train

1. **SLIDE 1 CH32 CAMSHAFTS & VALVE TRAINS**
2. **SLIDE 2 EXPLAIN Figure 32-1** This high-performance camshaft has a lobe that opens the valve quickly and keeps it open for a long time.
3. **SLIDE 3 EXPLAIN Figure 32-2** In many engines, the camshaft drives the distributor and the oil pump through a shaft from the end of the distributor.
4. **SLIDE 4 EXPLAIN Figure 32-3** camshaft rides on bearings inside the engine block above the crankshaft on a typical cam-in-block engine.

Check for **ADDITIONAL VIDEOS & ANIMATIONS**
@ <http://www.jameshalderman.com/>
WEB SITE IS CONSTANTLY UPDATED

VALVE & SEAT SERVICE

Videos

ON-VEHICLE NATEF TASK Research CAMSHAFT SPECS Page 93

5. **SLIDE 5 EXPLAIN Figure 32-4** Parts of a cam and camshaft terms (nomenclature).
6. **SLIDE 6 EXPLAIN Figure 32-5** composite camshaft is lightweight and yet flexible, because hollow tube can absorb twisting forces & lobes are hard enough to withstand the forces involved in opening valves.
7. **SLIDE 7 EXPLAIN Figure 32-6** Worn camshaft with two lobes worn to the point of being almost round.
8. **SLIDE 8 EXPLAIN Figure 32-7** fuel pump rocker arm rides on the camshaft eccentric.

DEMONSTRATION: Show camshaft and point out intake and exhaust lobes as well as the distributor drive gear and the fuel pump eccentric, if the cam has them

DISCUSSION: Ask the students what advantages overhead camshaft has as opposed to cam-in-block design.

ICONS

DEMO

DEMO



DEMO



Ch32 Camshaft/Valve Train

DEMONSTRATION: Show examples of steel and composite camshafts.

DEMONSTRATION: Show example of a camshaft with excessive lobe wear.

9. **SLIDE 9 EXPLAIN** Figure 32-8 timing chain hydraulic tensioner.

10. **SLIDE 10 EXPLAIN** Figure 32-9 The larger camshaft gear is usually made from fiber and given a helical cut to help reduce noise. By making the camshaft gear twice as large as the crankshaft gear, the camshaft rotates one revolution for every two of the crankshaft.

Camshaft & Flat Lifter (View) (Download)

Camshaft & Roller Lifter (View) (Download)

VVT Operation (View) (Download)

DEMONSTRATION: Show the students an example of a steel camshaft gear and a composite camshaft gear.

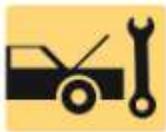
Composite camshaft gears have a nylon coating on the teeth to provide quiet operation. With age this nylon gets brittle, starts to break off in small pieces.

11. **SLIDE 11 EXPLAIN** Figure 32-10 replacement silent chain and sprockets. Original camshaft sprocket was aluminum with nylon teeth to control noise. This replacement set will not be noticeably louder than original and give many of miles of useful service.

12. **SLIDE 12 EXPLAIN** Figure 32-11 industry standard for when to replace a timing chain and gears is when 1/2 in. (13 mm) or more of slack is measured in the chain. However, it is best to replace the timing chain and gear anytime the camshaft is replaced or the engine is disassembled for repair or overhaul.

13. **SLIDE 13 EXPLAIN** Figure 32-12 replacement high-performance double roller chain. Even though a bit noisier than a flat-link chain, a roller chain does not stretch as much and will therefore be able to maintain accurate valve timing for a long time.

ICONS



Ch32 Camshaft/Valve Train

14. **SLIDE 14 EXPLAIN Figure 32-13** This dual overhead camshaft (DOHC) engine uses one chain from the crankshaft to the intake cam and a secondary chain to rotate exhaust camshaft.
15. **SLIDE 15 EXPLAIN Figure 32-14** A timing belt failed when the teeth were sheared off. This belt failed at 88,000 miles because the owner failed to replace it at the recommended interval of 60,000 miles.
16. **SLIDE 16 EXPLAIN Figure 32-15** This timing belt broke because an oil leak from one of the camshaft seals caused oil to get into and weaken the belt. Most experts recommend replacing all engine seals in the front of the engine anytime a timing belt is replaced. If the timing belt travels over the water pump, the water pump should also be replaced as a precaution.

DISCUSSION: Ask the students to explain the difference between a free-wheeling engine design & interference engine design. Figures 32-14/15

17. **SLIDE 17 EXPLAIN Figure 32-16** Many engines are of the interference design. If the timing belt (or chain) breaks, the piston still moves up and down in the cylinder while the valves remain stationary. With a freewheeling design, nothing is damaged, but in an interference engine, the valves are often bent.
18. **SLIDE 18 EXPLAIN Figure 32-17** head from a Mercedes showing bent valves when timing chain stretched and skipped over crankshaft sprocket. When this happened, piston kept moving and bent valves.

DEMONSTRATION: Show proper procedure for checking a timing chain for excessive wear and looseness.

HANDS-ON TASK: Have the students measure the slack of a timing chain installed on an engine.

19. **SLIDE 19 EXPLAIN Figure 32-18** slight angle and the curve on the bottom of a flat bottom lifter cause the lifter and the pushrod to rotate during normal operation.

ICONS



Ch32 Camshaft/Valve Train

20. **SLIDE 20 EXPLAIN Figure 32-19** The lobe lift is the amount the cam lobe lifts the lifter. The blue circle is called the base circle. Because the rocker arm adds to this amount, the entire valve train has to be considered when selecting a camshaft that has the desired lift and duration.

21. **SLIDE 21 EXPLAIN Figure 32-20** The ramps on the cam lobe allow the valves to be opened and closed quickly yet under control to avoid damaging valve train components, especially at high engine speeds.

DEMONSTRATION: DEMONSTRATE Show some examples of worn and/or broken timing belts.

22. **SLIDE 22 EXPLAIN Figure 32-21** A 1.5:1 ratio rocker arm means that dimension A is 1.5 times the length of dimension B. Therefore, if the pushrod is moved up 0.4 in. by the camshaft lobe, the valve will be pushed down (opened) $0.4 \text{ in.} \times 1.5$, or 0.6 in.

23. **SLIDE 23 EXPLAIN Figure 32-22** high-performance aluminum roller rocker arm. Both pivot & tip that contacts the stem of the valve are equipped with rollers to help reduce friction for more power and better fuel economy.

Rocker Arm Ratio (View) (Download)

24. **SLIDE 24 EXPLAIN Figure 32-23** Some engines today use rocker shafts to support rocker arms such as the V-6 engine with a single overhead camshaft located in the center of the cylinder head.

25. **SLIDE 25 EXPLAIN Figure 32-24** typical stud-mounted rocker arm.

26. **SLIDE 26 EXPLAIN Figure 32-25** Pushrod guide plates are bolted to the head and help stabilize the valve train, especially at high engine speeds.

27. **SLIDE 27 EXPLAIN Figure 32-26** pedestal-type rocker arm design that used one bolt for each rocker arm and is nonadjustable. If valve lash needs to be adjusted, different length pushrod(s) must be used.

DISCUSSION: Ask the students to explain the advantages of roller rocker arms.

ICONS

DEMO

DEMO



DEMO



Ch32 Camshaft/Valve Train

DEMONSTRATION: Show examples of roller rocker arms as opposed to cast non-roller rocker arms.

DEMONSTRATION: On an engine with adjustable rocker arms, the proper procedure for adjusting rocker arms

HANDS-ON TASK: On an engine with adjustable rocker arms, have the students use the service information to look up the correct adjustment procedure. If this type of engine is not available just have them look up and print out the procedure

ON-VEHICLE NATEF TASK Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages; determine necessary action (P-2) Page 94

28. **SLIDE 28 EXPLAIN** Figure 32-27 Overhead valve engines are also known as pushrod engines because of long pushrod that extends from lifter to rocker arm.

29. **SLIDE 29 EXPLAIN** Figure 32-28 When timing chain broke, valves stopped moving up and down but pistons kept moving and hit valves causing pushrods to bend.

DEMONSTRATION: Show how to check for bent pushrods by rolling them across a flat surface.

Some engines such as GM 2.8 L & 3.1 L use different lengths for intake and exhaust pushrods. Make sure not to mix pushrods up when disassembling these engines.

30. **SLIDE 30 EXPLAIN** FIGURE 32-29 Hardened pushrods should be used in any engine that uses pushrod guides (plates).

31. **SLIDE 31 EXPLAIN** Figure 32-30 Hydraulic lifters may be built into bucket-type lifters on some overhead camshaft engines.

32. **SLIDE 32 EXPLAIN** Figure 32-31 use of cam followers allows the use of hydraulic lifters with an overhead camshaft design.

33. **SLIDE 33 EXPLAIN** Figure 32-32 Hydraulic lash adjusters (HLA) are built into the rocker arm on some

ICONS



Ch32 Camshaft/Valve Train

OHC engines. Sometimes hydraulic lash adjusters may not bleed down properly if the wrong viscosity (SAE rating) oil is used.

DISCUSSION: Ask the students how oil viscosity may affect operation of hydraulic lash adjusters.

DEMONSTRATION: Show examples of hydraulic lash adjusters.

34. **SLIDE 34 EXPLAIN Figure 32-33** Graphic representation of a typical camshaft showing the relationship between the intake and exhaust valves. The shaded area represents the overlap period of 100 degrees.
35. **SLIDE 108 EXPLAIN Figure 32-34** As the lobe center angle decreases, the overlap increases, with no other changes in the lobe profile lift and duration.
36. **SLIDE 36 EXPLAIN Figure 32-35** Typical cam timing diagram.
37. **SLIDE 37 EXPLAIN Figure 32-36** Typical high-performance camshaft specifications on a straight-line graph. Intake valve duration = $39 + 180 + 71 = 290$ degrees. Exhaust valve duration = $7 + 180 + 47 = 234$ degrees. Because intake and exhaust valve specifications are different, the camshaft grind is called asymmetrical.
38. **SLIDE 38 EXPLAIN Figure 32-37** Typical camshaft valve timing diagram with the same specifications as those shown in Figure 32-36

DISCUSSION: Ask the students to define valve overlap.

HANDS-ON TASK: Have the students use service information to look up the valve overlap on a particular engine.

DISCUSSION: Ask the students why some dual overhead cam engines may have a different camshaft profile for each of the intake valves and exhaust valves. (Answer: This creates an engine that is able to produce a high torque over a broader engine speed range.)

ICONS



Ch32 Camshaft/Valve Train

Installing a high performance camshaft on a newer vehicle can have a significant impact on vehicle emissions.

DISCUSSION: Ask the students why intake valve should open slightly before the piston reaches top dead center

HANDS-ON TASK: Have the students calculate the lobe separation angle using camshaft data.

39. **SLIDE 39 EXPLAIN Figure 32-38** Older engines used flat-bottom lifters, whereas all engines since the 1990s use roller lifters.

40. **SLIDE 40 EXPLAIN Figure 32-39** All roller lifters must use some method to keep the lifter straight and not rotating.

DEMONSTRATION: Show disassembled hydraulic lifter

DEMONSTRATION: Show some examples of solid and hydraulic lifters.

41. **SLIDE 41 EXPLAIN Figure 32-40** cutaway of a flat-bottom solid lifter. Because this type of lifter contains a retaining ring and oil holes, it is sometimes confused with a hydraulic lifter that also contains additional parts. The holes in this lifter are designed to supply oil to the rocker arms through a hollow pushrod.

42. **SLIDE 42 EXPLAIN Figure 32-41** exploded view of a hydraulic roller lifter.

DEMONSTRATION: On an engine with roller lifters, show the proper installation of the roller lifter and retaining guides.

When installing new lifters, immerse them in clean oil and pump them up manually to eliminate the air from the lifter.

ICONS



Ch32 Camshaft/Valve Train

ON-VEHICLE NATEF TASK Inspect valve lifters; determine necessary action.
(P-2) Page 95

HANDS-ON TASK: Have the students use service information to determine how the camshaft, camshaft bearings, and lifters receive their lubrication.

43. **SLIDE 43 EXPLAIN** Figure 32-42 The cause of a misfire diagnostic trouble code was discovered to be a pushrod that had worn through the rocker arm on a General Motors 3.1 liter V-6 engine.

44. **SLIDE 44 EXPLAIN** Figure 32-43 Shaft-mounted rocker arms are held in position by an assortment of springs, spacers, and washers, which should be removed so that the entire shaft can be inspected for wear.

Lifters are noisy, always check oil level first. One of first signs of low oil level is noisy lifters because they pick up air. Excessively high oil level can also cause this noise.

DISCUSSION: Ask the students to discuss the possible causes of abnormal valve train noise.

HANDS-ON TASK: For a specific engine, have the students use service information to look up service procedure for removing and replacing camshaft.

45. **SLIDE 45 EXPLAIN** Figure 32-44 A dial indicator being used to measure cam lobe height.

DEMONSTRATION: Show how to measure the cam lobe height using a dial indicator.

HANDS-ON TASK: For a specific engine, have the students measure the cam lobe height using a dial indicator

DEMONSTRATION: DEMONSTRATE Show how to measure the lift of camshaft and compare it to service specifications.

ICONS



Ch32 Camshaft/Valve Train

HANDS-ON TASK: Have the students measure the lift of camshaft and determine if it meets specifications.

ON-VEHICLE NATEF TASK Check camshaft for wear, damage, and out-of-round; determine necessary action. (P-2) [Page 97](#)

ON-VEHICLE NATEF TASK Inspect camshaft bearing surface for wear, damage, out-of-round, and alignment; determine necessary action (P-2) [Page 98](#)

46. **SLIDE 46 EXPLAIN** Figure 32-45 Camshaft rotation during advance and retard.
47. **SLIDE 47 EXPLAIN** Figure 32-46 The camshaft is rotated in relation to the crankshaft by the PCM to provide changes in valve timing.
48. **SLIDE 48 EXPLAIN** Figure 32-47 Spline cam phaser assembly

DEMONSTRATION: Show an example of a camshaft position actuator oil control valve.

HANDS-ON TASK: Have students search service information to determine what controls camshaft position actuator oil control valve.

DISCUSSION: Ask the students to discuss the advantages of intake and exhaust camshaft phasing.

Control solenoid screen can become plugged if the oil is not changed regularly. Changes in performance and emissions.

49. **SLIDE 49 EXPLAIN** Figure 32-48 Spline phaser.
50. **SLIDE 50 EXPLAIN** FIGURE 32-49 The screen(s) protect the solenoid valve from dirt and debris that can cause the valve to stick
51. **SLIDE 51 EXPLAIN** Figure 32-50 vane phaser is used to move camshaft, using changes in oil pressure from the oil control valve.
52. **SLIDE 52 EXPLAIN** Figure 32-51 magnetically controlled vane phaser.

ICONS



Ch32 Camshaft/Valve Train

53. **SLIDE 53 EXPLAIN Figure 32-52** A camshaft position actuator used in a cam-in-block engine.

DEMONSTRATION: Using a scan tool and vehicle equipped with variable valve timing, show the students what variable valve timing data can be observed using the scan tool.

HANDS-ON TASK: For a vehicle that uses variable valve timing, have the students use service information to read a description of the variable valve timing and how it is controlled on that vehicle.

DEMONSTRATION: Show an example of a vane phaser system, if one is available.

HANDS-ON TASK: Have the students use service information to research the role that the PCM plays in activation of the variable valve controls.

ON-VEHICLE NATEF TASK Establish camshaft position sensor indexing. (P-1) Page 99

VVT Operation (View) (Download)

54. **SLIDE 54 EXPLAIN Figure 32-53** A plastic mockup of a Honda VTEC system that uses two different camshaft profiles—one for low-speed engine operation and the other for high speed.

55. **SLIDE 55 EXPLAIN Figure 32-54** Engine oil pressure is used to switch cam lobes on a VTEC system.

56. **SLIDE 56 EXPLAIN Figure 32-55** Oil pressure applied to the locking pin causes the inside of the lifter to freely move inside the outer shell of the lifter, thereby keeping the valve closed.

57. **SLIDE 57 EXPLAIN Figure 32-56** Active fuel management includes many different components and changes to the oiling system, which makes routine oil changes even more important on engines equipped with this system.

ICONS



DEMO



DEMO

DEMO



QUESTION



Ch32 Camshaft/Valve Train

HANDS-ON TASK: For a vehicle with variable timing, have students' list PCM codes that are associated with the variable valve timing system.

DEMONSTRATION: Using a scan tool, show how PWM is used to control the actuator solenoid.

HANDS-ON TASK: Have students use service information to research VTEC system used by Honda.

DEMONSTRATION: Show some examples of camshaft position sensors.

DEMONSTRATION: Show some examples, if available, of cylinder deactivation controls used by various OEMS.

DISCUSSION: Ask the students to discuss the main purpose of cylinder deactivation. (Answer: Fuel economy.)

HOMEWORK

[Crossword Puzzle \(Microsoft Word\) \(PDF\)](#)

[Word Search Puzzle \(Microsoft Word\) \(PDF\)](#)