Automotive Technology 6th Edition
Chapter 117 FRONT SUSPENSIONS & SERVICE
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. Describe different front suspension types. 2. Diagnose short/long-arm (SLA) suspension systems and Discuss strut suspension. 3. Explain how to perform a road test, a dry park test, and a Visual inspection. 4. Discuss the diagnosis of ball joints and kingpins. 5. Discuss the diagnosis of shock absorbers and struts. 6. Describe how to replace MacPherson struts. 7. Explain the diagnosis of stabilizer bar links and bushings. 8. Discuss the diagnosis of strut rod bushings, front coil springs, steering knuckles, torsion bars, and control arm bushings. 9. This chapter will help prepare for ASE Suspension and Steering (A4) certification content area "B" (Suspension System Diagnosis and Repair).
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

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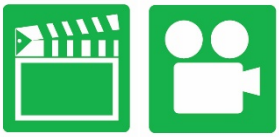
http://www.jameshalderman.com/automotive_principles.html

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

ICONS	Chapter 117 Front Suspension
	**1. SLIDE 1 CH117 FRONT SUSPENSIONS & SERVICE**
	**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**
	**Short/Long Arm Suspension (View) (Download)** **Strut Suspension (View) (Download)** **Spring and Shock Absorber (View) (Download)** **Suspension Components (View) (Download)**
	**2. SLIDE 2 EXPLAIN Figure 117-1** Most early vehicles used single straight axles. **3. SLIDE 3 EXPLAIN Figure 117-2** Typical kingpin used with a solid axle.
	**DISCUSSION: Ask the students to discuss why an automobile would use a solid-axle front suspension.**
	**DEMONSTRATION: Show the students examples of kingpins used with a solid axle.**
	**4. SLIDE 4 EXPLAIN Figure 117-3** Twin I-beam front suspension. Rubber bushings are used to support the I-beams to the frame and help isolate road noise
	**EXPLAIN TECH TIP: *Radius Rod Bushing Noise*** **When radius rod bushing on a Ford truck or van deteriorates, most common complaint from driver is noise. • SEE FIGURE 117–4. Besides causing tire wear, worn or defective radius rod bushing can cause following:**

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	1. **Clicking sound when braking (it sounds as if brake caliper may be loose).** 2. **Clunking noise when hitting bumps. When the bushing deteriorates, the axles move forward and backward with less control. Noise is the first sign that something is wrong. Without proper axle support, handling and cornering can also be affected.**
	5. **SLIDE 5 EXPLAIN Figure 117-4** rubber radius rod bushing absorbs road shocks and helps isolate road noise 6. **SLIDE 6 EXPLAIN Figure 117-5** Upper control arm is shorter than lower control arm on a short/long-arm (SLA) suspension. 7. **SLIDE 7 EXPLAIN Figure 117-6** A typical SLA front suspension using coil springs. 8. **SLIDE 8 EXPLAIN Figure 117-7** SLA-type suspension with the coil spring placed on top of the upper control arm. 9. **SLIDE 9 EXPLAIN Figure 113-8** torsion bar SLA suspension can use either the lower or upper control arm.
	**DISCUSSION: Discuss what causes radius rod bushing to deteriorate.**
	DISCUSS FREQUENTLY ASKED QUESTION: ***What Is a Coil-Over-Shock Suspension?*** **In some applications, spring and shock absorber are combined to fit within the upper and lower A-arms. This makes for a simple and lightweight front-type suspension and is used in a variety of vehicles including light pickup trucks. • SEE FIGURE 117–9.**
	10. **SLIDE 10 EXPLAIN Figure 117-9** A typical MacPherson strut showing all of the components of the assembly. A strut includes the shock and the spring in one structural assembly. 11. **SLIDE 11 EXPLAIN Figure 117-10** The modified strut front suspension is similar to a MacPherson strut suspension except that the coil spring is seated on the lower control arm and is not part of the strut assembly.

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	12. **SLIDE 12 EXPLAIN Figure 117-11** Multilink front suspension design varies depending on the vehicle manufacturer. **DISCUSS FREQUENTLY ASKED QUESTION: *What Is a HiPer Strut™?* Some 2012 and newer GM vehicles use a type of strut that uses an upper ball joint as a steering pivot rather than the top of strut. The advantage of HiPer Strut™ front suspension over MacPherson-type wheel suspension is a shorter wheel spindle length.** **• SEE FIGURE 117–12. The advantages of this design compared to conventional MacPherson strut include:** • **Reduced torque steer** • **Improved impact isolation on bumps and rough surfaces** • **Enables the use of bigger wheels** • **Allows camber adjustment with screws on the steering knuckle upper ball stud**
	13. **SLIDE 13 EXPLAIN FIGURE 117–12 HiPer Strut** (left) compared to traditional MacPherson strut (right). 14. **SLIDE 14 EXPLAIN FIGURE 117–13** A typical multilink front suspension system.
	**DISCUSS CHART 117-1 Suspension Problem Symptom and possible causes.**
	**HANDS-ON TASK: Have students label parts of MacPherson strut suspension using sticky notes.**
	**DEMONSTRATION: Show bearing from an upper strut mount**
	**DISCUSSION: Ask the students to discuss what customer complaints will be if the bearing in the upper strut mount goes bad**

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	**DISCUSSION:** Ask the students to discuss and describe noises made by defective wheel bearings and defective ball joints.
	**DISCUSSION: D**iscuss why it is recommended to have owner of the vehicle drive the vehicle when conducting a **ROAD TEST DIAGNOSIS**
	**ON-VEHICLE ASEEDUCATION TASK A2:** Identify and interpret suspension and steering system concerns; determine needed action.
	
	**ON-VEHICLE ASEEDUCATION TASK C1:** Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine needed action.
	
	**ON-VEHICLE ASEEDUCATION TASK C2:** Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine needed action.
	
	**EXPLAIN TECH TIP:** ***Road Test—Before and After*** **Many times, technicians will start to work on a vehicle based on description of problem by driver or owner. A typical conversation was overheard where the vehicle owner complained that vehicle handled "funny," especially when turning. The owner wanted a wheel alignment, and technician and shop owner wanted business. The vehicle was aligned, but problem was still present. The real problem was a defective tire. The service technician should have road-tested vehicle before any service work was done to confirm problem and try to determine its cause. Every technician should test-drive vehicle after any service work is performed to confirm that service work was performed correctly and that customer complaint has been resolved.** **This is especially true for any service work involving steering, suspension, or braking systems.**

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	**15. SLIDE 15 EXPLAIN Figure 117-14** A leaking strut. Either a cartridge insert or the entire strut will require replacement. If a light film of oil is seen, this is to be considered normal. If oil is dripping, then this means that the rod seal has failed. **16. SLIDE 16 EXPLAIN Figure 117-15** This front coil spring looks as if it has been heated with a torch in an attempt to lower the ride height of the vehicle. Both front springs will require replacement.
	**DISCUSSION: Discuss why it is recommended that both front springs in Figure 117–15 be replaced**
	**17. SLIDE 17 EXPLAIN Figure 117-16** It is easy to see that this worn control arm bushing needed to be replaced. The new bushing is shown next to the original.
	**DEMONSTRATION: Show examples of control arm bushings**
	**18. SLIDE 18 EXPLAIN Figure 117-17** Grease fitting projecting down from the surrounding area of a ball joint. The ball joint should be replaced when the area around the grease fitting is flush or recessed. **19. SLIDE 19 EXPLAIN FIGURE 117–18** Indicator ball joints should be checked with weight of vehicle on ground. **20. SLIDE 20 EXPLAIN Figure 117-19** dial indicator used to measure the suspension component movement **21. SLIDE 21 EXPLAIN Figure 117-20** If the spring is attached to the lower control arm as in this SLA suspension, the jack should be placed under the lower control arm as shown. A dial indicator should be used to measure the amount of freeplay in the ball joints. Be sure that the looseness being measured is not due to normal wheel bearing endplay. **22. SLIDE 22 EXPLAIN FIGURE 117-21** jack should be placed under the lower control arm of this modified MacPherson-type suspension. **23. SLIDE 23 EXPLAIN FIGURE 117–22** If spring is attached to the upper control arm, jack should be placed under the frame to check for ball joint wear**.**
	

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	**DEMONSTRATION:** Show examples of new & worn ball joints. Show how to use a dial indicator with locking pliers mount to measure suspension component movement: **FIGURES 117-18, 19** **HANDS-ON TASK:** Have students measure suspension component movement using a dial indicator
	
	24. **SLIDE 24 EXPLAIN FIGURE 117–23** special tool or a block of wood should be inserted between frame and upper control arm before lifting vehicle off ground. This tool stops force of spring against upper ball joint so that a true test can be performed on condition of ball joint.
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***What Is the Difference Between a Low-Friction Ball Joint and a Steel-on-Steel Ball Joint?*** **Before late 80s, most ball joints were constructed with steel ball that rubbed on a steel socket. This design created friction and provided for a tight high-friction joint until wear caused looseness in joint. Newer designs use a polished steel ball that is installed in a hard plastic polymer, resulting in a low-friction joint assembly. Because of difference in friction characteristics, vehicle may handle differently than originally designed if incorrect-style ball joints are installed. Most component OEMS state that low-friction ball joints in a vehicle originally equipped with steel-on-steel high-friction ball joints are usually acceptable, but high friction replacement ball joints should be avoided on a vehicle originally equipped with low-friction ball joints.**
	25. **SLIDE 25 EXPLAIN FIGURE 117–24** jacking point is under frame for checking play of a lower ball joint used with a MacPherson strut.

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	26. SLIDE 26 EXPLAIN FIGURE 117–25 This worn and rusty ball joint was found moving wheel and looking for movement in the joint. **27. SLIDE 27 EXPLAIN FIGURE 117–26** Taper breaker tool being used to separate upper ball joint from the steering knuckle. This is especially important for vehicles equipped with aluminum alloy control arms. **28. SLIDE 28 EXPLAIN FIGURE 117–27** A pinch bolt attaches the steering knuckle to ball joint. Remove pinch bolt by turning the nut, not bolt. **29. SLIDE 29 EXPLAIN FIGURE 117-28** If pinch bolt is overtightened, the steering knuckle can be deformed. A deformed knuckle can cause the pinch bolt to break and the ball joint could become separated from the steering knuckle. **30. SLIDE 30 EXPLAIN FIGURE 117-29** By drilling into the rivet, the holding force is released.
	**DEMONSTRATION: Show the students Examples of taper breaker tools**
	**DEMONSTRATION: Show the students how to use a torque wrench to torque fasteners to factory specifications.**
	**HANDS-ON TASK: Have students torque lug nuts to factory specifications by using torque wrenches.**
	**31. SLIDE 31 EXPLAIN Figure 117-30** The head of the rivet can be removed by using a larger-diameter drill bit as shown. **32. SLIDE 32 EXPLAIN Figure 117-31** Using a punch and a hammer to remove the rivet after drilling down through the center and removing the head of the rivet. **33. SLIDE 33 EXPLAIN Figure 117-32** Press-in ball joints are best removed using a large C-clamp press, as shown.
	**DEMONSTRATION: Show examples of tools needed for replacing and installing ball joints.**

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    	**It's a good idea to include ball joint removal tools, such as a ball joint removal socket or ball joint service kit, in your toolkit.** **DEMONSTRATION: Show the students how to remove a press-in ball joint by using a C-clamp press: SEE FIGURE 117-32** **ON-VEHICLE ASEEDUCATION TASK C5: Inspect, remove, and/or replace upper and/or lower ball joints (with or without wear indicators)** **DISCUSS CASE STUDY: *The Rattle Story*:** **A customer complained that a rattle was heard every time vehicle hit a bump. The noise sounded as if it came from rear. All parts of the exhaust system and suspension system were checked. Everything seemed okay until vehicle was raised with a frame-type hoist instead of a drive-on type. Then, whenever right rear wheel was lifted, noise occurred. The problem was a worn (elongated) shock absorber mounting hole. A washer with proper-size hole was welded over worn lower frame mount and shock absorber was bolted back into place.** **Summary:** • **Complaint—Vehicle owner complained of a rattle sound from the rear suspension at times.** • **Cause—lower shock mount was found to be worn (elongated) causing the noise.** • **Correction—steel washer was welded over the worn lower frame mount which restored the shock mount to the correct size and solved the noise issue.**

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	**34. SLIDE 34 EXPLAIN Figure 117-33** Typical kingpin assembly. **35. SLIDE 35 EXPLAIN Figure 117-34** Driving a kingpin out with a hammer. **36. SLIDE 36 EXPLAIN FIGURE 117–35** A kingpin being removed showing the worn bushing..
	**Some kingpins can be removed only by removing one knuckle cap (usually lower one), and using a grease gun. Pumping grease into upper end of kingpin bore will force kingpin out bottom.**
	**DISCUSSION: Discuss cuppy tire wear and possible causes for it. Have the students discuss how the condition of shocks and shock mounts can indicate how the vehicle is driven.**
	**37. SLIDE 37 EXPLAIN FIGURE 117–36** Most shock absorbers used on the front suspension can be removed from underneath the vehicle after removing the attaching bolts or nuts.
	**ON-VEHICLE ASEEDUCATION TASK D1: Inspect, remove, and/or replace shock absorbers; inspect mounts and bushings.**
	
	**New shocks are stored flat. Before installing new shocks, compress & extend them several times.**
	**ON-VEHICLE ASEEDUCATION TASK: C4. Inspect, remove, and/or replace strut rods and bushings.**
	
	**38. SLIDE 38 EXPLAIN Figure 117-37** Removing the upper strut mounting bolts. Some experts recommend leaving one of the upper strut mount nuts loosely attached to prevent the strut from falling when the lower attaching bolts are removed. **39. SLIDE 39 EXPLAIN Figure 117-38** A brake hydraulic hose is often attached to the strut housing. Sometimes all that is required to separate the line from the strut is to remove a spring clip.

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	40. **SLIDE 40 EXPLAIN Figure 117-39** Use a strut spring compressor fixture to compress the spring on a MacPherson strut before removing strut retaining nut. 41. **SLIDE 41 EXPLAIN Figure 117-40** Removing the strut rod nut. The strut shaft is being helped with one wrench while the nut is being removed with the other wrench. Notice that spring is compressed before nut is removed. 42. **SLIDE 42 EXPLAIN Figure 117-41** Typical MacPherson strut showing the various components. 43. **SLIDE 43 EXPLAIN Figure 117-42** After installing the replacement strut cartridge, reinstall the spring and upper bearing assembly after compressing spring. Notice that strut is being held in a strut spring compressor fixture**.** 44. **SLIDE 44 EXPLAIN Figure 117-43** Before final assembly, make sure the marks you made are aligned. Some struts are manufactured with marks to ensure proper reassembly. 45. **SLIDE 45 EXPLAIN Figure 117-44** strut on a modified MacPherson strut assembly can be replaced by removing the upper mounting nuts
	**DEMONSTRATION: Show examples of strut spring compressor fixtures and manual spring compressors.**
	**ON-VEHICLE ASEEDUCATION TASK: C10. Inspect, remove, and/or replace strut cartridge or assembly, strut coil spring, insulators (silencers), and upper strut bearing mount.**
	
	46. **SLIDE 46 EXPLAIN Figure 117-45** Stabilizer bar links should be replaced as a pair.
	**DISCUSSION: Ask the students to discuss why not all manufacturers recommend, as GM does, replacing stabilizer links in pairs and purchasing 2 kits so you can replace links on both left and right sides at same time: FIGURE 117-45**

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  Education Foundation     Education Foundation  	**ON-VEHICLE ASEEDUCATION TASK: C9.** **Inspect, remove, and/or replace front/rear stabilizer bar (sway bar) bushings, brackets, and links.** 47. **SLIDE 47 EXPLAIN FIGURE 117-46** A strut rod as viewed from the front of the vehicle. 48. **SLIDE 48 EXPLAIN FIGURE 117-47** Typical strut rod bushing with rubber on both sides of the frame to help isolate noise, vibration, and harshness from being transferred to the passengers. **DEMONSTRATION:** Show the students how to correctly remove strut rod nuts by using two wrenches **ON-VEHICLE ASEEDUCATION TASK C11:** **Inspect, remove, and/or replace track bar, strut rods/radius arms, and related mounts and bushings.** 49. **SLIDE 49 EXPLAIN Figure 117-48** if front coil springs are sagging, the resulting angle of the lower control arm causes the wheels to move from side to side as the suspension moves up and down. Note difference between the distance at "A" with good springs and the distance at "B" with sagging springs. 50. **SLIDE 50 EXPLAIN FIGURE 117–49** spring compressor is required by most vehicle OEMS to be used whenever disassembling a coil spring suspension system. **SAFETY Always pay attention to spring when it is being removed.** **DISCUSS CASE STUDY: *The Rock-Hard Problem*** **The owner of a six-month-old full-size pickup truck complained that occasionally when the truck was driven up into a driveway, a loud grinding sound was heard. Several technicians worked on truck, trying to find cause for noise. After left front shock absorber was replaced, noise did not occur for two weeks and then**

started again. Finally, service manager told technician to replace anything and everything in front suspension in an attempt to solve customer's intermittent problem. Five minutes later, a technician handed service manager a small, deformed rock. This technician had taken a few minutes to carefully inspect entire front suspension. Around bottom coil spring seat, technician found rock. Apparently, when truck made a turn over a bump, rock was forced between coils of coil spring, making a very loud grinding noise. But rock did not always get between coils. Therefore, problem occurred only once in a while. Technician handed rock to the very happy customer.

Summary:

- **Complaint—Vehicle owner complained of loud grinding sound from the front suspension at times.**
- **Cause—rock was found at bottom of coil spring seat.**
- **Correction—rock was removed.**

51. **SLIDE 51 EXPLAIN FIGURE 117–50** A spring compressor is required by most vehicle OEMS to be used whenever disassembling a coil spring suspension system.
52. **SLIDE 52 EXPLAIN Figure 117-51** rubber mallet is being used to support the upper control arm as the lower control is being lowered using a floor jack. After all of the tension has been removed from the coil spring it can be removed and the replacement installed.
53. **SLIDE 53 EXPLAIN Figure 117-52** Spring insulators install between the spring seat and the coil spring to reduce noise.
54. **SLIDE 54 EXPLAIN Figure 117-53** The holes in the lower arm are not only used to allow water to drain from the spring seat, but also are used as a gauge to show the service technician that the coil spring is correctly seated.

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DEMO	**DEMONSTRATION: Show examples of steering knuckles**
	ON-VEHICLE ASEEDUCATION TASK C6:. Inspect, remove, and/or replace steering knuckle assemblies.
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	ON-VEHICLE ASEEDUCATION TASK C7: Inspect, remove and/or replace short and long arm suspension system coil springs and spring insulators.
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	55. **SLIDE 55 EXPLAIN Figure 117-54** By rotating the adjusting bolt, the vehicle can be raised or lowered. 56. **SLIDE 56 EXPLAIN Figure 117-55** adapter and a press or large clamp are used to remove the old bushing from the control arm and to install a new bushing.
DEMO	**DEMONSTRATION: remove, and/or replace upper and lower control arms, bushings, shafts, and rebound bumpers**
	ON-VEHICLE ASEEDUCATION TASK C3: Inspect, remove, and/or replace upper and lower control arms, bushings, shafts, and rebound bumpers.
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DEMO	**DEMONSTRATION: Show the students how to use a torsion bar unloading tool: FIGURE 117-54**
	ON-VEHICLE ASEEDUCATION TASK C8: Inspect, remove, and/or replace torsion bars and mounts
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	56. **SLIDES 56-76 OPTIONAL EXPLAIN STRUT REPLACEMENT**

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	**SEARCH INTERNET: Have students use Internet for spring materials other than spring steel. Have students share their findings during the next class.**