

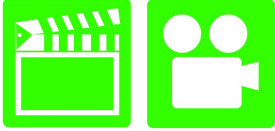
# Automotive Maintenance and Light Repair, 1<sup>ST</sup> Edition

## Chapter 66 DRIVE AXLES & DIFFERENTIALS

### Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers <b>Automotive Maintenance and Light Repair</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.	<p>Explain the chapter learning objectives to the students.</p> <ul style="list-style-type: none"><li>— Prepare for ASE Manual Drive Train and Axles (A3) certification test content area “E” (Rear Axle Diagnosis and Repair).</li><li>— Describe how the differential allows engine torque to be applied to both drive wheels and still allow a difference in the speed of the drive wheels during cornering.</li><li>— Discuss differential seals and bearings.</li><li>— Explain how a limited slip-type differential works.</li><li>— Determine the rear axle ratio.</li><li>— Perform a tooth contact pattern check and determine corrective action.</li><li>— Describe how to determine proper drive pinion gear depth.</li><li>— Explain how to achieve proper drive pinion bearing preload.</li><li>— Describe how to adjust the ring gear position to provide the proper backlash.</li></ul>
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.

## ICONS



## Ch66 DRIVE AXLES & DIFFERENTIALS

### 1. SLIDE 1 CH66 DRIVE AXLES & DIFFERENTIALS

### 2. SLIDES 2-4 EXPLAIN OBJECTIVES

Check for **ADDITIONAL VIDEOS & ANIMATIONS**

@ <http://www.jameshalderman.com/>

**WEB SITE REGULARLY UPDATED**

### DIFFERENTIAL GEARS

### WWW.MYAUTOMOTIVELAB.COM

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=DIFFERENTIAL%20GEARS&CLIP=PANDC/CHET/2012/AUTOMOTIVE/AUTO\\_SHOP\\_SAFETY/CLIP31DIFFGEARS1.MOV&CAPTION=CHET/CHET\\_MYLABS/AKAMAI/2012/AUTOMOTIVE/AUTO\\_SHOP\\_SAFETY/XML/CLIP31DIFFGEARS1.XML](http://media.pearsoncmg.com/ph/chet/chet_myLABS/akamai/template/video640x480.php?title=DIFFERENTIAL%20GEARS&clip=pandc/chet/2012/AUTOMOTIVE/AUTO_SHOP_SAFETY/CLIP31DIFFGEARS1.MOV&caption=chet_myLABS/akamai/2012/AUTOMOTIVE/AUTO_SHOP_SAFETY/XML/CLIP31DIFFGEARS1.XML)

### 5. SLIDE 5 EXPLAIN Differentials

6. **SLIDE 6 EXPLAIN** Figure 66-1 differential assembly changes the direction of engine torque and increases the torque to the drive wheels.

7. **SLIDE 7 EXPLAIN** Figure 66-2 difference between the travel distance of the drive wheels is controlled by the differential.

### 8. SLIDE 8 EXPLAIN Differentials

### DIFFERENTIAL COMPONENTS

### WWW.MYAUTOMOTIVELAB.COM

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYAUTOMOTIVELAB\\_2/ANIMATIONS/A8\\_ANIMATION/CHAPTER98\\_FIG\\_98\\_2/INDEX.HTM](http://media.pearsoncmg.com/ph/chet/chet_myAUTOMOTIVELAB_2/ANIMATIONS/A8_ANIMATION/CHAPTER98_FIG_98_2/INDEX.HTM)

**DEMONSTRATION: SHOW COMPLETE DIFFERENTIAL ASM. DEMONSTRATE HOW TURNING PINION TRANSFERS ROTATION OF AXLE SHAFTS 90 DEGREES FROM ROTATION OF PINION.**

### DIFFERENTIAL ACTION

### DIFFERENTIAL OPERATION

### WWW.MYAUTOMOTIVELAB.COM

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYAUTOMOTIVELAB\\_2/ANIMATIONS/A8\\_ANIMATION/CHAPTER98\\_FIG\\_98\\_3/INDEX.HTM](http://media.pearsoncmg.com/ph/chet/chet_myAUTOMOTIVELAB_2/ANIMATIONS/A8_ANIMATION/CHAPTER98_FIG_98_3/INDEX.HTM)

9. **SLIDE 9 EXPLAIN** Figure 66-3 When the vehicle turns a corner, the inner wheel slows and the outer wheel increases in speed to compensate. This difference in rotational speed causes the pinion gears to “walk” around the slower side gear.

10. **SLIDE 10 EXPLAIN** Parts of Differentials

## ICONS

## Ch66 DRIVE AXLES & DIFFERENTIALS



QUESTION



QUESTION



11. SLIDE 11 EXPLAIN Figure 66-4 hypoid gear set uses a drive pinion that meshes with the ring gear below the center line of the ring gear

**DISCUSSION: DISCUSS REASON FOR USING A HYPOID GEAR SET AS COMPARED TO A STANDARD BEVELED GEAR ARRANGEMENT FIGURE 66-4**

**DISCUSSION: DISCUSS THE DESIGN OF RING AND PINION THAT QUALIFIES IT AS A HYPOID GEAR ASSEMBLY. FIGURE 66-4**

12. SLIDES 12-13 EXPLAIN Parts of a Differential

14. SLIDE 14 EXPLAIN Figure 66-5 differential case provides support for ring gear, side bearings, & side gears.

**DEMONSTRATION: SHOW INSIDE WORKINGS OF THE DIFFERENTIAL AND POINT OUT THE MAJOR COMPONENTS. FIGURE 66-5**

15. SLIDES 15-16 EXPLAIN Parts of a Differential

17. SLIDE 17 EXPLAIN Figure 66-6 relationship among ring gear & drive pinion as well as side and spider gears

**DIFFERENTIAL EXPLODED VIEW**  
**WWW.MYAUTOMOTIVELAB.COM**

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYAUTOMOTIVELAB\\_2/ANIMATIONS/AS\\_ANIMATION/CHAPTER98\\_FIG\\_98\\_6/INDEX.HTM](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/as_animation/chapter98_fig_98_6/index.htm)

**AWD DIFFERENTIALS**  
**2WD DIFFERENTIALS**

**DEMONSTRATION: SHOW AN EXAMPLE OF A PINION GEAR AND CARRIER ASSEMBLY. SHOW LOCATION OF ALL MAJOR COMPONENTS OF THE CARRIER ASSEMBLY FIGURE 66-6**

18. SLIDES 18-23 EXPLAIN Parts of a Differential

24. SLIDE 24 EXPLAIN Figure 66-7 The drive side is the convex side of the ring gear except for some front axles used in four-wheel vehicles, and they often use the concave side on the drive side

**DEMONSTRATION: SHOW RING GEAR, INCLUDING HEEL, TOE, ROOT, DRIVE SIDE, AND DECELERATION SIDE. FIGURE 66-7**

**ICONS****Ch66 DRIVE AXLES & DIFFERENTIALS**

QUESTION



QUESTION



QUESTION

**HANDS-ON-TASK: HAVE THE STUDENTS IDENTIFY THE COMPONENTS OF A TYPICAL DIFFERENTIAL ASSEMBLY.**

25. SLIDES 25-34 EXPLAIN Differential Gear Ratios

35. SLIDES 35-37 EXPLAIN Differentials

38. SLIDE 38 EXPLAIN Figure 66-8 close-up view of side gears and spider (pinion) gear. Note ridges on gear teeth. These ridges are manufactured into the gear teeth to help retain lubricant so that no metal-to-metal contact occurs.

39. SLIDES 39-46 EXPLAIN Differentials













**DISCUSSION: DISCUSS GEAR RATIOS AND ADVANTAGES AND DISADVANTAGES OF LOW AND HIGH RATIOS.**

**DISCUSSION: DISCUSS ADVANTAGES AND DISADVANTAGES OF HUNTING AND NON-HUNTING GEAR COMBINATION. HAVE THEM DISCUSS WHY NON-HUNTING GEAR SETS HAVE TIMING MARKS.**

**HANDS-ON-TASK: HAVE THE STUDENTS USE MATHEMATICS TO FIGURE RATIO OF SEVERAL GEAR SETS. GIVE THEM DIAGRAMS OF A DOZEN RING AND PINION SETS. HAVE THEM DETERMINE WHETHER EACH SET IS HUNTING, NON-HUNTING, PARTIAL NON-HUNTING.**

**DEMONSTRATION: SHOW HOW TORQUE FLOWS THROUGH A STANDARD OPEN DIFFERENTIAL. SHOW THEM A STANDARD OPEN DIFFERENTIAL WITH THE COVER OFF. WHILE TURNING PINION FLANGE, HAVE A STUDENT HOLD ONE AXLE. TORQUE FLOWS TO FREE AXLE. AS STUDENT RELEASES HELD AXLE, BOTH WILL BEGIN TO TURN. **FIGURE 66-9****

**DISCUSSION: DISCUSS HOW TORQUE FLOWS THROUGH DIFFERENTIAL DURING STRAIGHT-AHEAD & TURNING MANEUVERS**

ICONS	Ch66 DRIVE AXLES & DIFFERENTIALS
	<p>47. SLIDES 47-50 EXPLAIN Limited Slip Differentials</p>
	<p>51. SLIDE 51 EXPLAIN Figure 66-9 (a) 2-wheel-drive vehicle equipped with an open differential. (b) A two-wheel-drive vehicle equipped with a limited-slip differential.</p>
	<p>52. SLIDE 52 EXPLAIN Limited Slip Differentials</p>
	<p>53. SLIDE 53 EXPLAIN Figure 66-10 Trac-loc limited-slip differential. This type of limited-slip differential uses preload force from a spring &amp; torque generated by side gears as 2 axles rotate at different rates to apply clutches and limit amount of difference in speed of 2 axles.</p>
	<p><b>DEMONSTRATION: SHOW LIMITED SLIP DIFFERENTIAL ASSEMBLY. SHOW THEM HOW THE CLUTCHES CONNECT SMALL PINION GEARS TO CASE. FIGURE 66-10</b></p>
	<p><b>BECAUSE OF CLUTCHES &amp; SPRINGS IN DIFFERENTIAL, YOU CAN USUALLY TELL IF A VEHICLE HAS A LIMITED SLIP DIFFERENTIAL BY ROTATING TIRES WHEN CAR IS LIFTED. IF BOTH TIRES ROTATE IN SAME DIRECTION, CAR HAS A LIMITED SLIP DIFFERENTIAL.</b></p>
	<p>54. SLIDES 54-72 EXPLAIN Limited Slip Differentials</p>
	<p>73. SLIDE 73 EXPLAIN Figure 66-11 Eaton locker differential</p>
	<p>74. SLIDES 74-78 EXPLAIN Limited Slip Differentials</p>
	<p>79. SLIDE 79 EXPLAIN Figure 66-12 This Eaton design differential uses a torque-limiting disc to prevent the possibility of breaking an axle in the event of a high-torque demand. When the disc tangs shear, the differential will continue to function but as an open rather than as a limited-slip differential.</p>
	<p>80. SLIDE 8- EXPLAIN Figure 66-13 Torsen differential. This type of differential provides torque to both drive wheels even if one tire is on ice. The complex system of gears allows this smooth transfer of torque without the use of clutches.</p>
	<p><b>DEMONSTRATION: SHOW DISASSEMBLED LIMITED SLIP DIFFERENTIAL. SHOW THEM HOW COMPRESSION OF THE CLUTCH PACKS LOCKS THE GEARS TO THE CASE</b></p>

## ICONS

## Ch66 DRIVE AXLES & DIFFERENTIALS

**DEMO**



QUESTION



**DEMONSTRATION: SHOW CONE DIFFERENTIALS DISASSEMBLED SO THEY CAN SEE HOW THE CONE IS FORCED INTO ITS SEAT TO MAKE A DIRECT LINK BETWEEN GEAR AND THE CASE**

**DISCUSSION: DISCUSS THE ADVANTAGES OF THE LIMITED SLIP DIFFERENTIAL IN CERTAIN SITUATIONS.**

**NATEF MLR TASK A3E1 CLEAN AND INSPECT DIFFERENTIAL HOUSING; CHECK FOR LEAKS; INSPECT HOUSING VENT.**

**NATEF MLR TASK A3E2. CHECK AND ADJUST DIFFERENTIAL HOUSING FLUID LEVEL.**

**NATEF MLR TASK A3E3 DRAIN AND REFILL DIFFERENTIAL HOUSING.**

81. SLIDE 81 EXPLAIN Differential Components

82. SLIDE 82 EXPLAIN Figure 66-14 This pinion flange is equipped with a damper weight to help dampen driveline vibrations.

83. SLIDES 83-85 EXPLAIN Differential Components

86. SLIDE 86 EXPLAIN Figure 66-15 collapsible spacer-type drive pinion shaft.

**DEMONSTRATION: SHOW DRIVE PINION FROM OVERHUNG AND STRADDLE MOUNTED PINIONS. DEMONSTRATE HOW TWO DIFFER IN LENGTH AND BEARING SURFACE.**

**DISCUSSION: DISCUSS SIMILARITIES AND DIFFERENCES OF OVERHUNG & STRADDLE MOUNTED PINIONS. WHAT ARE ADVANTAGES AND DISADVANTAGES OF BOTH TYPES OF PINIONS?**

87. SLIDES 87-92 EXPLAIN Differential Components

93. SLIDE 93 EXPLAIN Figure 66-16 Side bearings are press fit on the differential case.

94. SLIDE 94 EXPLAIN Differential Components









95. SLIDE 95 EXPLAIN Figure 66-17 Some side bearings






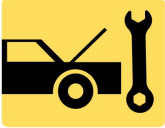
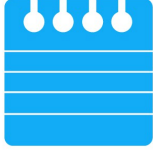

**DEMO**







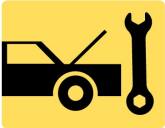





QUESTION




ICONS	Ch66 DRIVE AXLES & DIFFERENTIALS
       <p data-bbox="350 1205 456 1230">QUESTION</p> 	<p>use threaded adjusters to adjust preload.</p> <p>96. SLIDE 96 EXPLAIN Differential Components</p> <p><b><u>DEMONSTRATION: SHOW RING AND PINION AND DEMONSTRATE THE IMPORTANCE OF PROPER DEPTH PLACEMENT OF THE PINION GEAR INTO RING GEAR.</u></b></p> <p><b><u>HYPOID RING &amp; PINION GEAR SET</u></b></p> <p><b><u>DEMONSTRATION: SHOW THREADED AND SHIMMED ADJUSTMENT FOR PRELOAD ON SIDE BEARINGS</u></b></p> <p><b><u>WHEN INSTALLING SHIMS, A COATING OF GREASE WILL HELP HOLD THEM IN PLACE.</u></b></p> <p><b><u>Adjust Carrier, Threaded Adjusters</u></b></p> <p><b><u>Adjust Carrier</u></b></p> <p><b><u>Assemble Carrier</u></b></p> <p><b><u>DISCUSSION: HOLD A DISCUSSION ON THE ADVANTAGES OR DISADVANTAGES OF THREADED OR SHIMMED PRELOAD ADJUSTMENT</u></b></p> <p><b><u>SEARCH INTERNET: HAVE THE STUDENTS SEARCH INTERNET TO RESEARCH AN ELECTRONICALLY CONTROLLED ACTIVE DIFFERENTIAL. ASK THEM TO DISCUSS ADVANTAGE OF AN ACTIVE DIFFERENTIAL, HOW IT WORKS, AND WHAT SENSORS CONTROL ITS OPERATION</u></b></p> <p>97. SLIDES 97-99 EXPLAIN Differential Axle Bearings</p> <p>100. SLIDE 100 EXPLAIN Figure 66-18 (a) axle shaft itself is the inner race if a straight roller bearing is used.</p> <p>102. SLIDE 102 EXPLAIN Figure 66-18 (b) straight roller bearings are lubricated by the rear axle fluid, and a leak at the rear axle seal can cause this fluid to get onto brake components</p> <p>103. SLIDES 103-105 EXPLAIN Differential Axle Bearings</p>

ICONS	Ch66 DRIVE AXLES & DIFFERENTIALS
 	<p><b><u>DEMONSTRATION: SHOW EXAMPLES OF AXLE SHAFTS WITH TAPERED ROLLER BEARINGS, BALL BEARINGS, AND STRAIGHT ROLLER BEARINGS: FIGURE 66-18</u></b></p> <p>106. SLIDES 106-110 EXPLAIN Differential Identification</p> <p>111. SLIDES 111-113 EXPLAIN Determining the Axle Ratio of a Differential</p>
   <p>QUESTION</p>	<p><b><u>DEMONSTRATION: SHOW HOW TO ROUGHLY DETERMINE GEAR RATIO OF A DIFFERENTIAL AS DESCRIBED IN THE TEXT.</u></b></p> <p><b><u>DISCUSSION: DISCUSS THE PROCEDURE FOR DETERMINING GEAR RATIO WITHOUT OPENING THE DIFFERENTIAL. HAVE THEM EXPLAIN WHY THIS MIGHT BE HELPFUL FOR SERVICE</u></b></p>
	<p><b><u>HANDS-ON-TASK: HAVE STUDENTS DETERMINE GEAR RATIO OF A DIFFERENTIAL WITHOUT OPENING DIFFERENTIAL. HAVE THEM COMPARE THEIR RESULT WITH THE OEM INFORMATION ON THE GEAR RATIO OF THE DIFFERENTIAL</u></b></p>
	<p><b><u>HAVE A LOCAL SHOP THAT DOES A LOT OF DIFFERENTIAL WORK SAVE OLD PARTS TO BE USED FOR DEMONSTRATION IN CLASSROOM.</u></b></p>
	<p>114. SLIDE 114 EXPLAIN Figure 66-19 The pinion gear thrust washers can be destroyed by spinning one wheel for an extended period of time</p> <p>115. SLIDE 115 EXPLAIN Differential Inspection</p> <p>116. SLIDE 116 EXPLAIN Figure 66-20 differential has obviously been leaking. If the differential lubricant is low, wear may have occurred that would require further inspection.</p> <p>117. SLIDE 117 EXPLAIN Figure 66-21 (a) Backlash is determined by mounting a dial indicator to the differential housing and placing the button of the gauge against a tooth of the ring gear. Moving the ring gear back and forth will indicate on the dial indicator the amount of backlash.</p> <p>118. SLIDE 118 EXPLAIN Figure 66-21 (b) Backlash is</p>



ICONS	Ch66 DRIVE AXLES & DIFFERENTIALS
  	<p>clearance between drive pinion and the ring gear teeth.</p> <p><b>DEMONSTRATION: SHOW THE SETUP AND PROCEDURE FOR CHECKING RING GEAR BACKLASH. EXPLAIN IMPORTANCE OF THIS READING: <u>FIGURE 66-21</u></b></p> <p><b>DISCUSSION: HOLD A DISCUSSION ON CHECKING RING GEAR BACKLASH AND WHAT IT MEANS <u>FIGURE 66-21</u></b></p> <p>119. SLIDE 119 EXPLAIN Differential Inspection</p> <p>120. SLIDE 120 EXPLAIN Figure 66-22 Ring gear runout should be less than 0.002 inch (0.05 mm) as measured by a dial indicator.</p> <p>121. SLIDE 121 EXPLAIN Differential Inspection</p>
  	<p><b>DEMONSTRATION: SHOW SET-UP AND PROCEDURE FOR CHECKING RING GEAR RUNOUT. <u>FIGURE 66-22</u></b></p> <p><b>HANDS-ON-TASK: HAVE THE STUDENTS SET UP AND TAKE RING GEAR AND BACKLASH READINGS ON SEVERAL DIFFERENTIALS.</b></p> <p>122. SLIDE 122 EXPLAIN Figure 66-23 Force has to be applied to the ring gear to achieve a proper contact pattern.</p>
   	<p><b>DEMONSTRATION: SHOW HOW TO DO A TOOTH CONTACT PATTERN TEST ON A DIFFERENTIAL BY USING EITHER IRON OXIDE COMPOUND OR WHITE LITHIUM GREASE. <u>FIGURE 66-23</u></b></p> <p><b>WHITE LITHIUM GREASE WORKS VERY WELL ON GEAR TOOTH CONTACT PATTERN TEST</b></p> <p>123. SLIDE 123 EXPLAIN Figure 66-24 The beginning automotive student did not realize that the axle housing cover could fit the wrong way. The only problem was that ring gear scraped against cover</p> <p>124. SLIDES 124-127 EXPLAIN Differential Lubricant</p> <p><b>HAVE A LOCAL SHOP THAT DOES A LOT OF DIFFERENTIAL WORK SAVE OLD PARTS THAT CAN BE USED FOR DEMONSTRATION IN CLASSROOM.</b></p>

<b>ICONS</b>	<b>Ch66 DRIVE AXLES &amp; DIFFERENTIALS</b>
	<p><b>SEARCH INTERNET: HAVE STUDENTS USE INTERNET TO RESEARCH THE BELLEVILLE SPRING. ASK THEM TO REPORT INFORMATION THAT INCLUDES INFORMATION ON THE INVENTOR AND HOW THE SPRING WORKS.</b></p>