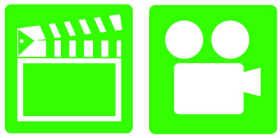
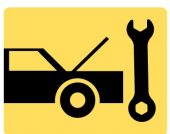
Automotive Maintenance and Light Repair, 1ST Edition

Chapter 67 Four-Wheel Drive and All-Wheel Drive

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** 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. ⁀ Prepare for ASE Manual Drive Train and Axles (A3) certification test content area "F" (Four-Wheel Drive Component Diagnosis and Repair). ⁀ Explain the difference between a mode shift and a range shift. ⁀ Describe the purpose and function of the center differential. ⁀ Explain the purpose and function of a viscous coupling. ⁀ Describe the difference between four-wheel drive and all-wheel drive. ⁀ Explain how the front axle is disconnected when two-wheel drive is selected.
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	Ch67 Four-Wheel Drive and All-Wheel Drive
	**1. SLIDE 1 CH67 Four-Wheel Drive and All-Wheel Drive** **2. SLIDES 2-3 EXPLAIN OBJECTIVES**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED**
	**DEMONSTRATION: SHOW FWD VEHICLE ON THE HOIST. POINT OUT THE TWO DIFFERENTIALS AND THE TRANSFER CASE**
	**DEMONSTRATION: SHOW FWD SELECTOR IN A VEHICLE AND PROCEDURE IN ITS OWNER'S MANUAL FOR CHANGING FROM FWD TO TWO-WHEEL-DRIVE.**
	**4. SLIDES 4-7 EXPLAIN** Four-Wheel-Drive Systems **8. SLIDE 8 EXPLAIN Figure 67-1** Many light trucks & sport utility vehicles use a transfer case to provide engine torque to all 4 wheels and to allow a gear reduction for maximum power to get through mud or snow **9. SLIDES 9-13 EXPLAIN** Four-Wheel-Drive Systems **14. SLIDE 14 EXPLAIN Figure 67-2** Cutaway of a manually-operated locking hub. **15. SLIDES 15-17 EXPLAIN** Four-Wheel-Drive Systems **18. SLIDE 18 EXPLAIN Figure 67-3** Manual locking hubs require that the hubs be rotated to the locked position by hand to allow torque to be applied to the front wheels. Automatic locking hubs enable the driver to shift into four-wheel drive from inside the vehicle.
	**DEMONSTRATION: SHOW THE STUDENTS AN EXAMPLE OF A LOCKING HUB ASSEMBLY. DEMONSTRATE THE INNER WORKINGS OF THE HUB: FIGURE 67-2, 3**
	**DISCUSSION: ASK THE STUDENTS TO DISCUSS THE PATH THE TORQUE FOLLOWS THROUGH THE CENTER OF THE HUB, THROUGH THE LOCKING DEVICE, AND OUT TO WHEEL.**
	**HANDS-ON-TASK: HAVE THE STUDENTS INSPECT A LOCKING HUB ASSEMBLY. HAVE THEM DETERMINE WHICH PARTS ARE THE LOCKING**

ICONS	Ch67 Four-Wheel Drive and All-Wheel Drive
	SYSTEM AND WHICH ARE THE DRIVE COMPONENTS. FIGURE 67-2, 3
	**19. SLIDE 19 EXPLAIN Figure 67-4** If a four-wheel-drive vehicle must be towed, it should be either on (a) a flatbed truck or (b) a dolly
	20. SLIDES 20-21 EXPLAIN Four-Wheel-Drive Systems
	22. SLIDE 22 EXPLAIN Figure 67-5 When turning a corner, each wheel takes a slightly different path and rotates at a slightly different speed. Unlike a part-time four-wheel-drive system, which when engaged locks the front and rear axles together, a full-time system uses a center differential that allows for any speed differences between the front and rear axles. It can therefore be activated on any surface—slippery or dry.
	**DISCUSSION: ASK THE STUDENTS TO DISCUSS WHY SOME VEHICLES HAVE FWD. DISCUSS WHEN FWD WOULD BE NEEDED**
	**23. SLIDES 23-26 EXPLAIN** Four-Wheel-Drive Systems
	**4WD Drivetrain, FWD Based** **4WD Drivetrain, RWD Based** **Active 4WD** **Active 4WD Transfer Case** **FWD Driveshaft Operation** **FWD Drivetrain**
	
	**DISCUSSION: DISCUSS DIFFERENCES BETWEEN PART-TIME & FULL-TIME FOUR-WHEEL-DRIVE**
	**HANDS-ON-TASK: HAVE THE STUDENTS' RESEARCH AUTOMOTIVE CAREERS THAT REQUIRE THE ABILITY TO REPAIR AND TROUBLESHOOT FWD VEHICLES. HAVE THEM DISCUSS IN CLASS CAREER OPPORTUNITIES, THEIR ADVANTAGES & DISADVANTAGES, & COMPENSATION LEVELS.**
	**27. SLIDE 27 EXPLAIN Figure 67-6** viscous coupling is a sealed unit containing many steel discs. One-half of them are splined to the input shaft, with every other disc

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	splined to the output shaft. Surrounding these discs is a thick (viscous) silicone fluid that expands when hot and effectively locks the discs together
DEMO	**DEMONSTRATION: SHOW VISCOUS COUPLING. DEMONSTRATE HOW THE COUPLING LOCKS UP AS SPEED INCREASES.**
QUESTION	**DISCUSSION: DISCUSS OPERATION OF A VISCOUS COUPLING**
	AWD Differentials
	AN EXAMPLE OF A DILATANT FLUID SIMILAR TO THAT USED IN A VISCOUS COUPLER IS SILLY PUTTY. UNDER LOW SHEAR FORCE, SUCH AS PULLING IT APART SLOWLY, SILLY PUTTY IS SOMEWHAT FLUID. PULLING IT APART FAST (HIGH SHEAR FORCE) CAUSES IT TO BECOME STRUCTURALLY LESS FLUID, AND IT SNAPS APART. THIS IS ALSO WHY SILLY PUTTY BOUNCES. ANOTHER VISCOUS COUPLER FOUND ON REAR-WHEEL-DRIVE CARS IS THE CLUTCH THAT HOLDS THE FAN TO THE FRONT OF THE ENGINE. AS ENGINE HEATS UP, THE FLUID BECOMES STIFFER, CAUSING FAN TO ENGAGE.
	28. **SLIDE 28 EXPLAIN Figure 67-7** center differential is the heart of a typical all-wheel-drive system. AWD systems do not use a low range, and therefore the vehicle may not be able to go off-road like a vehicle equipped with a four-wheel drive with a low range.
	29. **SLIDES 29-30 EXPLAIN 4WD SYSTEMS**
	31. **SLIDE 31 EXPLAIN** All-Wheel Drive
DEMO	**DEMONSTRATION: SHOW AWD VEHICLE, INCLUDING LACK OF CONTROLS IN DRIVER'S COMPARTMENT. WITH VEHICLE ON A HOIST, POINT OUT 2 DIFFERENTIALS & VISCOUS COUPLER, IF ONE IS PRESENT.**
QUESTION	**DISCUSSION: ASK THE STUDENTS TO DISCUSS USE OF AWD. HAVE THEM DISCUSS THE ADVANTAGES AND DISADVANTAGES ASSOCIATED**

ICONS	Ch67 Four-Wheel Drive and All-Wheel Drive
	**WITH AWD** 32. **SLIDE 32 EXPLAIN Figure 67-8** typical transfer case is attached to the output of the transmission and directs engine torque to rear or to front and rear differentials. 33. **SLIDES 33-35 EXPLAIN** Front and Rear Differential Axle Ratios
	**DISCUSSION: HAVE STUDENTS DISCUSS FRONT AND REAR GEAR RATIOS OF AN AWD VEHICLE. ASK THEM TO DISCUSS WHY THERE WOULD BE A PROBLEM IF BOTH GEAR RATIOS WERE EXACTLY SAME. WHAT IF THE REAR RATIO WAS HIGHER THAN THE FRONT?**
	**DEMONSTRATION: SHOW EXAMPLE OF A DRIVE CHAIN TRANSFER CASE. DEMONSTRATE CHANGE IN OUTPUT AS TRANSFER CASE SHIFTS BETWEEN MODES AND RANGES**
	36. **SLIDES 36-39 EXPLAIN** Transfer Case 40. **SLIDE 40 EXPLAIN Figure 67-9** exploded view of New Venture 241 transfer case 41. **SLIDES 41-51 EXPLAIN** Transfer Case
	**HANDS-ON-TASK: HAVE THE STUDENTS' RESEARCH OPERATIONAL FLAWS OF CHAIN DRIVE. ASK THEM TO DISCUSS THEIR FINDINGS, MAKING SURE TO INCLUDE A DISCUSSION OF TORQUE LOSS, ROLLER CHAINS, AND THE USE OF BELTS RATHER THAN CHAINS.**
	52. **SLIDE 52 EXPLAIN Figure 67-10 (a)** When one axle shaft is disconnected, both front wheels can rotate independently, reducing excessive tire wear. 53. **SLIDE 53 EXPLAIN Figure 67-10 (b)** In four-wheel-drive mode, vacuum is applied to the front part and the opposite side is vented to atmospheric pressure retracting the shift motor stem. The shift fork and collar move into engagement with both axle shaft gears. Engine torque from the front differential can now be applied to both front axles. When transfer case is placed in two-wheel drive, vacuum is applied to the other side of the diaphragm and shift collar moves, unlocking front axles.
	**DISCUSSION: DISCUSS THE TORQUE FLOW THROUGH A CHAIN-TYPE TRANSFER CASE LIKE THE ONE IN FIGURE 67–10**

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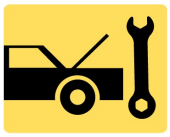	**SEARCH INTERNET:** HAVE STUDENTS USE INTERNET TO RESEARCH VISCOUS FLUIDS. ASK THEM TO DESCRIBE TO THE CLASS HOW SUCH A FLUID BECOMES STIFFER UNDER CONDITIONS SUCH AS THE TWO ENDS OF A VISCOUS COUPLER MOVING AT DIFFERENT SPEEDS.
	**DEMONSTRATION:** SHOW TRANSFER CASE **SHIFTING OPTIONS**, INCLUDING MANUAL FLOOR, VACUUM-OPERATED, AND ELECTRIC
	**DISCUSSION:** DISCUSS OPERATION AND SERVICE CONCERNS RELATED TO EACH OF THE THREE ENGAGEMENT OPTIONS: **MANUAL FLOOR, VACUUM-OPERATED, AND ELECTRIC**
	**DISCUSSION:** DISCUSS THE DIFFERENCE BETWEEN MODE SHIFT AND RANGE SHIFT
	**DISCUSSION:** DISCUSS WHEN FOUR-WHEEL LOW RANGE WOULD BE APPROPRIATE
	54. **SLIDE 54 EXPLAIN Figure 67-11** GM SUV front axle showing the electric axle disconnect actuator. 55. **SLIDES 55-56 EXPLAIN** Transfer Case 57. **SLIDE 57 EXPLAIN Figure 67-12** range shift selector on a Hummer H1 sport utility vehicle. This vehicle is always in four-wheel drive, but the driver can select neutral (N) or low range. 58. **SLIDES 58-62 EXPLAIN** Transfer Case 63. **SLIDE 63 EXPLAIN Figure 67-13** typical planetary gear set used in a transfer case. 64. **SLIDE 64 EXPLAIN Figure 67-14** Cutaway of a planetary gear set transfer case.
	**DEMONSTRATION:** SHOW **PLANETARY GEAR TRANSFER** CASE. DEMONSTRATE THE MODE AND RANGE SHIFTS AND HOW THEY AFFECT THE OUTPUT OF THE TRANSFER CASE.
	**DISCUSSION:** DISCUSS HOW GEAR REDUCTION IS ACHIEVED WITH A **PLANETARY GEAR SET**

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	**65. SLIDE 65 EXPLAIN** Transfer Case **66. SLIDE 66 EXPLAIN Figure 67-15** Two-wheel-drive/high-range torque flow in a NV231 transfer case. The sliding range clutch is shifted to the forward position by the range lever and fork, which connects the input gear to the output shaft and rear axle. The mode synchronizer sleeve is moved out of engagement from the drive sprocket to remove torque from the front axle. **67. SLIDE 67 EXPLAIN Figure 67-16** Four-wheel-drive/high-range torque flow in a NV231 transfer case. The range clutch position remains the same as in two-wheel drive/high-range, but the synchronizer sleeve is moved rearward and engages the drive sprocket clutch teeth. This action connects the drive sprocket to the rear output shaft, thereby applying equal torque to both front and rear output shafts. **68. SLIDE 68 EXPLAIN Figure 66-17** Four-wheel-drive/low-range torque flow in a NV231 transfer case. The mode synchronizer assembly remains engaged and the range clutch is moved to the rearward position. The annulus (ring) gear is fixed to the case and the input (sun) gear drives the pinion gears, which walk around the stationary annulus gear and drive the planetary carrier and output shaft at a speed lower than the input gear.
	**DEMONSTRATION: SHOW HOW THE CHAIN DRIVE SPROCKET IS ENGAGED FOR ALL-WHEEL DRIVE AND HOW THE PLANETARY SET IS ENGAGED FOR LOW-RANGE DRIVE IN THE FIGURES FOR THE NV231 TRANSFER CASE. FIGURE 67–16, 17**
	**DEMONSTRATION: SHOW INTERAXLE DIFFERENTIAL. DEMONSTRATE HOW THE DIFFERENTIAL IS SIMILAR TO A REAR DIFFERENTIAL IN THAT IT HAS PINION GEARS, A RING GEAR, AND A DRIVE PINION GEAR.**
	**69. SLIDES 69-75 EXPLAIN** Interaxle Differential **76. SLIDE 76 EXPLAIN Figure 67-18** bevel gear-type interaxle differential. **77. SLIDES 77-79 EXPLAIN** Interaxle Differential **80. SLIDE 80 EXPLAIN Figure 67-19** viscous coupling. Note that unit is attached to output shaft between transfer case (or transaxle) and rear differential. A typical viscous

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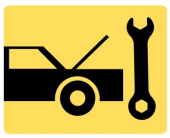
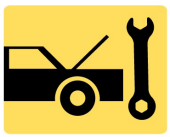
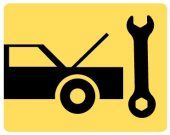
	coupling in a sealed unit is serviced as assembly.
	81. **SLIDE 81 EXPLAIN** Interaxle Differential
DEMO	**DEMONSTRATION: WHEN DIFFERENTIAL IS SHIFTED, IT LOCKS FRONT AXLE SENDS TORQUE TO THAT AXLE. SHOW STUDENTS THAT WHEN THE FRONT AXLE IS SHIFTED OUT, IT IS FREE-TURNING WITH NO TORQUE APPLIED. NOTE THAT THERE IS NO PROVISION FOR FOUR-WHEEL LOW**
	**HANDS-ON-TASK: HAVE THE STUDENTS ROTATE INPUT SHAFT AND OBSERVE THE TORQUE FLOW AND THEN SHIFT INTO ALL WHEEL AND SEE HOW TORQUE FLOW CHANGES TO BOTH SHAFTS**
	**HANDS-ON-TASK: HAVE THE STUDENTS USE AN INTERAXLE DIFFERENTIAL AND DETERMINE THE GEAR RATIO OF THE FRONT AND REAR AXLES IN ALL-WHEEL DRIVE. HAVE THEM DETERMINE THE GEAR RATIO OF FRONT AXLE WHEN THE DIFFERENTIAL IS IN REAR-WHEEL DRIVE**
	82. **SLIDES 82-83 EXPLAIN** Four-Wheel-Drive Axles 84. **SLIDE 84 EXPLAIN Figure 67-20** (a) A standard Cardan U-joint used on the output driveshaft from the transfer case to front differential assembly. (b) A Cardan-type U-joint at front drive wheels on a Jeep Wrangler 85. **SLIDES 85-90 EXPLAIN** Transfer Case Service and Problem Diagnosis
	**DISCUSSION: DISCUSS ADVANTAGES AND DISADVANTAGES OF FRONT AXLES WITH CARDAN U-JOINTS AND CV JOINTS**
DEMO	**DEMONSTRATION: SHOW PROCEDURE FOR REMOVING A CARDAN U-JOINT AXLE SHAFT. DEMONSTRATE HOW TO CHECK SEALS AND BEARINGS IN THE AXLE TUBES. SHOW THE STUDENTS HOW TO REPLACE A CARDAN U-JOINT**
	**HANDS-ON-TASK: HAVE THE STUDENTS' REMOVE THE LOCKING OR AUTOMOTIVE HUB ASSEMBLY, REMOVE THE CARDAN U-JOINT DRIVE AXLE, AND INSPECT THE U-JOINT AND DETERMINE IF IT NEEDS TO BE REPLACED. HAVE THEM REASSEMBLE THE AXLE AND HUB ASSEMBLY AND CHECK FOR SMOOTH OPERATION. GRADE STUDENTS ON THEIR ABILITY TO COMPLETE THE**

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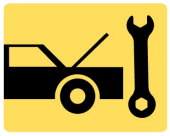
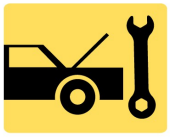
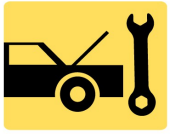
	TASK, FOLLOWING PROPER PROCEDURES AND ALL APPLICABLE SAFETY PRECAUTIONS
	91. **SLIDE 91 EXPLAIN Figure 6-22** Constant velocity (CV) joints are used on the front axles of many four-wheel-drive vehicles like this Chevrolet Blazer.
	**HANDS-ON-TASK: HAVE THE STUDENTS RESEARCH THE COST OF A REPLACEMENT TRANSFER CASE FOR A VEHICLE. ASK THEM TO INCLUDE COST OF LABOR TO REPLACE IT. HAVE THEM ROLE PLAY, PRESENTING THEIR FINDINGS TO THE CLASS THE WAY AN AUTOMOTIVE TECHNICIAN WOULD REPORT FINDINGS TO A CUSTOMER.**
	**SEARCH INTERNET: HAVE STUDENTS SEARCH INTERNET TO RESEARCH THE AVAILABLE VEHICLES WITH TRUE ALL-WHEEL-DRIVE CAPABILITY. ASK THEM TO BE PREPARED DISCUSS THE VEHICLES AND INDICATES WHETHER THE ALL-WHEEL DRIVE IS STANDARD OR AN OPTION.**
	92. **SLIDE 92 EXPLAIN** Transfer Case Service
	**NATEF MLR TASK A3G1 INSPECT FRONT-WHEEL BEARINGS AND LOCKING HUBS.**
	**DEMONSTRATION: SHOW STUDENT HOW TO DRAIN AND REFILL TRANSFER CASE. DISCUSS THE IMPORTANCE OF USING THE CORRECT FLUID IN ALL TRANSFER CASES**
	**DISCUSSION: DISCUSS WHY SOME TRANSFER CASES USE AUTOMATIC TRANSMISSION FLUID AND SOME USE GEAR LUBE**
	**HANDS-ON-TASK: HAVE THE STUDENTS DRAIN AND REFILL A TRANSFER CASE**
	**TRANSFER CASE & DIFFERENTIAL VENTS ON FWD SHOULD BE LOCATED AS HIGH AS POSSIBLE. BE CERTAIN THERE TUBING HAS NO KINKS IN IT & VENTS ARE NOT ROUTED**

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 	**NEAR HOT/MOVING PARTS** **NATEF MLR TASK A3G2 CHECK FOR LEAKS AT DRIVE ASSEMBLY SEALS; CHECK VENTS; CHECK LUBE LEVEL.** **TRANSAXLE SENSORS & SWITCHES** **WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=EVALUATING%20THE%20OPERATION%20OF%20TRANSAXLE%20SENORS%20-%20SWITCHES&CLIP=PANDC/CHET/2012/AUTOMOTIVE/MANUAL_TRANSMISION/EVALUATING_OPERATION_SENSOR_SWITCHES.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/MANUAL_TRANSMISION/XML/EVALUATING_OPERATION_SENSOR_SWITCHES.XML